Environment Canada Environnement Canada

Strategic Options for the Management of Toxic Substances - Dichloromethane

Report of Stakeholder Consultations

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Background

The Ministers of Environment and Health committed to consult stakeholders following their announcement of the results from the assessment of substances found toxic in the first Priority Substances List, pursuant to the *Canadian Environmental Protection Act* (CEPA). To ensure that the most effective and efficient environmental management options would be addressed, within the context of pollution prevention and sustainable development, the Strategic Options Process was developed with Environment and Health Canada as the key partners. This consultative mechanism provided the basis for recommendations to the accountable ministers.

Disclaimer

This report on stakeholder consultations is published by Environment Canada and Health Canada. It presents the results of the consultations, requested by the Minister of Environment and the Minister of Health regarding management options for the substances assessed as toxic under CEPA, in this case, dichloromethane.

Publication of this report does not constitute approval by the Ministers of Environment and Health of all its contents.

Canada

Acknowledgement

The Chair of this Issue Table would like to extend appreciation to all the members, corresponding members and other stakeholders that participated in the development and review of this report.

Executive Summary

Recommendations

Dichloromethane, also known as methylene chloride, is a versatile solvent used in a wide range of industrial process applications as well as being the active chemical in paint stripping and cleaning formulations. The substance was assessed as toxic pursuant to Sections 11(a) and 11(c) of the *Canadian Environmental Protection Act*, based on its potential to cause harm to the environment and to human health. The most recent estimate is that about 7,400 tonnes were used in 1995, of which about 6,300 tonnes were emitted.

An Issue Table, consisting of government, industry and environmental interest groups, was established to consider how dichloromethane should be managed in Canada. At an early stage in the their deliberations, participants considered the merits of a number of broad management options, several of which were subsequently subjected to a detailed economic analysis. Important elements of them are to be found in the following recommendations.

The recommendations are broadly supported by the members of the Issue Table. If fully implemented, these actions will result in reducing emissions of dichloromethane about 50 % from about 6,300 tonnes to about 3,100 tonnes.

1. Aircraft paint stripping application

- *1.1 Existing facilities should voluntarily commit to reduce annual emissions 50 % effective January 1, 2002 and 80 % effective January 1, 2006.*

  Emissions would **decrease to about 80 tonnes by 2002 and to about 35 tonnes by 2006** from about 160 tonnes emitted and 200 tonnes used in 1995.

- *1.2 Existing facilities should be mandated to reduce annual emissions 50 % and 80 % effective January 1, 2003 and January 1, 2007 respectively if voluntary actions do not attain these reduction goals.*

- *1.3 New facilities constructed after January 1, 2000 should be mandated to achieve 90 % emission control.*

- *1.4 Facilities that are presently not participating should commit to and participate in Environment Canada's program on Accelerated Reductions and Elimination of Toxics* (ARET).

The representative of Air Canada has indicated intent to participate in the ARET program.

- *1.5 Facilities that are currently exempted from annual reporting should commit to report dichloromethane to the National Pollutant Release Inventory* (NPRI).

  This reporting mechanism will allow tracking of progress in annual dichloromethane use and environmental releases. For NPRI-exempted facilities that participate in the ARET program, reporting to the NPRI would not be needed.

- *1.6 The appropriate government departments should disseminate information to the aircraft paint stripping facilities on research activities on alternate solvents and paint stripping technologies to enhance awareness of technology developments in this regard.*

2. Consumer paint stripping application

- *2.1 Paint stripping formulations containing dichloromethane sold for consumer use should be labeled to inform consumers of the chronic toxicity and potential carcinogenicity associated with human exposure when these products are improperly used. Labeling should be implemented when future labeling requirements for chronic and sub-chronic toxicity are adopted under the Hazardous Products Act.*

  Changes in use patterns among consumers resulting from labeling is expected to **decrease use and emissions 20 % to about 960 tonnes** from the 1200 tonnes of dichloromethane contained in paint stripping formulations in 1995.

  Chronic and sub-chronic toxicity criteria, currently under negotiation by representatives of member states to the Organization for Economic Cooperation and Development, are to be globally harmonized in the 1999-2000 time frame.

- *2.2 If a labeling program is not implemented through the Consumer Chemicals and Containers Regulations, the program should be implemented pursuant to the Canadian Environmental Protection Act, effective January 1, 2000.*

  The industry representatives oppose container labeling if it were applied only to dichloromethane-containing products.

- *2.3 Environment Canada and Health Canada should prepare an information pamphlet to inform consumers about the hazards of the various types of paint strippers and the general safety precautions to be taken when using these products.*

3. Commercial paint stripping application

- *3.1 Work practices guidelines should be developed by 2000 for the safe handling, storage, and use of dichloromethane-based paint strippers in the commercial furniture refinishing and other stripping applications.*

  Good work practices are able to conserve solvent use and minimize environmental releases, resulting in an estimated 20 % solvent use reduction, principally in furniture stripping applications. Dichloromethane emissions would **decrease to about 720 tonnes** from 1,000 tonnes of solvent used and 900 tonnes emitted in 1995. The Halogenated Solvents Industry Alliance has indicated its willingness to assist with developing and distributing these guidelines.

4. Flexible polyurethane foam blowing application

- *4.1 Companies with existing facilities should commit voluntarily to reduce annual process emissions of dichloromethane 50 % effective January 1, 2002.*

  These actions will reduce emissions of dichloromethane associated with its use as an auxiliary blowing agent, as well as the small quantities of solvent used for equipment cleaning, **to about 650 tonnes** from 1,300 tonnes used and emitted in 1995. The Canadian Flexible Foam Manufacturers Association supports this reduction goal, which is to be attained by the member companies of the Association as well as non-member companies.

This recommendation is intended to apply as a kind of bubble reduction target in the situation where a company owns or operates more than one facility thereby providing flexibility to choose the optimum mix of reductions among its individual facilities.

- *4.2 Existing facilities should be mandated to reduce annual emissions 50 % effective January 1, 2003 if voluntary actions do not attain this reduction goal.*

- *4.3 Existing facilities should eliminate dichloromethane as an auxiliary blowing agent in the manufacture of flexible polyurethane foam by 2007.*

- *4.4 Facilities should commit to and participate in Environment Canada's program on Accelerated Reductions and Elimination of Toxics* (ARET).

  The Association supports this recommendation. Its member companies as well as non-member companies have committed to register with this program.

- *4.5 Facilities that are currently exempted from annual reporting should commit to and report dichloromethane to the National Pollutant Release Inventory* (NPRI).

  This reporting mechanism will allow tracking of progress in annual dichloromethane use and environmental releases. For NPRI-exempted facilities that participate in the ARET program, reporting to the NPRI would not be needed.

- *4.6 New facilities constructed after January 1, 2000 that use dichloromethane as an auxiliary blowing agent in the manufacture of flexible polyurethane foam should be mandated to achieve a process emission performance that would be equivalent to 90 % emission control applied to a conventional dichloromethane foam production process.*

  This interim provision is intended to allow the use of a nominal quantity of dichloromethane in the foam production process, particularly in the production of specialty foams, for which the carbon dioxide process is not fully proven to the extent where dichloromethane can be entirely replaced.

5. Pharmaceutical and chemical intermediates applications

- *5.1 Existing facilities that use dichloromethane in tablet coating processes should voluntarily commit to reduce annual dichloromethane emissions 90 % or install control technology with 90 % capture efficiency, effective January 1, 2002.*

  These actions would **reduce annual emissions to about 60 tonnes** from about 600 tonnes used and emitted in 1995.

- *5.2 Existing facilities should be mandated to achieve 90 % emission control effective January 1, 2003 if voluntary actions do not attain this goal.*

- *5.3 New facilities or production lines constructed after January 1, 2000 that use dichloromethane in the manufacture of pharmaceutical chemicals, other chemical intermediates and in tablet coating should be mandated to achieve 90 % emission control.*

- *5.4 Facilities should commit to and participate in Environment Canada's program on Accelerated Reductions and Elimination of Toxics* (ARET).

  All companies support voluntary action and participation in the ARET program with the exception of one company that prefers not to participate in the ARET program.

- *5.5 Facilities that are currently exempted from annual reporting should commit to report on dichloromethane to the National Pollutant Release Inventory* (NPRI).

  This reporting mechanism will allow tracking of progress in annual dichloromethane use and environmental releases. For NPRI-exempted facilities that participate in the ARET program, reporting to the NPRI would not be needed.

- *5.6 No further environmental controls are deemed necessary for existing facilities that manufacture chemical intermediates because current process controls capture about 90 % of the emissions.*

  In 1995, dichloromethane use in this sector was about 300 tonnes and emissions were about 30 tonnes.

6. Adhesives application

- *6.1 Manufacturers should voluntarily commit to reduce the dichloromethane content in adhesive products formulated in Canada 70 % effective January 1, 2002.*

  These actions would **reduce annual emissions to about 240 tonnes** from about 800 tonnes used in domestically manufactured products in 1995.

  The Adhesives and Sealants Manufacturers Association of Canada has indicated that its member companies as well as non-member companies support this goal.

- *6.2 Manufacturers should be mandated to achieve a 70 % emission reduction in DCM use January 1, 2003 if voluntary actions do not attain this goal.*

  It is anticipated that the solvent reductions, if it becomes necessary to mandate these, would be implemented in the form of limits on the DCM content in adhesives.

- *6.3 Facilities should commit to and participate in Environment Canada's program on Accelerated Reductions and Elimination of Toxics* (ARET).

  The Association supports this recommendation. Member companies as well as non-member companies of the Association intend to register with the ARET program before the end of 1998.

- *6.4 Facilities that are currently exempted from annual reporting should commit to report dichloromethane to the National Pollutant Release Inventory* (NPRI).

  This reporting mechanism will allow tracking of progress in annual DCM use and environmental releases. For NPRI-exempted facilities that participate in the ARET program, reporting to the NPRI would not be needed.

- *6.5 Government should apply the same restrictions on imported dichloromethane-based adhesive products as those made to apply to domestically manufactured products if imported dichloromethane-based products exceed the 1995 imports.*

  About 200 tonnes of dichloromethane were contained in imported products in 1995. The Association is concerned that unfair competitive advantages may arise in the domestic market if future imports of dichloromethane-based adhesives increase.

7. Cleaning applications

- *7.1 Dichloromethane-containing cleaning products and aerosol paint products sold in Canada for consumer use should be labeled to inform consumers of the chronic toxicity and potential carcinogenicity associated with human exposure when improperly used. The labeling requirement should be made effective at a date consistent with the labeling of consumer paint stripping products.*

- *7.2 Existing facilities that use more than 10 tonnes of dichloromethane annually should voluntarily commit to reduce annual emissions 50 % effective January 1, 2003.*

  Dichloromethane use would decrease to about 270 tonnes from 600 tonnes. Emissions would **decrease to about 130 tonnes** annually from about 300 tonnes in 1995 among these eleven facilities.

- *7.3 Existing facilities that use more than 10 tonnes of dichloromethane annually should be mandated to achieve 50 % emission control effective January 1, 2004 if voluntary actions do not attain this goal.*

- *7.4 New facilities that use dichloromethane in any cleaning applications in a quantity greater than 5 tonnes annually constructed after January 1, 2000 should be mandated to require 80 % emission control.*

- *7.5 All facilities should commit to and participate in Environment Canada's program on Accelerated Reductions and Elimination of Toxics* (ARET).

- *7.6 Existing facilities that use dichloromethane for cleaning the mixing chamber of low-pressure reaction-injection molding machines should voluntarily commit to eliminate this use effective January 1, 2007 by converting to high-pressure machines.*

  These actions would **substantially eliminate the emissions** of dichloromethane. Solvent usage for cleaning injection molding machines was about 150 tonnes in 1995 and emissions were about 50 tonnes.

- *7.7 New reaction-injection molding machines used in the production of molded polyurethane foam purchased after January 1, 2000 should be mandated to be of the high-pressure type that minimize the need for cleaning with dichloromethane.*

- *7.8 Facilities that are currently exempted from annual reporting should commit to report dichloromethane to the National Pollutant Release Inventory* (NPRI).

  This reporting mechanism will allow tracking of progress in annual dichloromethane use and environmental releases. For NPRI-exempted facilities that participate in the ARET program, reporting to the NPRI would not be needed.

8. Laboratories application

- *8.1 No further environmental controls are required because current laboratory practices capture about 95 % of the dichloromethane emissions.*

  Emissions were about 15 tonnes of the 300 tonnes used in 1995.

9. Aerosols application

- *9.1 Dichloromethane-containing aerosol products sold in Canada for consumer use should be labeled to inform consumers of the chronic toxicity and potential carcinogenicity associated with human exposure when improperly used. The labeling requirement should be made effective at a date consistent with the labeling of consumer paint strippers.*

  Changes in use patterns among consumers resulting from labeling is expected to result in some conservation of solvent, comparable to the 20 % decrease associated with labeling of consumer paint strippers.

- *9.2 Existing and new consumer pesticide products that contain dichloromethane should not be registered under the Pest Control Products Act effective January 1, 2000.*

  This action would eliminate about 20 tonnes of dichloromethane used in pesticide aerosol containers in 1995.

  Dichloromethane emissions, as a result of Recommendations 9.1 and 9.2, would **decrease to about 60 tonnes** from about 100 tonnes contained in consumer products in 1995.

- *9.3 No control measures are considered necessary for dichloromethane-based products used in commercial and industrial applications since material safety information is prescribed by workplace legislation.*

  About 100 tonnes of dichloromethane were used in commercial products in 1995.

10. General recommendations

- *10.1 Scientific assessments of the environmental and human health toxicity of non-dichloromethane paint stripping solvents should be undertaken. Information from these assessments is necessary before actions to eliminate dichloromethane in paint strippers can be considered.*

- *10.2 The annual quantities of dichloromethane imported as a commodity as well as in formulated products should be tracked.*

Analysis

The emission reductions to be attained in future years according to the preceding recommendations are based on emissions that are referenced to the quantity of dichloromethane used in 1995. Accordingly, they represent reductions to be attained through solvent conservation, replacing dichloromethane with alternate solvents or adding emission controls. The reduction targets are not intended to cap the use of dichloromethane at each facility, which in some cases would have the effect of precluding facilities from expanding their production.

About 8,500 tonnes of dichloromethane were imported to Canada in 1995, largely by three foreign producers. This included about 7,500 tonnes as neat dichloromethane, 600 tonnes contained in formulated products and 400 tonnes as recycled solvent.

Direct exports of about 1,000 tonnes of neat dichloromethane and about 200 tonnes in formulated products resulted in the estimate of about 7,400 tonnes used domestically. Environmental releases to the atmosphere are estimated at about 6,300 tonnes or 85 % of the total quantity used.

The industry stakeholders maintain that virtually all paint stripping solvents pose some type of health, safety or environmental risk. The lack of relative risk information and the lack of scientific information on the toxicity of alternative solvents were raised as barriers if the federal government were to consider phasing out dichloromethane in a number of applications, most particularly for consumer paint stripping products.

According to the industry stakeholders, new published scientific information indicate that dichloromethane does not pose a cancer risk to humans and may in fact pose less harm, if properly used, than alternative solvents for which scientific information is not as extensive. A report by the U.S Environmental Protection Agency has concluded that n-methyl pyrrolidone, an alternative solvent in some applications, poses reproductive and developmental risks to exposed individuals. The industry representatives asked that these considerations be taken into account before the Departments of Environment and Health prohibit or consider further limits on the use of dichloromethane.

The manufacturers of consumer paint stripping products expressed concern also over the marketing practices of some alternative solvent suppliers who promote their products as safe. Industry believes these claims are unsubstantiated by incomplete toxicology information. For these reasons the industry stakeholders viewed as inequitable the recommendation on hazard labeling of consumer products containing dichloromethane, unless labeling also were made to apply to the alternative solvents.

The member organizations of the Canadian Environmental Network, although supportive of the technical recommendations, would prefer government to adopt the general strategy to reduce chemical use in commerce rather controlling environmental releases. As a general principle, they also do not support voluntary non-regulatory actions left to the discretion of industry as these will not guarantee public health protection. In regards to the commercial paint stripping sector - a large user of solvent, the Canadian Environmental Network consider the recommendations as not going far enough and would prefer that measures be taken to reduce solvent use in this application.

Economic impacts of the recommendations

Environment Canada analyzed the cost impacts from the preceding recommendations on revenues and profits within the broad product or services markets of the respective sectors in which dichloromethane is used.

The cost of the proposed reductions of dichloromethane in the aircraft paint stripping sector would be negligible in relation to total revenues of the airline industry in 1995. The environmental control costs based on alternative solvents would add about 1 % and 2 % respectively to the reported losses in 1995 to achieve 50 % and 80 % emission reductions. It is to be expected that the cost impact on individual airline companies and particularly on small aircraft maintenance firms could vary significantly. This will depend on their ability to adjust to alternate solvents in combination with the proposed allowance to retain the use of a small quantity of dichloromethane solvent. Some facilities may choose to retain dichloromethane solvent by installing emission controls, a substantially more costly option than solvent substitution.

The costs of container labeling and attendant consumer education programs incurred by the manufacturers of paint stripping and aerosol consumer products would account for about 2 % and 5 % respectively of the 1995 sales determined for these two sectors. These costs would represent about 23 % and 72 % of the respective sector profits. When the labeling program costs are applied to the revenues and profits against the broader market of varnishes and paints sales, the impact would be less than about 0.2 % of profits. The impact would vary widely among individual companies and would be felt particularly by companies that manufacture only dichloromethane-based products.

The implementation of best work practices by the small commercial paint stripping facilities would have nominal impacts. Compliance costs would be negligible in relation to revenues and would affect profits about 5 %.

Emission reductions of 50 % as the intermediate goal for the flexible polyurethane foam sector would account for less than about 0.5 % of revenues and about 5 % of profits when the costs are applied to the aggregate revenues of the foam and plastics market. When the costs are applied to the portion of the estimated product sales associated with dichloromethane-manufactured foams, which account for about 35 % of all foams produced, the impacts would be about 1 % and 13 % respectively. The costs to convert to non-dichloromethane manufacturing processes as the long term goal would account for about 22 % of the estimated profits associated with foam products made with dichloromethane.

The control costs associated with the proposed 90 % reduction of dichloromethane in the pharmaceutical sector would comprise less than 0.5 % of the total profits in the pharmaceuticals and medicines market in 1995. The cost impacts in broad terms would be negligible when total sales of all products are considered. It was not possible for Environment Canada to determine the cost impacts on the portion of the revenues and profits associated with products that use dichloromethane tablet coating processes.

The proposed 70 % reduction in dichloromethane used to formulate adhesives would incur costs of about 2 % of total revenues and about 25 % of total profits associated with the general adhesives market. This cost impact would be significant as the manufacturers adjust to non-dichloromethane adhesive formulations, particularly for one company that presently manufacturers only dichloromethane-based adhesives.

It was not possible to evaluate the cost impacts to achieve the proposed 50 % emission reduction in cleaning applications at facilities that use more than ten tonnes of dichloromethane annually. Eleven facilities fall into this size category. It is noted, however, that when contacted by Environment Canada in the fall of 1997, all but one facility had replaced or planned to replace dichloromethane with alternative solvents.

1. Introduction

1.1 Context

Dichloromethane (DCM), also known as methylene chloride, was assessed as toxic pursuant to Sections 11(a) and 11(c) of the *Canadian Environmental Protection Act* (CEPA). According to Section 11(a) of the Act, a substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment. Under Section 11(c) a substance is toxic if it constitutes or may constitute a danger to human life or health.

The management of toxic substances is guided by the federal government's *Toxic Substances Management Policy* (TSMP), which was published in 1995. The key objectives of this policy are:

- The virtual elimination from the environment of toxic substances that occur predominantly from human activity and are persistent and bioaccumulative. These are referred to as Track 1 substances.
- The management of other toxic substances through their life cycle to prevent or minimize their release into the environment taking into account socio-economic factors when determining long-term environmental goals. These are referred to as Track 2 substances.

Under this policy, DCM is a *Track 2* substance.

1.2 Strategic Options Process

To ensure that the most effective and efficient environmental management options would be addressed, within the context of pollution prevention and sustainable development as well as the federal government's *Toxic Substances Management Policy,* the Strategic Options Process was developed with Environment Canada and Health Canada as the key partners. This consultative mechanism provides the basis for recommendations to the ministers accountable for CEPA.

Stakeholders were invited to participate in the consultation process in a June, 1996 letter from Environment Canada. Invitations were extended to the provinces and territories by letters to the members of the CEPA Federal-Provincial Advisory Committee (FPAC). A list of the Issue Table members and corresponding members is found in **Appendix B**.

The terms of reference for the Issue Table, developed at the first meeting held September 17-18 1996, were as follows:

- to ensure relevant stakeholders were invited from industry, non-governmental organizations, and key federal departments,
- to gather relevant technical, scientific and economic information from which recommendations could be drawn,
- to consider the management of DCM from a life cycle perspective,
- to analyze relevant environmental management options and their attendant socioeconomic impacts,
- to complete a report on management options within 18 months, and
- to maintain a file accessible to the public.

1.3 Strategic Options Report

This report presents the findings of the consultations and sets out recommendations on the management of environmental releases of DCM used in consumer, commercial and industrial applications.

2. Problem Definition

2.1 Toxicity of dichloromethane

In the *Priority Substances List (PSL) Assessment Report*, published in 1993, it was concluded that current releases of DCM could harm the environment (Section 11(a) of the Act) and may constitute a danger to human life or health (Section 11 (c) of the Act).

The environmental toxicity finding was based on limited data suggesting that concentrations of DCM in receiving waters may be sufficient to cause adverse effects to some aquatic organisms, notably certain freshwater nematodes that were considered the most sensitive receptors.

DCM is classified by Health Canada as "probably carcinogenic to humans" based on studies of animal test species and exposure/carcinogenic potency indices. The principle route of exposure of the general population is inhalation, constituting between 97.4 and 98.7 % of the total estimated intake among various age groups. Indoor air is the most important source of human exposure to DCM in Canada. Based on exposure/carcinogenic potency indices, Health Canada considers the need for reducing human exposure to DCM as low to moderate.

The International Agency for Research on Cancer (IARC) has classified DCM as a possible human carcinogen. It is understood that a review of scientific information completed by the Agency in 1998 re-affirmed this classification.

The federal government's *Toxic Substances Management Policy* provided the framework for addressing DCM in the stakeholder consultations. Under this policy, DCM is a *Track 2* substance because its bioaccumulation and persistence characteristics do not meet the criteria for a *Track 1* substance. Accordingly, the selection of the best management options for DCM took into account scientific, technical and socio-economic considerations in reducing releases and exposure in the life cycle of DCM.

2.1.1 Industry request to re-assess the CEPA toxicity designation of dichloromethane

The Halogenated Solvents Industry Alliance Inc. (HSIA), in a March 1996 letter to the Ministers of Environment and Health, petitioned the federal government to re-assess the finding that DCM is a toxic substance under CEPA. HSIA suggested that significant new scientific data would change the conclusion that associated the carcinogenic response in laboratory animal studies with the same response in humans. HSIA also questioned the conclusion that DCM harms certain aquatic invertebrate species.

The HSIA requested a Board of Review under Section 89 of CEPA to re-assess the nature and extent of the harm posed by DCM before the government determined management options. In a May 1996 letter to HSIA, Environment Canada advised that officials from the Departments of Environment and Health would examine the scientific information provided.

In May 1997, Health Canada replied to the HSIA. The Department acknowledged the petition concerning the human carcinogenicity of dichloromethane and provided its rationale for retaining the conclusions of the PSL Assessment Report. Health Canada does not accept that the submitted information is sufficient evidence for the premise that the putative mechanism of carcinogenesis is irrelevant to humans. Therefore, based on a review of the data submitted in support of the petition, both Environment Canada and Health Canada concluded that a reassessment of the toxicity of DCM was not warranted at this time.

2.2 Uses in Canada

Dichloromethane is a versatile solvent used in a variety of industrial applications that include degreasing and the manufacture of pharmaceuticals, plastics and polyurethane foam, as well as for industrial, commercial and consumer paint stripping. DCM offers many advantages. Its useful properties include high solvency, rapid evaporation at room temperature, low corrosiveness, and non-flammability.

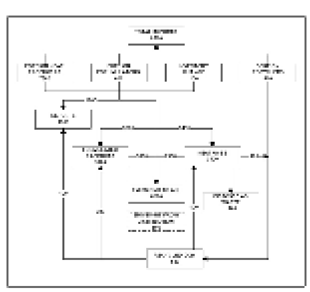
The Issue Table addressed all industrial, commercial and consumer applications where DCM is used. **Figure 1** shows the overall flow of this substance in Canadian commerce. DCM is not produced in Canada and is imported as a pure chemical in neat form, as a component in formulated products and to a lesser extent as a recycled product.

In 1995, approximately 8,500 t of DCM were imported from either the USA or the United Kingdom as neat (7,500 t), formulated (600 t), or as recycled solvent (400 t). Approximately 1,300 t were exported from Canada (1,000 t of imported pure DCM were immediately re-exported and another 200 t and 100 t were exported in formulated products and recycled solvent respectively). Approximately 7,400 t were consumed by domestic end users either as neat solvent (3,500 t) or in the formulation of consumer and industrial products (3,900 t). An estimated 500 t were recovered from recycled solvent, which was supplied to neat and formulated product end users; 400 t were imported and 100 t originated from domestic sources.

An estimated 1,100 t of DCM were contained in wastes. Most of the DCM waste collected is blended with other chlorinated solvents and sent for incineration through waste management companies.

DCM demand in Canada has declined over the last 20 years, decreasing about 1.6 % per year on average between 1976 and 1995. The phase-out of CFCs and 1,1,1-trichloroethane as ozone-depleting substances prior to 1996 has contributed to a recovery in DCM demand as an alternative chemical in the manufacture of flexible polyurethane foam and adhesives. Overall demand is projected to grow about 1.8 % per year on average to 2010, recognizing that a number of factors can change this growth rate such as general economic conditions, voluntary industry initiatives to minimize use, possible government regulatory interventions, and the increasing availability of substitute solvents for some applications.

Figure 1: DCM supply and distribution in Canada 1995 (t)



2.3 Environmental releases in a life-cycle context

Releases of DCM to the environment from a life-cycle management perspective were reviewed by members of the Issue Table who concurred with the following approach.

- **Manufacturing and recycling**
  There is no manufacture of DCM in Canada and only small quantities are recycled from Canadian sources (a larger quantity of recycled DCM was imported from the USA). Environmental releases of DCM and other pollutants associated with the processing of wastes are adequately managed through existing provincial regulatory and permitting processes. To ensure that the maximum amount of used DCM is recovered and recycled, free movement of these wastes should be maintained across interprovincial and international borders.

- **Transportation of DCM products and wastes**
  The federal Transportation of Dangerous Goods Act and the Export and Import of Hazardous Waste Regulations under CEPA, as well as relevant provincial laws adequately regulate this portion in the life-cycle management of DCM. An estimated 100 t is emitted to the environment in the distribution chain.

- **Sector uses of DCM**
  This part of the life cycle was recognized as the most important in relation to environmental releases and is the main focus of the strategic options review.
  Evaporative losses to the atmosphere are the main pathway of environmental releases from the various industrial and consumer applications. Controlling emissions or managing DCM uses should effectively reduce environmental releases, which is the primary objective of the SOP.

- **Disposal of solid wastes**
  DCM-contaminated wastes generated by industry are being collected as hazardous wastes and appear to be well managed through proper disposal and waste management practices. In view of the regulatory coverage of solid wastes by provincial and municipal jurisdictions, no further actions are deemed necessary. A small, but unmeasurable quantity of residual DCM is released via wastes to the environment in packaged consumer products (paint stripper, cleaning solutions and aerosol containers) that enter the domestic or commercial solid waste stream.

- **Disposal of liquid wastes**
  Liquid wastes in treated or untreated form, associated with industrial processes using DCM, are typically directed to municipal sewers. Since provincial and municipal laws currently regulate industrial pollutant releases to publicly owned treatment works, no further actions are deemed necessary.

- **Contaminated sites**
  While DCM has been detected in ground and surface waters, a survey conducted for Environment Canada in support of the work of this Issue Table found that DCM concentrations at most sites were near or slightly above the detection level. DCM was detected at 183 sites. At 166 of these sites (157 of these were sources of drinking water), DCM concentrations were well below the 50 µg/L prescribed in the Canadian Drinking Water Guidelines. The contamination at most sites appeared to be associated with laboratory facilities while industrial sources caused the contamination at 17 ground water sites. Better management of DCM and environmental controls as well as its replacement with alternate chemicals and non DCM-based processes should minimize future releases to the environment.

Table 1 summarizes DCM end uses and emissions. A total of 7,400 t of DCM was used in 1995 and approximately 6,300 t or 85 % were emitted to air. Negligible amounts were released to land or surface and groundwater. Approximately 1,100 t or 15 % was collected for waste disposal and recycled or incinerated.

Table 1: DCM use and environmental releases by application, 1995

Application	No. of Facilities	Use (t)	Estimated Emission (t)
Commercial/Industrial			
Aircraft paint stripping	22	200	200
Commercial paint stripping:			
- furniture	1400	1000	900
- autobody	5600	100	<100

- other	500	300	<300
PU foam blowing	11	1300	1300
Pharmaceuticals	10	600	600
Intermediate chemicals	11	300	<100
Adhesives:			
- PU slabstock foam	11	350	350
- secondary foam fabricators	150	150	150
- other industrial	1000	500	500
Cleaning:			
- plastics processing	430	600	250
- other	340	300	250
Laboratories	1500	300	<100
Aerosols - industrial products	5000*	100	100
Total	15,985	6100	4900
Consumer Products			
Paint strippers	806,000*	1200	1200
Aerosols - consumer products	1,210,000*	100	100
Total	2,016,000*	1300	1300
Losses in distribution			100
Total Use/Emissions		7400	6300

* Estimated number of containers for consumer paint strippers and aerosol products. Industrial aerosol product containers were estimated at 570,000 used at 5000 facilities

Direct human exposure at the point of commercial and industrial use was estimated at 32,000 persons per year. An estimated 2,000,000 persons per year were directly exposed while using consumer paint strippers, aerosol paints, insecticides, and cleaning solutions. **Table 2** shows the geographical distribution of DCM uses and emissions for 1995. Approximately 49 % of the emissions occurred in the province of Ontario and 29 % in Quebec. The Prairie provinces, British Columbia, and the Atlantic provinces accounted for 11 %, 8 % and 3 % of all DCM emissions respectively.

Table 2: Geographic distribution of DCM uses and releases, 1995

Application	Region	Use (t)	Emission (t)
Aircraft paint stripping	Atlantic	10	8
	Quebec	16	13
	Ontario	84	67
	Alberta, Man., Sask	54	43
	BC	36	29
Consumer and commercial paint stripping	Atlantic	180	175
	Quebec	780	750
	Ontario	940	900
	Alberta, Man., Sask	390	375
	BC	310	300
PU foam blowing	Atlantic	---	---
	Quebec	300	300

	Ontario	900	900
	Alberta, Man., Sask	100	100
	BC	<100	<100
Pharmaceuticals and intermediates	Atlantic	0	0
	Quebec	190	110
	Ontario	550	500
	Alberta, Man., Sask	155	15
	BC	10	1
Adhesives	Atlantic	30	30
	Quebec	270	270
	Ontario	500	500
	Alberta, Man., Sask	95	95
	BC	100	100
Cleaning, laboratories and aerosols	Atlantic	45	27
	Quebec	390	260
	Ontario	650	280
	Alberta, Man., Sask	200	80
	BC	110	50
TOTAL USES/EMISSIONS		7495	6378

Paint stripping, flexible polyurethane foam, adhesive, pharmaceutical, and aerosol uses accounted for over 90 % of the DCM emitted to the environment. The chemical intermediates synthesis industry and analytical laboratories are the only applications where a high percentage of the emissions are captured (90 % or greater).

3. Technical and Cost Analyses

Under a contract[1] issued by Environment Canada to CHEMinfo Services Inc., the consultant was requested to examine the current uses of DCM in Canada, estimate the environmental releases, and determine the technical options and costs for controlling environmental releases. The control options were categorized according to "low", "medium" and "high" emission reduction ranges as a means to assess the control costs and to enable the subsequent economic analyses by Environment Canada. The findings of the contractor's study are summarized in the ensuing section.

Various information sources were used in compiling the estimates of DCM uses and environmental releases. The primary source of information was data collected from a Notice issued on January 27, 1996 under Section 16 of the *Canadian Environmental Protection Act*. 282 companies responded to the Section 16 Notice. Other sources included the National Pollutant Release Inventory (NPRI), import data from Revenue Canada, and other published studies.

3.1 Aircraft paint stripping application

In 1995, approximately 200 t of DCM were used to strip paint from aircraft. Seventeen commercial aircraft repainting facilities, which strip small aircraft, accounted for approximately 60 % of the total quantity used. The remainder was used to strip paint from medium and large aircraft operated by the major airlines and the Canadian military. The two major airlines have paint stripping operations at four locations: in Ontario, British Columbia, and Alberta. The Department of National Defense has one maintenance facility located in Ontario where small aircraft are refinished.

DCM is supplied as formulated paint stripper from both Canadian and U.S. sources. Imports account for approximately 25 % of the supply.

Paint strippers are used to remove surface coatings from whole aircraft and aircraft components. Aircraft coatings must be replaced when they can no longer protect the aluminum substrate, when the cosmetic appearance of the aircraft is unacceptable, or when it is necessary to undertake scheduled inspection and maintenance work. Aircraft of the major airlines are typically stripped every four to eight years. In 1995, DCM was used to strip paint from an estimated 575 small aircraft, 56 medium and large aircraft owned or leased by the major airlines and 31 in the military fleet.

An estimated 80 % of the DCM evaporates during the stripping process. A survey of maintenance facilities conducted by CHEMinfo Services Inc. found one major airline and one commercial operation with on-site wastewater treatment systems used to collect and treat waste sludge. At other facilities the wastes are collected for disposal by waste management firms that either incinerate the wastes or recover and recycle the DCM.

The technical control options to reduce DCM emissions include better operating practices and replacement of DCM strippers with either alkaline benzyl alcohol solvent or dry media blasting. Better work practices could reduce DCM emissions by approximately 20 % as the low emission reduction option and would not be expected to increase costs. A partial switch to alternate solvents would result in an intermediate range of emission reductions.

In the analysis of sector control costs for the high reduction option, CHEMinfo Services assumed that alternate solvents would be used for small aircraft stripping while medium and large aircraft would be stripped by dry media blasting technology using wheat starch. Several companies including one Canadian firm are developing the wheat starch technology. This technology is scheduled for evaluation in a full-scale application on a large aircraft in 1998. The costs of substituting DCM with benzyl alcohol strippers were calculated on the basis of increased stripping times required for benzyl alcohol (i.e. from 12 to 16 hours more time) and attendant greater revenue losses from the additional time that aircraft are out of service. The costs for dry media blasting were calculated from limited capital and operating cost data currently available. The cost assumptions and the cost estimates for dry media blasting are therefore tentative. Annualized sector costs for the high reduction option were estimated at $5.84 million and unit cost at $36,500 per tonne of DCM emission reduction.

Demand for DCM solvents in the aircraft sector, in the absence of any government interventions, is expected to grow in direct proportion to business growth in the commercial airline and private aircraft sectors. DCM use by the year 2000 is projected to be 8 % higher than in 1995. However, the voluntary adoption of alternate stripping solvents and methods such as dry media blasting may displace some of the future growth in DCM.

3.2 Consumer paint stripping application

DCM solvents are generally judged to perform better than other solvent-based products, giving almost universal effectiveness in domestic applications. They remove practically any type of paint from any surface without damage, and are fast acting at room temperature. DCM's lack of flammability is an important safety advantage for consumer uses.

In 1995, DCM-containing formulations accounted for over 90 % of the consumer paint stripper market. Consumer products are packaged for retail sales in one to four litres size containers. DCM content in non-flammable products is typically 70 - 90 % by volume but can vary and be as low as 20 % in flammable products. At least one manufacturer supplies a flammable stripper containing DCM as low as 3 %. Some paint strippers are DCM-free and may contain n-methyl pyrrolidone (nMP), dibasic esters (DBE), or other organic solvents as the active ingredients.

About 1,200 t of DCM were used in the formulation of consumer products in 1995 distributed in an estimated 800,000 product containers. It is estimated that 90 % of the solvent evaporates during the stripping process and the remainder is retained in the stripping residues and as residual liquid in containers. A very small portion of near empty containers is deposited at consumer hazardous waste collection depots, which makes the quantity of unused paint stripper collected for proper environmental disposal negligible (on the order of hundreds of kilograms per year). Most consumers deposit their containers and waste residues from stripping with their household solid wastes where, through the municipal solid waste stream, the DCM is ultimately released to the environment.

The consumer market for paint strippers is mature and business dynamics are geared mainly to capturing market share rather than expanding the total demand. Industry suppliers estimate an average annual growth rate of 2 % in the overall consumer market with DCM-containing products growing at 1 % per year. Products containing nMP and DBE or other alternate formulations are projected to slightly increase their market share.

The only means available to protect consumers and minimize environmental releases are, either to enhance consumer awareness of the hazards of the substance through container labeling and education, have consumers use other solvent-based strippers or use mechanical stripping as much as possible.

The low reduction option that is estimated to reduce consumer use about 20 % is based on the anticipated response of consumers to container labeling some of who will likely choose to avoid DCM-based products. A labeling program would involve negligible or no new capital expenditures. Additional operating costs would be associated with the cost of installing labeling equipment on the production line and supplying point-of-use information pamphlets. Annualized sector costs for these changes were estimated at $0.25 million per year amortized over 10 years. The unit cost would be about $750 per tonne of DCM emissions reduced.

The high reduction option assumes that several types of alternatives share in the total replacement of DCM-based formulations in the marketplace. Annualized sector costs for these higher priced solvents were estimated at $5.4 million and unit costs at $4,500 per tonne.

3.3 Commercial paint stripping application

Approximately 1,400 t of DCM were used at commercial paint stripping facilities in 1995. Furniture restoration shops accounted for about 1,000 t or approximately 70 % of this use. Autobody shops accounted for about 100 t. Miscellaneous uses such as, industrial and marine vessel refinishing facilities, metal finishing shops, facilities maintenance contractors, and building restoration firms accounted for about 300 t of the total used in this sector.

The commercial DCM paint stripper market is widely dispersed among about 1,400 furniture restoration firms, 5,600 autobody shops, and 500 other facilities. Distributors sell DCM in neat form to formulators who supply formulated paint stripper products directly to end-users or to subdistributors. The subdistributors sell only formulated products to end-users. Imported paint stripping formulations sold through wholesale chains dominate the supply to the autobody repair market.

An estimated 90 % of the DCM evaporates during the stripping process and the remainder is collected as waste solids or sludge that are deposited in the municipal solid waste stream or disposed through waste management firms. Empty product containers are either recycled or deposited in the municipal solid waste stream.

Furniture restoration firms apply the solvent using one of three procedures: hand stripping, dip tanks, and flow-over systems[2]. A limited survey by CHEMinfo Services showed that most shops hand-strip the articles. Only 10 % reported using a dip tank and 14 % used flow-over systems. While autobody shops predominantly use sanding to remove automobile coatings, small quantities of strippers are used for special coating removal problems and for refinishing antique vehicles.

Demand for commercial DCM paint strippers is projected to grow slowly at 1 % to 2 % per year similar to the consumer paint stripper market. Most shops have no specific plans to reduce consumption of DCM paint strippers although a few are evaluating alternate strippers. One company purchased a thermal unit in 1997 to remove paint from auto parts although this process is not as effective as DCM strippers.

The technical control options to reduce DCM emissions include better work practices or the replacement of DCM strippers with alternative solvents. Better work practices could reduce DCM emissions approximately 20 %. DBE and nMP or DBE/nMP solvent blends offer a technically viable option to replace DCM-based strippers in many applications.

The low reduction option, which is estimated to reduce DCM emissions 20 %, is based on operator training and education of users in all sector applications. In developing the cost estimates, it was assumed that all employees working in this sector would be trained and re-trained on a three-year cycle. Annualized sector costs of these changes were estimated at $0.18 million per year and $700 per tonne of DCM emissions reduced.

The high reduction option assumes replacing DCM strippers entirely with DBE and nMP strippers or blends of these solvents. Substitution costs were calculated on the basis of higher material costs and additional labour costs associated with the alternate solvents, which are slower acting. Annualized sector costs were estimated at $16.5 million and unit costs at $13,000 per tonne of DCM emission reduction.

3.4 Polyurethane (PU) foam blowing application

A total of 1,300 t of DCM was used at eleven polyurethane (PU) foam stabstock production plants in 1995 where it is used as an auxiliary-blowing agent in the production of flexible foam. Slabstock foam producers are supplied neat (pure) DCM in bulk either by foreign producers or Canadian chemical distributors.

Virtually all of the DCM in the production process is emitted to atmosphere and the PU foam sector represents some of the largest point sources of DCM releases. About 40-50 % of the DCM is vented from the process areas and the remainder slowly evaporates from the foam product during curing and storage.

Polyurethane foam is produced by the reaction of a polyisocyanate with a polyether polyol and water. Typically, a diisocyanate stream is reacted with another stream containing the polyol and other additives. DCM is added under pressure to the polyol stream prior to mixing. The reactant streams are metered and rapidly mixed under pressure in the "mixhead" of the urethane slabstock foam machine. The exothermic reaction generates CO_2, which expands the foam. An auxiliary-blowing agent is added to make low density or soft foams and to cool the material. The foam mixture is discharged from the mixhead into a trough where foam expansion occurs.

Small quantities of the solvent are used to flush feed lines, clean mixing heads between foam batches and for general cleaning of machine parts and tools. The flushed DCM is mostly reused. DCM-contaminated wastes are recovered for waste disposal or recycling.

Several softening additives have been developed that are able to modify the chemical reactions that, together with the inherent CO_2 generated by the primary reactants, are able to form foams with varying softness. This reduces or eliminates the need for an auxiliary blowing agent. According to industry sources, a new softener recently developed in the U.S. should enable industry to meet proposed U.S. EPA NESHAP regulations. These regulations would reduce DCM use 60 %-70 % as a result of limits placed on the allowable DCM that can be used for the production of different grades of foam.

Several CO_2 technologies have been developed and one technology introduced in 1993 (CarDio^{TM}) appears to be most promising in being able to replace DCM as the auxiliary foam blowing gas. The supplier of the technology claims it is capable of making all densities of foam and eliminates the need for DCM entirely, although industry representatives expressed the opinion that DCM would continue to be necessary to produce certain grades of foam.

DCM consumption is projected to increase in the polyurethane foam sector approximately 1 % per year over the next five years. DCM requirements may decrease, however, if PU foam producers adopt new softening agents or other technologies.

DCM emission reductions of 30 %-70 % are attainable when softening agents are used. Process changes would incur the additional cost of the chemical softening agents and related capital costs of $50,000 per plant for the new technology. Annualized sector costs are estimated at $0.45 to $0.69 million and unit costs at $1,060 to $1,150 per tonne of DCM emission reduction. The high reduction option if based on a complete replacement of DCM using CO_2 foam blowing technology is estimated to incur annualized operating and capital costs of $2.2 million for the sector resulting in a unit cost of $1,690 per tonne of DCM emission reduction.

3.5 Pharmaceuticals and chemical intermediates application

DCM is used in neat form in the coating process for pharmaceutical and nutritional tablets, as well as for the synthesis of complex organic chemical intermediates. Approximately 600 t and 300 t of DCM were used respectively at ten pharmaceutical and eleven chemical intermediates manufacturers in 1995. The solvent is supplied by Canadian chemical distributors.

Virtually all the DCM used in the production of pharmaceutical and nutritional tablet coatings is emitted to atmosphere.

During the manufacture of chemical intermediates, about 90 % of the solvent is contained within the batch reactors and recovery systems. The remaining 10 % is emitted to atmosphere. The recovered solvent is collected by waste management firms and is either treated to recover the DCM or is incinerated.

In a typical tablet coating process, coating solutions of DCM/alcohol solvents are cyclically sprayed onto tablets to build up several coating layers. A spraying cycle usually involves a short spray application followed by a drying period. Emissions from the coating process are drawn from the process area by ventilation systems that discharge to atmosphere.

Manufacturers of chemical intermediates produce a variety of chemical products for use in the production of pharmaceutical, pesticide and other organic chemical products. DCM functions as a carrier or extraction solvent for the production of specific chemical products requiring high quality and purity. Chemical intermediates suppliers typically follow manufacturing methods and processes specified by their pharmaceutical or other customers.

DCM consumption for tablet coating is expected to decline 65 % relative to 1995 by the year 2000 as aqueous-based tablet coating technology is more widely adopted. In Canada, most of the DCM used in the pharmaceutical sector is concentrated at one major manufacturer. By the year 2000, this company expects to reduce its annual DCM use 50 % to 75 % relative to 1995.

Chemical intermediates manufacturers generally can not replace DCM with other chemicals and future demand is expected to grow 67 % by the year 2000. This strong demand reflects business activity that is expected to grow substantially over the next few years.

Technical control options to reduce DCM emissions in the pharmaceutical industry include adjusting the DCM concentration in the tablet coating solvent mixture, using aqueous tablet coating processes or capturing and recovering solvent emissions. Adjustments in the concentration of DCM for tablet coating could reduce emissions approximately 20 % and would not incur any significant additional costs. Vapour capture and control technology could reduce emissions over 90 % while aqueous coatings technology could eliminate DCM entirely. Industry sources have indicated that up to 10 % of current DCM usage may have to be retained for specialized tablet coatings.

The high reduction scenario assumed by CHEMinfo Services for this sector, representing a 90 % emission reduction, was based on the one large pharmaceutical manufacturer converting to aqueous coating technology while the smaller manufacturers would install vapour capture and control technology. Annualized sector capital and operating costs were estimated at $1.9 million and unit costs at $3,500 per tonne of DCM emission reduction.

The chemical intermediates sector already captures up to 90 % of DCM emissions. Cooling and condensing residual vapours that are emitted from processes could capture additional solvent. Annualized sector costs to further reduce emissions would be $2.48 million. This option has a very high unit cost of DCM emission reduction ($92,000) because of the small incremental quantity of solvent that would be recovered.

3.6 Adhesives application

DCM-based adhesives comprise about 10 % to 15 % of all hydrocarbon adhesives used in industrial applications. About 1,000 t of DCM were used in the formulation of adhesives as shown in the following table.

Table 3: DCM use in adhesive applications

Application	No. of facilities	Use in 1995 (t)
Polyurethane foam:		
- slabstock producers	11	350
- secondary fabricators	150	150
Other industrial applications	1,000	500

The non-flammability, fast evaporation and compatibility with most substrates are key properties that make DCM suitable for many adhesive applications. Adhesive formulations are manufactured by blending resin and other ingredients with DCM in batch mixers followed by packaging in drums or pails, which are sold to end-users. About 70 % of the DCM or 700 t is supplied to the market by domestic formulators who purchase neat solvent from chemical distributors in Canada. About 200 t are contained in imported formulated products while 100 t of neat solvent are used in the formulation of adhesives by end-users. There are about ten domestic formulators, two of which dominate the market.

Essentially all DCM evaporates during and after adhesive application by end-users. Up to 3 % of the consumption may evaporate during the blending operations at adhesive formulators. No significant waste solvents are generated during the formulation of adhesives.

Solvent-based adhesives are usually applied using specialized spray guns such as in the fabrication of foam products cut from polyurethane foam stabstock or other materials. Lamination of several foam layers to achieve the desired firmness of foam products is a common adhesive fabrication process. Also, polyester fabric materials can be bonded to the foam underlay using DCM adhesives.

Demand for DCM-based adhesives is expected to grow 3 % to 4 % per year between 1995 and the year 2000. This growth may be reduced somewhat by conversion to aqueous-based adhesives.

The only option for reducing evaporative emissions is to change to water-based or other solvent-based adhesives. Hydrocarbon-based solvents, however, present flammability hazards during their manufacture as well as in their end-use, a constraint that precludes use of these solvents from practical considerations. Water-based adhesives require investment in new spray equipment and air filtration equipment to capture overspray. In some cases they are not sufficiently developed to use in those applications.

The assessment of control costs for the low reduction option by CHEMinfo Services was based on replacing 10 % (a 100 t reduction in DCM) of the DCM-based adhesives with currently available water-based products. Annualized sector capital and operating costs for this option were estimated at $1.5 million with a unit cost of $15,350 per tonne of DCM emission reduction.

For the medium reduction option CHEMinfo Services assumed that DCM reductions in the range 40 % to 70 % may be achieved within the next 5 to 10 years as more water-based formulations are developed and proven. Total annual costs were estimated at $7.7 million and unit cost at $15,350 per tonne of DCM emission reduction.

For the high reduction option, it was assumed that 50 % of the DCM-based adhesives are replaced with water-based products and the remainder would be replaced with flammable solvent-based adhesives. In the cost estimates, the capital investment for additional ventilation and explosion proof equipment was also included. Annualized total costs were estimated at $9.83 million and unit costs at $9,830 per tonne of DCM emission reduction.

3.7 Cleaning application

A total of 900 t of DCM was used in cleaning applications at approximately 800 industrial facilities in 1995 as shown in **Table 4**. Most of the DCM used for cleaning applications is supplied in neat form by Canadian chemical distributors.

The high solvency of DCM and its ability to dissolve oils and greases quickly makes it an effective cleaning solvent for plastic resins and other cleaning applications. The solvent is commonly used to flush the mixing heads of PU foam injection molding machines.

DCM is used to clean spray guns in the hand lay-up manufacturing processes of plastic components, molds, equipment, and tools. It is also used as a polishing solvent for plastic surfaces and in immersion and vapour degreasing of parts, but not widely.

Table 4: DCM usage in cleaning applications

Range of usage (t/y)	No. of facilities	1995 usage (t)	Average use (t/facility)
>50	3	180	60
10-49	8	160	20
1-9	86	240	2.8
<1	675	320	0.5
Total	772	900	

About 630 t or nearly 70 % of the DCM was used by processors and fabricators of plastic (polyurethane, acrylic, polyester, and ABS) products while the remainder (270 t) was used in diverse cleaning applications. About 245 t were estimated as the quantity emitted to the environment from plastics processing uses, largely as evaporative emissions. Molded foam and other reaction injection molding manufacturers capture and collect a large proportion of spent solvent that is sent to waste disposal firms for recycling or incineration. An estimated 150 t of the 630 t was used for cleaning PU injection molding equipment.

An estimated 270 t were used in other cleaning applications for a variety of substrates. In these uses, about 237 t were emitted to the environment. These cleaning applications included metal, electronics, glass, concrete, and textiles. Metal applications include small auto parts (brakes, clutches, etc.) through to large metal fabricators (air ducts, tubing, etc.)

A modest increase in DCM for cleaning uses may occur over the next five years since some companies have no plans to switch from DCM. However, adoption of water-based cleaners and other solvents may substantially replace DCM, particularly in the plastics manufacturing sector. Many plastics manufacturers and fabricators are switching to alternate solvents. In the manufacture of molded PU foam, new high-pressure injection molding machines, which do not require flushing of the mixhead with DCM, are replacing low-pressure machines.

The main control option for this application sector is to replace DCM with other organic solvents. Other solvents or solvent blends can provide effective cleaning performance at comparable cost in most applications. Acetone, toluene, methanol and d-Limonene are some of the possible solvents that can be used instead of DCM. However, many of the substitutes are flammable and expenditures on fire protection equipment would add substantial costs. Emissions capture and control systems, while technically feasible, would be prohibitively expensive for either existing facilities or new facilities.

In the assessment of the high emission reduction option, CHEMinfo assumed that most companies would be able to find a replacement solvent for DCM. The annualized cost to the sector of switching to other solvents, some of which are flammable, was estimated at $4.2 million with a unit cost of $8,700 per tonne of DCM emission reduction.

It is relevant to note that significant reductions in the use and emissions of chlorinated substances for example, are being achieved under the Memorandum of Understanding (MOU) between the Canadian Motor Vehicle Manufacturers' Association (CMVMA), Ontario Ministry of Environment and Energy and Environment Canada. Signed in April 1992 this MOU, referred to as the "Canadian Automotive Manufacturing Pollution Prevention Project", commits CMVMA participating companies to reducing or eliminating the use, generation and release of 29 toxic substances including DCM and five other chlorinated solvents.

The 1996 progress report of the CMVMA pollution prevention project, released to the public by the federal Minister of the Environment, outlined the proactive efforts by the automotive industry to voluntarily reduce uses and releases of toxic substances. In the case of DCM, Chrysler Canada reported the complete elimination of DCM as a cleaning solvent from a truck assembly plant. A patented non-chlorinated cleaner with inert particulate additives replaced DCM for the cleaning of paint line equipment.

3.8 Laboratory application

About 300 t of DCM were used at approximately 1,500 laboratories in 1995. Neat DCM is supplied to laboratories by Canadian chemical distributors usually in ½, 1, 2 ½, 4 and 20 litre bottles. Approximately 90 % of the solvent is used by analytical laboratories to extract organic compounds from water, soil, air, oil and grease, and other media. Environmental laboratories typically use this solvent to extract organic compounds such as polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and pesticides.

Approximately 95 % of the DCM is recovered and collected as a liquid waste. A small portion of the recovered DCM (~10 %) is recycled. Waste solvent and empty DCM containers are collected by waste management firms. DCM releases to the environment are therefore very low.

Demand for DCM as an extraction solvent is expected to grow 8 % from 1995 to the year 2000. However, no consistent opinions on projected future trends were obtained from the laboratories that were surveyed since one-half thought their DCM use would decrease while others expected their use to increase.

Technical control options to reduce DCM emissions include solvent substitution and further capture of emissions. Analytical laboratories could replace DCM with other solvents but many established analytical protocols are based on DCM solvent. Environmental releases could be reduced nominally through sample miniaturization and replacing DCM solvent extraction procedures with water-solid phase extraction procedures. Capturing evaporative DCM losses in fume hoods followed by carbon adsorption control systems could also further reduce DCM emissions. Additional emission controls were estimated to incur annualized costs of $0.32 million. This option has a very high unit cost ($22,700) of DCM emission reduction because of the small incremental amount of DCM recovered.

3.9 Aerosols application

About 200 t of DCM were used in aerosol formulations in 1995. DCM solvent is preferred in aerosol products because of its particular properties including fast evaporation rate, high solvency, and non-flammability.

Aerosol products containing DCM are typically sold in 12-ounce cans and include the following product categories: metallic paints, insecticides, mold release agents, cleaning agents, lubricants, disinfectants, and paint removers. The propellants used in these formulations include isobutane, CO_2 and dimethyl ether. Approximately 1.8 million aerosol cans containing DCM were sold in Canada in 1995. Metallic paints accounted for approximately 60 % or 1.2 million of the total units.

In the 1980s, aerosol producers began a program to reduce and eliminate DCM in consumer paints. At that time 80 % of the formulations contained DCM whereas today about 5 % of the metallic aerosol paints contain this solvent.

Approximately 100 t of DCM in industrial aerosol products were exported to the U.S. and an equal amount was imported in industrial and consumer products from the U.S., which are distributed by Canadian subsidiaries or wholesalers and major retailers. Essentially all DCM contained in aerosol products is released to the environment at the point of use, to the atmosphere (90 %) or as residual product in containers which go to municipal or to hazardous waste streams (10 %). Fugitive emissions from the production processes were estimated to be less than 1%. Between 80 % and 100 % of aerosol cans are used until empty and most are deposited in municipal solid waste streams. Some partially filled paint cans are collected by waste management firms and sent to hazardous waste processing facilities that recover the solvent to produce general-purpose waste paint, which is sold into export markets.

Demand for DCM in aerosol applications is expected to remain constant. Formulators reported that DCM use has declined in recent years and is only being used in formulations requiring specific evaporation rates, unique solvency, or non-flammability.

Reformulation of both industrial and consumer aerosol products with non-DCM solvents was assumed as the high reduction option. DCM could be removed from consumer aerosol paints by increasing the aluminum flake content by up to three times the current level.

For industrial aerosol products, it was assumed that hydrofluorocarbons (HFCs) could be substituted to provide flammability retardant characteristics similar to DCM. Mold release agents account for about 50 % of the DCM used in industrial applications. It was assumed that performance product aerosols have a similar DCM content, which could be replaced by HFCs in the interim, although these are considered greenhouse gases and are scheduled for phase-out in year 2020.

The annualized sector cost to reformulate consumer and industrial aerosols was estimated at $1.1 million attributed to higher material costs. The resulting unit cost is about $5,500 per tonne of DCM emission reduction. For the low and medium reduction options, the costs were calculated simply by apportioning the non-DCM and DCM-based products.

3.10 Summary

The technical control options to reduce DCM emissions can be grouped into three broad categories: solvent substitution, manufacturing process changes, and capture and treatment of DCM emissions.

Solvent substitution appears to be the most cost-effective option to reduce environmental releases associated with paint stripping, adhesives, pharmaceuticals (tablet coating), aerosols, and cleaning products.

Manufacturing process changes by adding softening agents or using special polyols are capable of reducing the quantity of DCM as an auxiliary blowing agent while maintaining the desired flexible foam qualities. This approach, however, appears to have limitations in the production of certain grades of soft flexible polyurethane foam. Further emission reductions would have to be achieved by adding emission capture and control systems, but these systems would be prohibitively expensive. Replacing DCM as the auxiliary blowing agent with CO_2 foam-blowing technology would appear to be the only realistic option.

Emission capture and control technology are technically feasible for several of the industrial applications including aircraft paint stripping, pharmaceutical tablet coating and possibly for some of the larger cleaning applications. Except for essential tablet coating processes in the production of pharmaceuticals, they would be prohibitively expensive in most applications. The combination of very dilute solvent-laden air concentrations and very high workplace air ventilation rates would require equipment that would be physically large and costly.

Table 5 shows the technical control options according to the three emission reduction groupings of low (10-30 %), medium (40-70 %) and high (up to 100 %) for each of the application sectors as reported in the study by CHEMinfo Services.

For most of the applications, no unique medium or low reduction options were identified because the applicable technologies were the same as for the high reduction option with the exception of polyurethane (PU) foam blowing. In these cases, the extent to which alternate solvents would replace DCM determined the reductions to be obtained.

Table 5: Technical control options

Application	**Low reduction (10 - 30%)**	**Medium reduction (40 - 70%)**	**High reduction (up to 100%)**
Paint stripping-Aircraft	better operating practices	alkaline benzyl alcohol stripper; wheat starch media blasting	alkaline benzyl alcohol stripper; wheat starch media blasting
Paint stripping-consumer	container labeling and education	replace DCM with other solvents (DBE; nMP)	completely replace DCM with other solvents DBE; nMP)
Paint stripping-Commercial	better operating practices	partially replace DCM with other solvents (DBE; nMP)	completely replace DCM with other solvents (DBE; nMP)
PU foam blowing	chemical softeners to lower DCM usage	chemical softeners to lower DCM usage	carbon dioxide for auxiliary blowing agent
Pharmaceuticals (tablet coating)	lower DCM concentration	aqueous coating process and emission control	aqueous coating process and emission control
Chemical Intermediates	emission control	emission control	emission control
Adhesives	water-based adhesives	water-based adhesives	water-based adhesives and flammable solvents
Cleaning	alternative solvents or cleaning technology	alternative solvents or cleaning technology	alternative solvents or cleaning technology
Laboratories	emission control	emission control	emission control
Aerosols	reformulate with alternate solvents	reformulate with alternate solvents	reformulate with alternate solvents

Direct costs to industry or to consumers to reduce emissions vary according to the level of emission reduction to be achieved. According to the CHEMinfo Services report, a total phase out of DCM would result in annual costs (operating costs and capital costs) of approximately $50 million. To achieve medium and low emission reductions would respectively cost $27 million and $4 million annually. Annualized and unit costs for the emission reduction options are summarized in **Table 6**.

Table 6: Annualized sector and unit costs for the technical control options

Application	**Annualized[1] cost**			**Unit[2] cost**		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**
Aircraft paint stripping	Nil	2,920,000	5,840,000	Nil	36,500	36,500
Consumer paint stripping	225,000	2,700,000	5,400,000	750	4,500	4,500
Commercial paint stripping	175,000	8,250,000	16,500,000	700	13,000	13,000
PU foam blowing	450,000	690,000	2,200,000	1,150	1,060	1,690
Pharmaceuticals	Nil	1,050,000	1,900,000	Nil	3,500	3,500
Chemical intermediates	500,000	1,240,000	2,480,000	91,850	91,850	91,850
Adhesives	1,500,000	7,700,000	9,800,000	15,350	15,350	9,800
Cleaning	840,000	2,100,000	4,200,000	8,700	8,700	8,700
Laboratories	64,000	160,000	320,000	22,700	22,700	22,700
Aerosols	220,000	550,000	1,100,000	5,500	5,500	5,500
Total	3,974,000	27,360,000	49,740,000			

[1] Annualized capital plus annual operating costs in dollars
[2] Dollars per tonne of DCM emissions reduced

[1] CHEMinfo Services Inc. 1997. Dichloromethane Uses in Canada: Review of Control Options and Regulatory Requirements. Prepared for Environment Canada, Pacific and Yukon Region
[2] Flow-over systems provide a continual flow of stripper over the furniture. Paint stripper dripping off furniture is recycled back into a storage tank and fresh stripper is added to the tank to replenish evaporative losses.

4. Environmental Management Options

4.1 Issue table discussions on selecting the general management options

At the first Issue Table meeting in September 1996, Environment Canada presented for discussion a variety of possible management tools (**Table 7**) that could be considered in determining the approach to be taken for implementing control programs.

The following salient points were made during the selection of the management options:

- Representatives of the Halogenated Solvents Industry Alliance Inc. emphasized that recognition should be given to the many worker health protection and environmental management programs that have been adopted by the chemical manufacturing industries in recent years, most notably the program, *Responsible Care* of the Canadian and U.S. chemical manufacturing industry.

- Representatives from the foam blowing, adhesives, and pharmaceutical manufacturing sectors stated that they are inherently committed to reduce DCM use and would prefer a voluntary approach to meet the DCM reduction goals that may be proposed. These goals should provide reasonable time for the assessment of new technologies.

- Industry expressed a desire for a "level playing field" within Canada as well as with imported products and with the environmental standards in the U.S. For example in the U.S., standards have been issued or proposed for the aerospace, flexible PU foam and pharmaceutical manufacturing sectors, as well as for hazard labeling of DCM-containing consumer products.

- Industry representatives could not support a goal to completely phase out all uses of DCM. They observed that, despite the decreasing use of this solvent, it will continue to have niche applications such as specialty flexible PU foams, adhesives, pharmaceuticals, laboratory solvents, and chemical intermediates.

- Industry representatives noted that the phase-out and supplier control options could contravene the provisions of several international agreements, namely the North American Free Trade Agreement (NAFTA) and the General Agreement on Tariffs and Trade (GATT), which is now the World Trade Organization (WTO). The participants representing pharmaceutical manufacturers emphasized that Health Canada's food and drug regulations must take precedence in the event that environmental controls conflicted with drug manufacturing regulations.

- For consumer products, industry prefers container labeling. Labeling requirements according to the representatives of formulating companies should apply to all consumer paint stripping and aerosol products, not only to products containing DCM.

- The ENGO representative disagreed with some of industry's positions and maintained that the provisions in NAFTA should not prevent Canada from making independent decisions and that a simple phase-out regulation with a sufficient time frame would not be onerous to industry. Recycling of DCM in wastes should also be given prominence in the analysis of management options.

From the initial list of management options, four were chosen for further analyses:

A. Performance standards in the form of enforceable regulations, non-enforceable technical guidelines or voluntary mechanisms
B. Container labeling of DCM-based consumer products.
C. Phase-out of DCM-based consumer paint strippers. This was extended to include aerosol products.
D. Domestic phase-out of DCM applications.

Table 7: General management tools

Type	Point of application
Regulation	
Performance standards	Industrial users
Mandatory technology	Industrial users
Supplier controls (content restrictions)	Formulators (consumer products)
Phase out	Distributors
Economic Instruments	
Caps (quotas) and trading	Importers Distributors Formulators
Taxes or charges	Importers Distributors Formulators
Financial incentives	Formulators Industrial users
Recycling in place of Deposit-refund	Formulators Industrial users
Voluntary	
Non-structured agreements	Industrial users

Structured agreements	Industrial users
Information Provisions	
Labeling	Consumer products

While all management options were reviewed at the September, 1996 meeting of the Issue Table, only the four options listed above were selected for analysis. Regulatory measures that would prescribe specific technology was generally opposed by the industry representatives because this approach would not provide sufficient flexibility for industry to make the optimal emission reduction decisions in the most cost-effective manner.

Environment Canada advanced quotas as a management option because they would provide DCM reductions with certainty. Under a restricted supply, market demand would determine the commodity price among users who would compete for the available supply according to affordability. Some users would be forced to using alternate solvents or process technology or installing emission controls as the price of the commodity increased. Also, a quota mechanism is attractive because it would be fairly simple to administer by government in contrast to the complexity associated with compliance monitoring and enforcement programs of conventional regulatory instruments.

Several industry representatives stated that they would strongly oppose quotas if they restricted DCM imports because such measures would contravene the free trade provisions under the North American Free Trade Agreement or the General Agreement on Tariffs and Trade. A legal opinion received by Environment Canada, moreover, concluded that if a quota mechanism were to be considered, the quotas would have to be made to apply to all domestic uses as well as to imports of DCM to avoid possible contravention of international free trade rules.

Taxes, charges and financial incentives were viewed as too intrusive by the industry participants. If any financial incentive programs were to be established to offset investments in new plant equipment or environmental controls, the funds would have to be raised through taxes or charges on DCM. The administrative complexity and compliance monitoring costs to government of such programs are factors that would have to be considered.

Supplier controls in the form of restrictions on the content of DCM in paint strippers for example, were considered ineffective because users would end up applying greater quantities of the more dilute formulations. Therefore, the actual quantity of the active solvent used and attendant environmental releases would likely remain unchanged.

4.2 Economic analyses

4.2.1 Methodology

The four broad environmental control options outlined in the previous section were selected by the industry and government participants on the Issue Table as relevant options for economic analyses. Both cost-benefit and cost impact analyses were carried out to provide a basis for an evaluation of the options.

Cost-benefit analysis has inherent limitations because a monetary valuation of the benefits was possible only for reduced operating costs for certain industrial sectors and for the consumer paint stripping sector where benefits were determined in relation to health impacts. A valuation of the environmental impacts of DCM, as determined in the *Priority Substances Assessment* report, was not possible. The analysis also was not able to value the potential environmental or human health impacts associated with the use of alternative products.

The cost-benefit analysis was based on comparing the technical environmental control costs developed by CHEMinfo Services Inc. to the benefits associated with avoiding the estimated annual mortality risk among consumers using DCM-based paint strippers.

Health Canada estimated the theoretical risk of the number of deaths resulting from exposure during the use of consumer paint strippers to range as high as 3.3 per year among the estimated 1.3 million users, although a wide range of uncertainty is to be expected in theoretical risk assessments of this kind.

The associated monetary value of an avoided risk of mortality was assigned $6 million. Many studies that have attempted to value human life in a monetary context have been undertaken by worker unions in support of salary remuneration associated with jobs having risks of harm or death. Such studies have valued human life in the range from $2.3 to $10 million. The $6 million valuation used in the cost-benefit analyses in this report was selected as the amount of money society would be willing to pay to avoid the incremental risk of mortality due to cancer from exposure to DCM during stripping of paint.

A 10 % discount rate as prescribed by Treasury Board was applied in all of the analyses.

A full description of the economic analyses is contained in the Environment Canada report, *Economic Impact Analysis of Dichloromethane Management Options.*

4.2.2 Economic analyses of control options

4.2.2.1 Performance standards and container labeling of consumer products

The report by CHEMinfo Services Inc. presents preliminary cost estimates for three ranges of emission reductions for each of the application sectors based on technical control considerations relevant to each application of DCM. These annualized costs, which are summarized in **Table 6** of **Section 3**, were used by Environment Canada as the basis for assessing the impacts on broad revenues and profits within the product markets of each sector. The economic analyses conducted by Environment Canada on the three ranges of emission reductions are documented in the report, *Economic Impact Analysis of Dichloromethane Management Options.* The impacts of the recommended control actions resulting from the stakeholder consultations are taken from this report and are summarized for each sector at the end of the subsections within **Section 4**.

Because it was not possible to segregate the broadly coded revenue data obtained from Statistics Canada, the economic analyses in most cases were not able to assess the impacts on the revenues and profits on the portion of sales associated with the output of products or services that use DCM.

4.2.2.2 Domestic phase-out of DCM

An analysis of a domestic phase-out of DCM in all applications was conducted to evaluate the cost impact if such a measure were considered. This management option was advanced by Environment Canada for reasons stated earlier in **Section 4.1**, namely that a quota mechanism would be administratively simple and would achieve absolute DCM reductions. The quotas were arbitrarily set at reduction increments of 30 %, 70 % and 95 % in years three, six and nine within a ten-year time horizon.

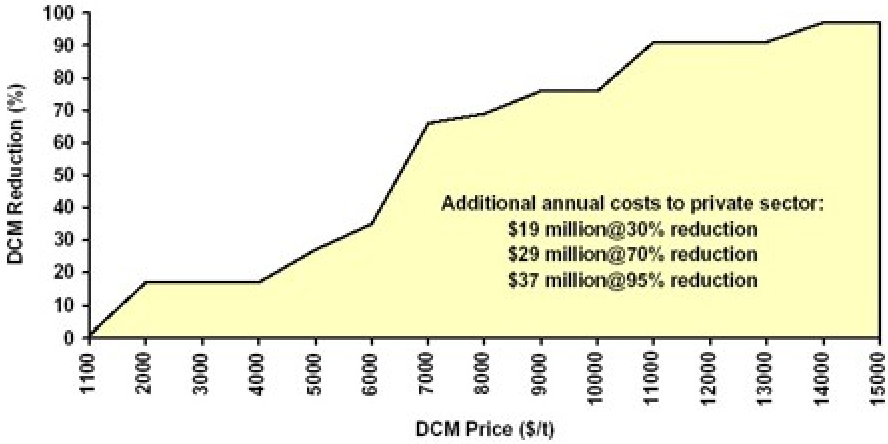
The benefit value used in this cross-sector analysis of cost-benefits, as in the analysis of the container labeling program, was based solely on reduced operating costs for specific sectors and the avoided mortality associated with consumer uses of paint strippers. Economic modeling of this kind is inherently limited in not being able to convey other benefits that might accrue from broad reductions in DCM use and environmental releases. Collateral benefits might include such things as reducing the quantities of a hazardous chemical and hazardous wastes being transported and the related lower expenditures of industry and government in managing the life cycle risks of this toxic substance.

The cost to government in administering the quota program was estimated at $100,000 in the first year of the program and $45,000 in each of the subsequent years based on experience with the quota program administered by Environment Canada for ozone-depleting substances.

The costs to the private sector were those developed by CHEMinfo Services and were used in the model to generate the price increase of DCM. The price of DCM would increase due to competing market demands for a diminishing supply of this commodity. As shown in **Figure 2**, the price of DCM would escalate to $4,400, $6,600 and $13,900 per tonne in years 3, 6 and 7 from the 1995 price of $1,100. Corresponding reductions in use would be 30 %, 70 % and 95 % respectively.

In year three, flexible polyurethane foam manufacturers would be the first to phase out this chemical because the cost of process changes would be less than continuing its use with current technology. In year six, DCM use in consumer and commercial paint stripping, pharmaceutical manufacturing and aerosol formulations would be phased out as the market price further increased. In year nine, adhesives, aircraft depainting, laboratories, and the manufacturing of chemical intermediates would remain as the only applications using DCM because either DCM could not be substituted with other chemicals or environmental controls would cost more than retaining DCM.

Figure 2: Affect on DCM price from declining use quotas



The additional annual costs to be accounted for by the private sector are $19 million, $29 million and $37 million respectively at the 30%, 70% and 95% reduction levels. If these reductions were implemented in years 3, 6 and 9, the present value of all costs to the private sector and to government over the ten-year period would be $115.9 million. The present value of the benefits would be $52.3 million. Consequently, the net present value is negative at $63.6 million (i.e. the present value of the costs exceeds the present value of the benefits).

Although a quota mechanism that would limit DCM imports would be far less complex than conventional regulatory instruments for government to administer, import quotas if challenged, may be found to contravene international free trade rules.

To avoid this potential contravention, quotas would have to be applied domestically and directed to users, which would significantly increase the administrative complexity of this mechanism. Notwithstanding this and other considerations, a general phase-out of DCM could not be justified on economic grounds based on the preliminary cost-benefit analysis.

There are also technical and economic constraints. Even though a phase-out through a quota measure provides flexibility to affected sectors, it remains that presently, some applications have no adequate alternatives to DCM, or very expensive alternatives. Consequently, the flexibility built into this approach is reduced.

4.3 Stakeholder discussions on evaluating specific control options

Following the first Issue Table meeting in September 1996, the two subsequent consultation meetings held May 26-30 and October 20-22 1997 focused the dialogue on identifying and selecting specific control options for each sector.

Initial proposals by Environment Canada on the specific control options for the respective sectors were discussed at the meeting held in May. At the October meeting, stakeholders reviewed more specific control measures as presented in Draft No. 1 of this report.

Environment Canada proposed the following general considerations to guide the discussions:

- Emission reduction targets could be applied to an individual facility or to the particular sector as a "bubble" target. The bubble approach, where appropriate, could provide more flexibility in decision-making among facilities within a sector since they could choose the technically optimum and most cost-effective means to meet the sector emission reduction target.

- Voluntary actions by industry to achieve emission reductions were encouraged as an alternative to government regulatory measures.

- Several voluntary mechanisms are available. Companies can register with Environment Canada's program on Accelerated Reduction and Elimination of Toxics (ARET). In other cases, emission reductions could be undertaken as a voluntary commitment in the form of a formal government-association agreement with the association acting on behalf of all member and non-member companies. Alternatively formal administrative government-company agreements could enjoin commitments to specific reductions in environmental releases.

- Annual reporting of DCM uses and environmental releases by facilities, where appropriate, would allow Environment Canada to track progress in DCM emission reductions. The National Pollutant Release Inventory (NPRI) was suggested as the preferred reporting vehicle, but this would require currently exempted facilities to commit to voluntary annual reporting to the NPRI.

The meeting discussions, organized into use sectors, are summarized in the following section.

Following the feedback received at the October meeting, changes were incorporated and the report was distributed December 30, 1997 as Draft No. 2 for a final round of comments. Written comments were received from HSIA and CFFMA, most of which were incorporated in the report.

4.3.1 Aircraft paint stripping application

4.3.1.1 Stakeholder discussions

The second Issue Table meeting on May 26, 1997 was attended by representatives of Air Canada, Bombardier/Canadair, Department of National Defense, Water Technology International Corporation, Flying Colors (a small aircraft refinishing company), Deane & Co. (a supplier of alternate strippers), CAE Electronics Ltd. (a supplier of dry media blasting technology), Dow Canada (a DCM supplier), the Halogenated Solvents Industry Alliance Inc., and Center for Emissions Control.

None of the 22 aircraft paint stripping facilities in Canada has emission control systems. Wastewater treatment systems, which treat DCM-contaminated wastewater, are in place at several of the large aircraft maintenance facilities. The Department of National Defence (DND) operate a paint stripping facility for small aircraft at Trenton, Ontario. Paint stripping of all other DND aircraft and vehicles are contracted out to the private sector.

Air Canada recently completed evaluations on the stripping of two medium and one large aircraft with alkaline benzyl alcohol, which worked well technically but required 12 to 16 hours of reaction time compared to 30 minutes for DCM solvents. As a consequence, aircraft stripping operations would have to be redesigned substantially to accommodate the much longer reaction time of the weaker solvent.

The Canadian military and some commercial airline companies and manufacturers are committed to using DCM alternatives as much as is practical. Company representatives noted that re-education of personnel and re-designing of aircraft depainting and refinishing practices would be needed to reduce the costs of implementing benzyl alcohol stripping or other paint stripping technologies.

Approximately 67 % of the DCM used for aircraft paint stripping is used for stripping small aircraft. Company representatives from the small aircraft refinishing sector described their activities as more business oriented where facilities commonly use refinishing to attract business for other services such as maintenance and interior renovations.

Satisfactory alternatives to DCM have not been found for certain specialized aircraft or for aircraft with many layers of built-up coatings. Any change to alternative paint strippers may be more difficult for this small business sector. The representative for Flying Colors Ltd. stated that it would be technically difficult to eliminate DCM for small aircraft paint stripping.

In the U.S., only 10 % to 20 % of the small aircraft refinishing industry would be subject to EPA's aerospace NESHAP according to the CEC representative. Some Issue Table participants suggested, however, that some states and the EPA may further restrict DCM use in the future and may include the small aircraft facilities. The Canadian companies are concerned that, if controls were imposed in Canada with unrealistic time frames, Canadian companies may not be competitive with companies in the U.S.

The technical control options report by CHEMinfo Services concluded that overall sector reductions of approximately 20 % can be achieved through better operating practices. Environment Canada encouraged the companies to adopt and implement operating practices in the short term that could achieve this nominal reduction because such changes would not incur significant expenditures.

A 50 % emission reduction goal was proposed at the May 26 meeting as attainable based on increasing the use of non-DCM strippers for components or for whole aircraft in the small, medium and large aircraft size categories. An 80 % reduction was discussed as an emission performance target over a longer time horizon. The 80 % reduction would be similar to the emission control requirement contained in EPA's current National Emission Standard for Hazardous Air

Pollutants (NESHAP) for the aerospace sector. It is understood that, in practical terms, the high capital and operating costs of such control systems will inherently cause a shift to non-DCM solvents and possibly to dry media blasting technology when the latter technology is proven.

Several companies in North America, including CAE Electronics Ltd., Montreal, are developing dry media blasting for medium and large size whole aircraft. This technology, when proven, may provide a cost-competitive alternative to solvents in the future. Dry media blasting technology is currently used for paint stripping of aircraft components and aircraft surfaces constructed of composite materials, the latter being associated with military aircraft in the services of forces in Canada and USA.

The industry representatives emphasized the need to ensure that any future environmental regulations provide a "level playing field" within the aircraft sector, particularly among the small aircraft maintenance facilities that are less inclined to implement changes voluntarily than the major airlines. Regulatory measures are likely needed to ensure that small aircraft maintenance facilities implement environmental controls.

Environment Canada challenged industry to achieve the reduction goals through voluntary commitments. Participation in the Accelerated Reductions and Elimination of Toxics (ARET) program would provide an established mechanism in this regard. Alternatively, administrative agreements between government and the individual companies could enjoin companies to meet specified emission reductions. An administrative agreement with an association is not possible for this sector since the small maintenance firms do not have an association. Although carriers are members of the Air Transport Association of Canada (ATAC), its mission does not encompass environmental business.

The Air Canada representative expressed interest in pursuing participation in Environment Canada's program on the Accelerated Reduction and Elimination of Toxics. The representative of the Department of National Defense stated that DND is currently participating in the ARET program and continues to evaluate options to minimize DCM in its varied uses for aircraft paint stripping, parts cleaning, degreasing, etc.

In a letter to the aircraft depainting facilities dated July 17, 1997, Environment Canada proposed a staged emission reduction approach with elements of mandatory and voluntary compliance approaches. In the first phase, a 50 % reduction in DCM was proposed by 2002 relative to the estimated total use of 200 tonnes in 1995. The concept was to provide an option for industry to achieve the reductions within a "bubble" applied over all paint stripping facilities or to achieve the reduction at each facility. If voluntary actions did not attain this reduction target, it was proposed that regulatory measures would be implemented in 2003.

In the second stage, an 80 % emission reduction by 2007, or earlier, was proposed in the July letter. This reduction target is based on the capability of solvent vapor capture and control technology as defined in the EPA NESHAP. An annual allowance of 100 kg per year of DCM per aircraft (medium and large aircraft), and 50 kg for small aircraft, would be provided for spot stripping and stripping of components for facilities that choose to phase out DCM solvents for whole aircraft depainting.

For new aircraft depainting facilities constructed after January 1, 1999, emission controls capable of 90 % DCM removal were proposed, although this date was amended to year 2000 for all industrial sectors as being a more practical date.

In order to track progress in DCM use and emission reductions, it was proposed that all facilities report to Environment Canada's National Pollutant Release Inventory even though some may be currently exempted from mandatory reporting. For those facilities that participate in the ARET program, NPRI reporting would not be needed.

Only Air Canada replied to the July letter from Environment Canada indicating its support to the proposed control actions.

The third Issue Table meeting October 20, 1997, was attended by representatives of Air Canada, Canadian Airlines International, Department of National Defense, Canadian Auto Workers Locals 112 and 1967, Flying Colors (a small aircraft refinishing company), Deane & Co. (a supplier of alternate paint strippers), Dow Canada (a DCM supplier), the Halogenated Solvents Industry Alliance, and the Canadian Environmental Network.

During the discussions on the preliminary recommendations in Draft No. 1 of this report the industry representatives supported the proposed control actions, although the representative of Canadian Airlines International was not able to commit to the emission reductions since major new expenditures are difficult while the company is facing an uncertain financial future.

The CEN representative made the general comment that CEN has submitted a recommendation to Environment Canada to lower the 10 t/y criteria for mandatory reporting to the NPRI.

The representative of the Center for Emission Control (CEC) suggested an outreach by government to disseminate information on on-going research on alternate solvents and paint stripping technologies to companies, particularly the small firms who may not have easy access to the most recent R&D information.

4.3.1.2 Economic impacts

The environmental control costs, estimated by CHEMinfo Services at $2,920,000 and $5,840,000 annually, would add about 1 % and 2 % respectively to the reported airline industry losses of about $302 million in 1995 to achieve 50 % and 80 % emission reductions. While these costs are negligible when the total revenues are considered for the airline industry as a whole in 1995, the cost among small firms maintaining general aviation aircraft likely will be significant.

It is to be expected that the cost impact on individual airline companies or on small aircraft maintenance firms would vary widely as they convert to alternate solvents, the probable choice of this industry rather than installing emission control systems that would be prohibitively expensive. The representative for a small aircraft manufacturer had stated during the consultation meetings that conversion to alternate solvents could increase the costs to the small Canadian aircraft refinishing companies to the extent that they may not be competitive with companies in the U.S. No data, however, was provided in support of this claim.

In other communications, a small aircraft refinisher with a typical business volume of about 50 aircraft per year in sizes up to a Beech 190 aircraft, informed Environment Canada that conversion to alternate solvents was feasible. The recommendations being proposed would enable the company to adjust to the alternate solvents while being able to use the annual DCM allowance of 50 kg per aircraft for tough jobs.

4.3.2 Consumer and commercial paint stripping applications

4.3.2.1 Stakeholder discussions

The second Issue Table meeting held May 27, 1997 was attended by representatives from Swing Paints, LePage, Recochem, Fielding Chemicals, Home Hardware, John Goudey Mfg. (consumer/commercial paint stripping formulators/distributors), Clark's Antique Specialty Supply (a furniture refinisher), Techno-Strip Industries (an automotive parts refinisher), Van Waters & Rogers, Canada Colors & Chemicals (DCM distributors), Dow Canada (a DCM supplier), ISP Canada (a supplier of alternate strippers), and the Halogenated Solvents Industry Alliance Inc.

Environment Canada advanced for consideration, both mandatory container labeling of consumer products and a phase-out of DCM-based solvents in the consumer market. The results of preliminary cost-benefit analysis of phasing out DCM-based paint strippers and a cost impact analysis of container labeling were presented in support of these options.

These analyses were based on an assessment by Health Canada of the potential health risk of consumers using paint strippers as discussed in **Section 4.2.1**.

Container labeling was advanced as a means to inform consumers of the hazard associated with the improper use of products in the same way that commercial and industrial users have access to Material Safety Data Sheets through the Workplace Hazardous Materials Information System (WHMIS).

The phase-out of DCM-based paint strippers was advanced by Environment Canada and Health Canada as a means of eliminating with certainty the health risk associated with exposure to this solvent.

Some industry representatives questioned the assumptions used in Health Canada's draft risk assessment that made theoretical estimates of the annual mortality associated with consumers exposed to DCM-based paint strippers. The average annual mortality, in the draft document presented by Health Canada at the May 1997 meeting, was estimated to be in the range up to 1.1 among the estimated 1.3 million users. Subsequently, Health Canada revised this earlier exposure estimate and derived a higher estimate of annual mortality that could range up to 3.3. The revised draft document was transmitted July 28, 1997 by the Issue Table Chair to stakeholders with the record of the May meeting.

The CEC representative provided information on consumer product labeling mandated in 1987 in the U.S. by the Consumer Products Safety Commission. Studies of use patterns among consumers of paint strippers showed that fewer people used DCM products after package labeling became law. In particular, package labeling was effective in warning infrequent users about the potential health hazards of DCM and about the need to work in properly ventilated areas.

During the discussion on Environment Canada's cost-benefit analysis of a phase-out of DCM-based strippers, which would have positive net economic benefits, some industry representatives strongly opposed this suggested course of action for a number of reasons. Some of the alternate solvents are flammable, some cause eye irritations and for some, the toxicity is not fully established. In the case of nMP, which is highly absorptive through skin tissue, some industry representatives argued that its toxicology is not as well defined as it is for DCM and may pose unknown risks as great as DCM. The representatives of the HSIA and Swing Paints stated that it would be premature to phase out DCM-based strippers when alternate products have not been proven safe.

With regard to Environment Canada's analysis of the cost impacts of mandatory container labeling, some industry representatives questioned the appropriateness of the broad assumptions used in the analysis. Several industry representatives questioned the validity of the cancer risk analysis by Health Canada since recent scientific studies show that DCM does not pose a cancer risk to humans. Other industry participants felt that assessing the labeling cost impact against the aggregated total revenues and profits from sales of all paint and varnish products was misleading. They argued that the cost impact analysis should be assessed against the paint stripper market alone in which case the impact could be significant. The impact would be even greater and more significant on individual companies that produce DCM-containing formulations as their major or only product.

The representative of the LePage Division of Henkel Ltd. stated that her company has been an industry leader in package labeling and supported mandatory labeling. The representative of Techno-Strip Industries Ltd. indicated that his company has reduced DCM for stripping automotive parts in favor of non-DCM solvents.

The Fielding Chemicals Ltd. representative stated that an earlier evaluation of paint strippers under Environment Canada's former Environmental Choice program concluded that DCM solvents were the best products when efficacy and environmental impacts were considered.

The Swing Paints Ltd. representative strongly opposed container labeling if it were to be applied to DCM-based products alone, again based on the reason that alternate products may also pose health risks. He also pointed out that nMP is very slow drying and has to be wiped off surfaces with another organic cleaning solvent, some of which will be reactive VOCs thus creating an environmental impact of another kind. The additional solvent adds to the cost, which had not been factored into the cost impact analysis done by Environment Canada.

In summary, the industry representatives supported mandatory labeling provided that it was applied to all paint stripping solvents. The representative for CEN supported mandatory labeling even if it could not be applied to all products. There was some discussion as to whether the *Consumer Chemicals and Containers Regulations* (CCCR) under the *Hazardous Products Act* or the *Canadian Environmental Protection Act* is the most appropriate enabling legislation. Environment Canada undertook to communicate with Health Canada and to determine the possible applicability of the HPA regulations, which would be preferred over having another set of regulations under CEPA. The results of this communication and further information on the CCCR are discussed in Section 5. It was generally agreed that the implementation date proposed for labeling should be harmonized with the CCCR, if it is determined that these regulations provide the appropriate enabling authority.

The Chair stated that it was not possible for Environment Canada to have container labeling apply to paint strippers whose active ingredients were substances that have not been assessed as toxic pursuant to the provisions of CEPA. Consequently, container labeling if mandated under CEPA could only be made to apply to DCM-based products.

In response to the arguments advanced by the industry participants over the lack of proven safety of alternate solvents, the Chair suggested that this report would include a recommendation to have the federal government undertake scientific assessments on the environmental and health toxicity of alternate solvents. The Chair, however, did not rule out the possible future reconsideration to eliminate DCM-based stripping formulations.

Such action would have to consider the scientific assessments of alternate solvents by Environment Canada and Health Canada. In the absence of this information, no recommendation can be made on the acceptability of alternate solvents at this time.

Emission reductions of approximately 20 % can be expected as a result of product labeling and education of consumers on the proper use of DCM paint strippers based on a qualitative assessment of changes in consumer product sales following the implementation of labeling in the US in 1987. Similar reductions can be assumed for consumer uses of cleaning solutions and aerosols.

With regard to the discussions on commercial furniture stripping it was noted that work practices guidelines have been developed in the U.S. It was agreed that similar guidelines should be developed for the Canadian facilities. Industry supported the development of these guidelines. The representatives of the Halogenated Solvents Industry Alliance and the Center for Emissions Control stated that they would be willing to assist in the development of guidelines for furniture stripping operations as well as for commercial automotive stripping applications. The intent is to have these guidelines prepared before the year 2000. Conservation practices through the adherence with such guidelines are expected to reduce DCM emissions about 20 %.

The third Issue Table meeting on October 22, 1997, was attended by representatives from Swing Paints, LePage, Recochem, Fielding Chemicals, John Goudey Mfg. (consumer/commercial paint stripping formulators/distributors), Clark's Antique Specialty Supply (a furniture refinisher), Techno-Strip Industries (an automotive parts refinisher), APCO Industries, Canada Colors & Chemicals (DCM distributors), Dow Canada (a DCM supplier), the Halogenated Solvents Industry Alliance and the Canadian Environmental Network.

Considerable discussion ensued around the recommendation to mandate container labeling and on the need for government to conduct scientific assessments on the toxicity of alternate solvents. Several industry representatives repeated their earlier concern over the appropriateness of Health Canada's cancer risk assessment when scientific evidence suggests that DCM does not present a cancer risk to humans. The representatives from all manufacturers of consumer paint stripping solvents re-iterated their strong opposition to mandatory container labeling if the requirement is to apply only to DCM-based products on the grounds that other solvents have not been proven safe. The Dow Canada representative pointed out that the *Consumer Chemicals and Containers Regulations* (see **Section 6.1**), which are in the process of being amended from a list-based regulation to one based on toxicity criteria, are expected to apply to all products. As a result, the concerns of industry would be addressed in this regard.

With respect to the recommendation directed to the federal government to conduct toxicity assessments of alternate solvents, various views were expressed on the placement of this recommendation in the Executive Summary. Some members suggested re-locating this recommendation and making it a "general recommendation" because the potential toxicity of alternate solvents is a barrier to phasing out DCM in other applications as well. The Chair stated that he would consider making this a general recommendation.

In the event that the CCCR are not amended, the Chair stated that the recommendation to implement labeling through the *Canadian Environmental Protection Act*, which could only be made to apply to DCM-based strippers, would remain. To delay the implementation of labeling while waiting for the completion of toxicity assessments of alternate products by the federal government would be neither responsive to the expectations for control actions on DCM nor equitable in relation to the control actions being asked of the other users of this substance.

4.3.2.2 Economic impacts of container labeling on the consumer paint stripping sector

Economic analyses were conducted by Environment Canada to assess both cost impacts and cost-benefits of labeling applied to consumer paint stripping products.

The cost to label containers and to provide information pamphlets was estimated by CHEMinfo Services at $225,000 annually for consumer paint strippers.

The 1995 revenues of DCM-based paint stripper sales were determined from data contained in the report by CHEMinfo Services since the Statistics Canada data only reported the aggregated paint and varnish market revenues. Sales revenues were estimated at $13,750,000. Total profits would be about $1,000,000 if a profit margin of 7 % is applied against the revenues.

The resulting impact of the labeling program costs was estimated to be about 23 % on the annual profits from paint stripper sales. When the costs are applied to the aggregated sales of all varnishes and paints, as reported in the Statistics Canada data, the impact would be less than 0.2 %.

The cost-benefit analysis of labeling and consumer education programs was based on the benefits associated with avoiding the mortality risk among users of consumer paint strippers.

In order to evaluate the benefit impact of a labeling program, two assumptions are central to this analysis. First, an assumption has to be made about the estimated annual risk of mortality from cancer of persons exposed to DCM. Such an estimate assesses the number of persons that use DCM paint strippers, the average annual exposure of a person and the exposure circumstances.

Second, it is assumed that labeling would, at least theoretically, inform consumers sufficiently to cause them to avoid or minimize their exposure to DCM when stripping paint or using DCM-based aerosol or other products. The avoided exposure, in turn, would avoid the annual mortality risk as determined by Health Canada's exposure assessment. Further details on the exposure assessment and the theoretical estimates of mortality among consumers using DCM-based paint strippers are contained in the report by Health Canada, *Estimated Cancer Deaths due to DCM Exposure from Consumer Paint Stripping in Canada.*

In the economic analysis, $6 million was selected by Environment Canada to represent the value that society would be willing to pay to avoid the incremental risk of mortality due to cancer.

In addition to the costs incurred by industry for the product labeling program, the costs to government that would be associated with compliance monitoring also are included in the analysis. Program administration was estimated to cost government $100,000 in the first year of the program and $45,000 in each of the subsequent years for each of the product sectors. Environment Canada based the government cost on the ozone-depleting substances and phosphate in detergents programs. The ozone-depleting substances program has some similarity to this context since it deals with consumer products that involve monitoring of domestic and imported products while the detergents monitoring program involves monitoring of products at retail.

In the economic model, the time horizon assumed that labeling would be implemented in year three of an arbitrary reference scale, and that seven years beyond this time would be a reasonable period over which to assess the costs.

The costs to industry and the costs incurred by government as well as the health benefit value over a ten-year period are calculated as present values to 1995 as shown in **Table 8**.

Table 8: Costs and benefits analysis of consumer paint stripper container labeling (over a ten-year period referenced to 1995, $000)

Total costs to the private sector	Present value of private sector costs	Total costs to government	Present value of government costs	Present value of all costs	Total benefits	Present value of benefits	Net present value
1,800	1,000	415	240	1,250	158,400	88,500	87,300

The net present value, which represents the difference between the present value of costs and present value of benefits, was determined to be as high as $ 87.3 million over the ten-year time horizon.

Various factors such as the environmental control costs and their affects on the margin of profit, the types of products manufactured, the relative sales volumes of different products, the corporate ownership, and the time frame allowed for attaining compliance, etc. all could affect specific firms in different ways. Each firm would have to assess its circumstances and decide on the course of action that would minimize its cost impacts. A firm manufacturing more than one product line for example may choose to discontinue the targeted product if this served its interests. A firm having U.S. affiliates could benefit by exiting this segment of its production in Canada and shift the product line to its U.S. affiliate that is equipped to handle container labeling.

If labeling were mandated for domestic consumer products, it would be necessary also to mandate the same labeling specifications on imported products. Failure to do so would undermine the environmental protection measures taken domestically.

4.3.2.3 Economic impacts from a phase-out of DCM-based paint strippers

An analysis of the costs and benefits was undertaken of the economic impact arising from a phase-out of DCM-based consumer paint strippers, an option advanced by Environment Canada. A phase-out could be implemented by applying progressively declining quotas on the quantity of DCM used in the manufacture of these products. Since measures taken to prohibit the domestic manufacture of DCM-based products would not prohibit imported products, additional measures would have to be taken in this regard.

It is noted that any measures taken to prohibit the importation of targeted products may contravene international free trade rules, which would mean that domestic sales of the targeted products would have to be prohibited as well. Because of the international trade implications, it would be necessary to obtain legal advice should this measure be pursued.

The annual cost to industry was estimated by CHEMinfo Services at $5,400,000.

Program administration was estimated to cost government $100,000 in the first year of the program and $45,000 in each of the subsequent years. Environment Canada based this estimate on its ozone-depleting substances and phosphate in detergents programs. The ozone-depleting substances program has some similarity to this context since it deals with consumer products that involve monitoring of domestic and imported products while the detergents monitoring program involves monitoring of products at retail and conducting analytical analysis on selected retail products.

In the economic analysis, the benefit valuation was based on $6 million as the value that society would pay to avoid the incremental risk of mortality due to cancer from exposure to DCM among users of paint stripping products.

If a phase-out were mandated in year three of an arbitrary ten-year time horizon, the present value of benefits would exceed the present value of costs, excluding any costs associated with the use of alternative chemicals, up to $63.3 million as shown in **Table 9**.

Table 9: Costs and benefits analysis of a phase-out in DCM-based consumer paint stripper products (over a ten-year period referenced to 1995, $000)

Total costs to the private sector	Present value of private sector costs	Total costs to government	Present value of government costs	Present value of all costs	Total benefits	Present value of benefits	Net present value
43,200	23,800	415	240	24,000	158,400	87,300	63,300

This option was strongly opposed by the consumer paint stripping industry representatives who considered such a measure extreme and unnecessary when labeling would provide the desired human health protection.

4.3.2.4 Economic impacts on the commercial paint stripping sector

The implementation of best work practices by the small commercial paint stripping facilities would be achieved through the development of work practices guidelines and attendant training programs. Better operating practices may achieve up to a 20 % emission reduction. CHEMinfo Services estimated the training programs to incur annual costs of $175,000. When these costs are considered against estimated revenues of $100 million annually, the impact would be negligible. The impact would be about 10 % on profits of about $1.8 million in 1995 based on a margin of about 1.8 %.

4.3.3 Flexible polyurethane (PU) foam application

4.3.3.1 Stakeholder discussions

The second Issue Table meeting May 28, 1997 was attended by representatives from Foamex Canada, Valle Foam Industries, Vitafoam Products, Woodbridge Foam (manufacturers of flexible polyurethane foam), APCO Industries (a DCM distributor), Dow Canada (a DCM supplier), the Halogenated Solvents Industry Alliance, and the Canadian Environmental Network.

Environment Canada presented information on its preliminary economic analysis of the cost impacts of the control options identified in the report by CHEMinfo services as well as information on the Accelerated Reduction and Elimination of Toxics program.

Several participants from the foam manufacturing sector pointed out that the industry has recently adjusted, at considerable expense, to the phase out of CFCs formerly used in foam blowing. DCM was universally adopted as the replacement blowing agent because of its suitable chemical and physical properties as well as for important safety considerations because it is non-flammable. Government's current exercise to now control DCM makes it difficult for industry to adjust yet again to changing environmental needs that could have been set out at the time when CFCs were being phased out.

When industry representatives were asked at the May 28 meeting about their views on attainable emission reductions, they unanimously supported voluntary actions. While the voluntary approach is preferred, the industry participants also emphasized the need to maintain a "level playing field" among all manufacturers.

Environment Canada proposed a two-phase approach that would involve an intermediate reduction target and a longer time horizon to achieve a phase out of DCM. In the first phase, a 50 % emission reduction was suggested for 2002 based on the consideration that foam softening agents could be used to reduce the need for DCM as an auxiliary blowing agent for certain grades of foam. Discussion ensued around the feasibility of a 50 % reduction or a 68 % reduction. The 68 % reduction was understood by Environment Canada as the reduction anticipated from the proposed EPA NESHAP, which prescribe allowable quantities of DCM to be used in manufacturing various foam grades.

Environment Canada suggested that industry could consider the reduction target against the total sector emissions as a kind of "bubble" within which each facility would decide its reduction share. Alternatively, the conventional approach would be for each facility to reduce emissions 50 %.

The enabling mechanisms for voluntary actions could be Environment Canada's program on Accelerated Reduction and Elimination of Toxics (ARET) or an administrative agreement between government and the Association. In the former approach, individual companies would be required to file a submission to the ARET Secretariat. In the latter approach, all companies including non-member companies of the Association would be enjoined to the emission reductions specified in the signed agreement. The representative for Foamex Canada Ltd. stated that, as a member company of the Canadian Flexible Foam Manufacturers Association (CFFMA), he would contact the member and non-member companies of the Association to sound them out on the voluntary concept.

Environment Canada proposed the elimination of DCM as an auxiliary blowing agent in a longer time horizon of 2007 as a technology-forcing recommendation. This was based on the consideration that several CO_2 foam-blowing technologies are currently available. This technology is licensed to some 20 plants worldwide although no installations are currently operating in Canada. One technology, the CarDio™ technology, may be capable of making all but the softest densities of flexible foam products. It was noted that one Canadian flexible foam manufacturer plans to switch its process to the CO_2 technology.

The Dow Canada Ltd representative suggested that the acceptability of CO_2 technology be reviewed in relation to Environment Canada's policies on greenhouse gas emissions.

The Woodbridge Foam Corporation representative mentioned that, for the reason of lower cost, polyester fibre fill is replacing flexible foam as the backing in furniture cushions. Consequently, this shift away from foam is resulting in a market loss for foam, and should be considered in Environment Canada's economic impact analysis.

The Dow Canada Ltd. representative further suggested that the economic analysis also should consider the consequent impact that Environment Canada's pending scientific assessment of ethylene glycol in the *Priority Substances List 2* may have on costs, should this chemical be determined toxic. Since ethylene glycol is used in the manufacture of polyester fibre fill, consequent future environmental controls that may be imposed on the manufacture of polyester fibre fill may favor a market demand back to polyurethane foam.

The representative of the Canadian Environmental Network stated that, while he supports the emission reduction goals, CEN does not support voluntary compliance mechanisms.

Several industry representatives expressed concern over plans of the Ontario Ministry of Environment and Energy to tighten the 1/2-hour point of impingement and 24-hour ambient air standard respectively from 5,300 $\mu g/m^3$ to 150 $\mu g/m^3$ and from 1,765 $\mu g/m^3$ to 50 $\mu g/m^3$.

The Chair stated that it would have been helpful to have a representative from the OMEE participate in these meetings, however, no provinces opted to participate except BC, which is participating as a corresponding member.

The representative of Foamex Canada Ltd., which uses HCFCs in the manufacture of specialty low-density foams, was made aware of Environment Canada's proposed plans to mandate the phaseout of HCFCs in year 2020. Meanwhile, regulations are being developed to restrict HCFCs to applications where they replace ozone-depleting substances.

Following the discussions and advice received at the May 28 meeting, Environment Canada, in a letter to the Canadian Flexible Foam Manufacturers Association dated June 10, 1997, outlined the proposed reduction goals and timelines. In order to track progress in DCM use and emission reductions, it was proposed that all facilities report to Environment Canada's National Pollutant Release Inventory even though some may be currently exempted from mandatory reporting. For those facilities that would participate in the ARET program but do not meet the reporting criteria set by NPRI, they would not need to report to NPRI so as to minimize reporting to government.

The third Issue Table meeting on October 21, 1997 was attended by representatives from Foamex Canada, Valle Foam Industries, Vitafoam Products, Woodbridge Foam (flexible polyurethane foam manufacturers), Chemcrest (a molded foam manufacturer), APCO Industries (a DCM distributor), Dow Canada (a DCM supplier), a representative from Canadian

Auto Workers Local 112, the Halogenated Solvents Industry Alliance, Ontario Ministry of Environment, and the Canadian Environmental Network.

The CFFMA representative, referred to the Association's written response, dated August 26, 1997 to the proposal contained in Environment Canada's letter. The Association concurs with the proposed course of action with the exception of the 68 % DCM reduction target for existing facilities. The industry representatives maintained that this reduction was not feasible with chemical softening agents since Environment Canada based its technical goal on broad reductions estimated to be achieved by the DCM restrictions proposed in EPA's NESHAP for flexible polyurethane foam production. The extrapolation of the US control measure, which proposes to place a set of complex limits on the quantities of DCM allowed for production, should not be translated directly to a process control objective. Since CFFMA's proposal for 50 % emission reduction can be achieved with process changes using chemical softening agents, the 50 % reduction goal was accepted by Environment Canada.

The CFFMA representative stated that in his communication with member companies all supported the 50 % emission reduction as a goal for each company, and although costly, they intend to undertake the necessary process changes voluntarily. By allowing the reduction to be applied to a company rather than individual facilities, industry will be able to choose the best combination of measures among its individual facilities. All companies intend to participate in the ARET program.

With respect to the proposed recommendation for a 50 % emission reduction to DCM-based foam blowing processes at new facilities effective January 1, 2000, the representative for CEN suggested that this be changed. He suggested new DCM-based processes be prohibited in view of the phase-out being proposed for the year 2007. In subsequent discussions with four manufacturers, they accepted a proposal by the Chair that would restrict DCM use to a quantity equivalent to the emissions resulting from 90 % emission control on current DCM-based foam blowing processes. Although new foam blowing technologies are likely to use CO_2, this provision would allow some auxiliary use of DCM for an interim period to establish the full reliability of the CO_2 foam blowing technology.

The representative of the Ontario Ministry of Environment described the program and consultation process that began in 1996 to update the ministry's ambient air quality standards. DCM was among the first group of air pollutants selected for review. Ontario's regulatory program is based on the Point of Impingement Standards for air pollutants in conjunction with a prescribed atmospheric dispersion model for determining allowable emission rates under Certificates of Approval. Revised 24-hour Ambient Air Quality Criteria and ½-hour Point of Impingement Standards for a number of pollutants, including DCM, have been proposed. The ministry will be developing policy options for implementing the proposed air quality standards and further consultations with stakeholders are anticipated in this regard.

The Vitafoam Products representative asked if the MOE and Environment Canada could coordinate their efforts. The Woodbridge Foam representative expressed concern over Ontario's very stringent proposed ½-hour Point of Impingement Standard, which would require over 90 % reduction in emissions from his company's facility. The MOE representative stated that the ministry will work to ensure that provincially-imposed controls would be compatible to the greatest extent possible with the recommendations resulting from the federal government's consultations on DCM.

4.3.3.2 Economic impacts

The 50 % in emission reductions were estimated by CHEMinfo Services to cost industry about $2.0 million annually. These costs would account for less than about 0.5 % of about $630 million total revenues and about 5 % of about $45 million total profits when the costs are applied to the aggregate revenues in the foam and plastics market. When the costs are applied to the portion of the estimated product sales associated with dichloromethane-manufactured foams, which account for about 35 % of all foams produced, the impacts would be about 1 % and 13 % respectively.

The costs to convert to non-dichloromethane manufacturing processes were estimated by CHEMinfo Services at about $3.5 million annually. The elimination of DCM in the long term as proposed would account for about 22 % of the estimated total $15 million profits associated with the portion of the foam market that formerly used dichloromethane in the manufacturing process.

4.3.4 Pharmaceutical and chemical intermediates manufacturing applications

4.3.4.1 Stakeholder discussions

The second Issue Table meeting on May 29, 1997 was attended by representatives from Novopharm representing the Canadian Drug Mfr. Assoc., Merck Frosst, Wyeth-Ayerst (pharmaceutical manufacturers), Torcan Chemical, Raylo

Chemical (chemical intermediates manufacturers), Van Waters & Rogers, APCO Industries (DCM distributors), Dow Canada (a DCM supplier) the Halogenated Solvents Industry Alliance, and the Canadian Environmental Network.

All companies reported that research and technology development to replace DCM tablet coating processes are always on-going. For some pharmaceutical products, non-DCM processes are already in place while for other products long term research studies are needed to establish the integrity of alternate processes, such as shelf life and compatibility between the substrate and aqueous processes - a special problem with water soluble substrates. Some companies have been able to convert to aqueous tablet coating technology, but at substantial cost, largely associated with the long and complex drug approval protocol of the Health Protection Branch of Health Canada. The Merck Frosst representative stated that his company no longer uses DCM in its tablet coating processes.

Some industry representatives, in response to Environment Canada's proposal to consider a phase-out of DCM, suggested that regulatory actions taken by government in support of environmental quality goals should recognize possible essential uses of DCM. The representative of Merck Frosst, although the company is not a user of DCM, commented that the life-saving benefits of a drug far outweigh the negligible environmental risk associated with DCM used in manufacturing processes.

The industry representatives suggested that Environment Canada coordinate its consultation process with Ontario Ministry of Environment and Energy, which is proposing to tighten its ½-hour Point of Impingement ambient air quality standard. The Chair stated that the Province of Ontario, as others, had been informed and invited at the outset to participate in these consultations but had declined. An invitation to Ontario, however, would be extended for the third meeting anticipated in October.

The Novopharm representative stated that the company has converted some of its production to non-DCM tablet coating and continues to evaluate aqueous coating technology for other applications, some of which still require long term testing. Novopharm will try to maximize the aqueous technology and work towards a 50 % to 75 % reduction in 2000.

Taking into consideration the comments received at the May 1997 meeting, it was concluded that a two-stage control approach might be appropriate. In the first phase, voluntary actions would allow companies to meet the proposed 90 % emission control target, effective January 2002 for existing facilities. The 90 % control would apply as the efficiency to be obtained from DCM capture and removal technology for tablet coating processes. In the second phase, the 90 % emission control would be mandated if voluntary actions did not achieve the reduction target by 2002. By taking the performance standard approach, rather than mandating the elimination of DCM, the concerns of industry would be accommodated in situations where DCM is needed for manufacturing chemical intermediates, in tablet coating processes or for research and technology development.

In general, the industry representatives supported reductions in environmental releases of DCM, and would prefer to implement these through voluntary actions.

Voluntary mechanisms could involve an administrative agreement with the Pharmaceutical Manufacturers Association of Canada (PMAC) and Canadian Drug Manufacturers Association (CDMA), or individual agreements with the each company. Participation in Environment Canada's program on Accelerated Reduction and Elimination of Toxics (ARET) would be another option. Since one pharmaceutical manufacturer used over 80 % of the total DCM used by all facilities, compliance with the proposed emission reduction target would be most easily facilitated through industry's participation in the ARET program. The representative for Novopharm stated that his company would work towards a 50 % to 75 % reduction in the 2002 to 2003 time frame, but not through any formal commitment to a program such as ARET.

With respect to the use of DCM in the manufacture of intermediate chemicals, the participants concluded that no additional controls are considered necessary because current processes capture over 90 % of the DCM used.

In order to track progress in DCM use and emission reductions, it was proposed that all facilities report to Environment Canada's National Pollutant Release Inventory even though some may be currently exempted from mandatory reporting. For those facilities that participate in the ARET program and that do not meet the reporting criteria of NPRI, reporting to the NPRI would not be needed.

The third Issue Table meeting on October 21, 1997 was attended by representatives of Novopharm representing the Canadian Drug Mfr. Assoc, Merck Frosst, Glaxo Wellcome (pharmaceutical manufacturers), Torcan Chemical (a chemical intermediates manufacturer), APCO Industries (a DCM distributor), Dow Canada (a DCM supplier), the Halogenated Solvents Industry Alliance, the Ontario Ministry of Environment, and the Canadian Environmental Network.

The Novopharm representative re-iterated the company's commitment to maximizing its use of aqueous technology and thought that a 90 % reduction would be achievable by 2002.

The Glaxo Wellcome representative noted that while the company is currently using only a small quantity of DCM, a recent business opportunity would require the use of DCM in the manufacture of the new product. He expressed concern that the proposed control requirements would add to the production costs thereby making the business opportunity unattractive.

Considerable discussion ensued around the wording and the effect of an emission reduction target of 90 % as opposed to a control target. It was generally agreed that a 90 % emission reduction requirement coupled with a 90 % emission control requirement should be included as the recommended control options. This would allow companies the choice of reducing emissions by changing to aqueous technology or by retaining the DCM process technology and installing add-on emission controls.

The Merck Frosst representative suggested adding a further requirement for existing facilities that manufacture new pharmaceutical products should be required to install emission controls effective January 1, 2002. A provision such as this would ensure that all manufacturers install emission controls even though a manufacturer could possibly achieve the 90 % reduction without installing emission controls. If emission controls were not required, a manufacturer, after reducing its DCM emissions by 90 %, might retain a substantial residual allowance of DCM available for the manufacture of new products using the DCM coating process. A manufacturer in this position would enjoy a competitive advantage over the other manufacturers who used far less quantities of DCM in 1995, the reference year for the emission cutbacks.

A legal opinion received by Environment Canada subsequent to the October meeting suggested that an emission control regulation based on the kind of product being manufactured could not be enacted under CEPA. Consequently, a provision linking the installation of emission controls to a certain type of pharmaceutical product could not be considered.

For new facilities constructed after January 1, 2000, the proposal to control emissions 90 % was acceptable to all participants.

The representative of the Ontario Ministry of Environment described the program and consultation process that began in 1996 to update the ministry's ambient air quality standards. DCM was among the first group of air pollutants selected for review. Ontario's regulatory program is based on the Point of Impingement Standards for air pollutants in conjunction with a prescribed atmospheric dispersion model for determining allowable emission rates under Certificates of Approval.

Revised 24-hour Ambient Air Quality Criteria and ½-hour Point of Impingement Standards for a number of pollutants, including DCM, have been proposed. The ministry will be developing policy options for implementing the proposed air quality standards and further consultations with stakeholders are anticipated in this regard.

4.3.4.2 Economic impacts

Although no cost estimates were specifically made of the proposed 90 % emission reduction, the costs developed by CHEMinfo Services for the conversion of existing DCM tablet coating processes to water-based processes provide a sufficiently comparable basis for analyzing the cost impacts of the recommended 90 % reduction target. The annual costs were estimated at $1.9 million. The control costs associated with the proposed 90 % reduction would comprise less than 0.5 % of the total $391 million profits in the pharmaceuticals and medicines market in 1995 and less than 0.05 % of the total revenues.

The cost impacts in broad terms would be negligible when total sales of all products are considered. It was not possible for Environment Canada to determine the cost impacts on the specific product lines currently using dichloromethane tablet coating processes that would be converted to water-based coating technology or that may be retrofitted with emission control technology if companies choose the latter approach.

4.3.5 Adhesives applications

4.3.5.1 Stakeholder discussions

The second meeting of the Issue Table on May 30, 1997 was attended by representatives from Helmitin Canada, Roberts Co., Dural Div. of Multibond, Zytec (adhesives formulators), Dow Canada (a DCM supplier), the Halogenated Solvents Industry Alliance and the Canadian Environmental Network.

The HSIA representative noted that DCM-based adhesives have a number of key properties such as solvency, non-flammability, and a fast evaporation rate that make DCM the solvent of choice for many adhesive applications.

Water-based adhesive technologies have made some inroads, as have hydrocarbon solvent systems. Some of the larger polyurethane slabstock foam manufacturers have switched to water-based adhesives in their fabrication operations and others are in the process of perfecting water-based adhesive technology.

A representative of the Adhesives and Sealants Manufacturers Association of Canada (ASMAC) noted that conversion to water-based systems by some of the smaller users of industrial adhesives has been slow because of conversion costs and for technical reasons.

For example, some adhesives are formulated with DCM for its compatibility with certain plastics or resin compounds, a property that is not easily achieved with other solvents. Users are also reluctant to switch to alternative flammable industrial adhesive products containing acetone, hexane, and aliphatic hydrocarbons.

In 1995, approximately 800 t DCM were used in the domestic manufacture of adhesives, and an additional 200 t were contained in imported products. The Issue Table Chair suggested that domestic reductions should be referenced to the 800 t used by the domestic industry in 1995.

The industry representatives were challenged by the Chair to determine the DCM reductions achievable and feasible for their sector and to suggest a time line for such reductions. Environment Canada was receptive to the concept of applying the reductions as a "bubble concept" to the overall use of DCM within the sector. The bubble concept would allow flexibility among the formulators to choose the most feasible and cost-effective DCM reduction approach. The representative for CEN suggested a reduction goal of 70 % by year 2000 from the 800 tonnes of DCM used.

Environment Canada proposed that companies report voluntarily their quantity of DCM used annually to enable Environment Canada to track progress. The reporting focus for each company could be the Adhesives and Sealants Manufacturers Association who would submit the data annually to Environment Canada. Another tracking option is for companies to report to the National Pollutant Release Inventory even though some are exempted from mandatory reporting. The industry representatives indicated the latter approach would be acceptable. The Zytec Inc. representative stated that his company has been reporting to the National Pollutant Release Inventory even though the company is not required to report because it does not meet the employee and DCM quantity criteria.

Environment Canada asked the industry representatives to consider the feasibility of a 70 % reduction goal to be achieved through voluntary actions. If this reduction goal is not met, it was proposed to mandate the reductions effective in 2003 by restricting the DCM content in adhesives similar to the limits prescribed in EPA's NESHAP for wood furniture manufacturing. These regulatory limits would be applied to both domestic and imported products to achieve equitable application of the restrictions.

A Environment Canada representative described the Accelerated Reduction and Elimination of Toxics (ARET) program and its availability to companies that may choose to implement their DCM reductions through voluntary actions. Another approach would be an administrative agreement between government and the association that would enjoin the companies to the reduction goal.

In order to track progress in DCM use and emission reductions, it was proposed that all facilities report to Environment Canada's National Pollutant Release Inventory (NPRI) even though some may be currently exempted from mandatory reporting. For those facilities that participate in the ARET program, NPRI reporting would not be needed.

Environment Canada further clarified the proposed course of action in a letter dated June 12, 1997 to the Association. In the reply dated August 12 the Association, on behalf of member and non-member companies, advised that industry generally concurred with the proposed course of action. The Association also committed to encourage its members to participate in the ARET program. The Association indicated too that it would not support any government action to regulate the DCM content in products.

The third Issue Table meeting on October 20, 1997 was attended by representatives from Helmitin Canada, LePage Div. of Henkel (adhesives formulators), Dow Canada (a DCM supplier), the Halogenated Solvents Industry Alliance, and the Canadian Environmental Network.

The representative for the Adhesives and Sealants Manufacturers Association reaffirmed the commitment of the domestic manufacturers to the proposed course of action, as outlined in the Association's letter of August 12, 1997. All companies reiterated their preference to take voluntary actions to meet the reduction target. It is anticipated that all companies will have signed on to the ARET program by the end of 1998, or earlier.

The Association representative stated that its members would want government to restrict imports of DCM-based adhesives if they increase beyond 200 tonnes of DCM contained in imported products in 1995. Otherwise foreign DCM-based products will enjoy a competitive advantage in the domestic adhesives market that would be unfair to domestic manufacturers who, having to restrict DCM content, may have higher product costs. The Chair stated that tracking of DCM imports will be important and that a recommendation to develop a tracking system has been included in this report. If action is to be taken in the future to restrict imports of DCM-based adhesives, such a measure would be most feasible if controls were made to apply to both domestically manufactured and imported products. Similarly, if voluntary actions by industry fail to reach the reduction target mandated reductions would have to be implemented by limiting the DCM content in adhesives.

The adhesive industry representatives' concern over a 70 % content limit is related to their inability to satisfy the demand for a nonflammable product in those applications. For this reason, they prefer that the reductions (voluntary or mandatory) be accomplished through an overall reduction in DCM use in adhesives.

4.3.5.2 Economic impacts

The assessment of technical control options and costs made by CHEMinfo Services were based on scenarios of 50 % and 100 % reductions in the use of DCM, with both scenarios assuming conversion to water-based adhesive formulations. Annual costs were estimated at about $7.4 million and $8.4 million respectively. The 70 % reduction being proposed would fall within the range of the cost estimates made by the contractor.

Environment Canada determined that the impact of the proposed reduction measures on industry would incur costs of about 2 % on total revenues of about $420 million and about 25 % on total profits of about $29.7 million in 1995. The revenue and profit data are based on aggregate sales of adhesives products. These cost impacts are substantial. The consequences would be particularly significant for one company that is not diversified and presently manufacturers only dichloromethane-based adhesives.

4.3.6 Laboratory, cleaning, and aerosol applications

4.3.6.1 Stakeholder discussions

The second issue Table meeting May 26, 1997 was attended by representatives from K-G Packaging (a manufacturer of aerosol pesticides, adhesives and paint products), Novamann (an analytical laboratory), Dow Canada (a DCM supplier), and the Halogenated Solvents Industry Alliance.

The Novamann representative described DCM as an essential solvent for many prescribed analytical procedures. It cannot be easily replaced. The Chair noted that, according to the CHEMinfo Services report, laboratories typically capture approximately 90 % of the DCM emissions making further controls not practically possible or economically feasible. Environment Canada with the concurrence of the laboratory sector participant at the May meeting concluded that further emission reductions in laboratory applications would not be warranted because of the existing high level of emissions being captured.

DCM is used in selected aerosol products such as metallic paints, insecticides, mold release agents, lubricants, and some specialty cleaners. DCM-containing aerosols represent less than 5 % of the total number of aerosol cans sold in Canada. A representative of K-G Packaging at the May meeting, the largest Canadian aerosol manufacturer, noted that domestic manufacturers compete with imported aerosol products and that certain specialty and high hazard industrial applications require non-flammable solvents, a need best met by DCM. Non-DCM aerosols can be of lower quality and may sell at a higher price, which would make domestic products less competitive with imported DCM-based products if the government intended to regulate only domestically manufactured products.

Environment Canada proposed mandatory container labeling of DCM-containing products at retail, consistent with the recommendation that is being presented for DCM-based consumer paint strippers. The labeling would be made to apply to both domestic and imported DCM-based products. The representative from K-G Packaging agreed with this approach.

Since no representatives from the polyurethane foam and cleaning sectors attended this meeting, the Chair stated that Environment Canada would be contacting a number of facilities to encourage their attendance at the next meeting in October because this sector is a significant user of DCM. Cleaning applications in plastics processing applications, according the estimates contained in the CHEMinfo Services report, account for approximately 70 % of the total 900 t used in this sector.

The third Issue Table meeting on October 22, 1997 was attended by representatives from K-G Packaging (a manufacturer of aerosol pesticides, adhesives and paint products), Global Upholstery (a manufacturer of molded foam cushions), Mirolin (a manufacturer of acrylic bathroom units), Dow Canada (a DCM supplier), the Halogenated Solvents Industry Alliance, and the Canadian Environmental Network.

The Mirolin Inc. representative reported that the company manufactures acrylic bathtubs, shower bases and enclosures using an open mold spray-up process. The company has been able to reduce its unit consumption of DCM by improving work practices although a net increase in total quantity has resulted from increased production. The company had tried acetone cleaner but considered its flammability risk unacceptable. A solvent mixture of terpene and nMP is being tried with some success, but it does not work as well as DCM. Emission capture and control systems, according to the company representative, are considered far too costly to install because of the very high ventilation rates being used to extract the air inside the plant.

The Chair noted that, according to the information in the report by CHEMinfo Services, 3 facilities in the cleaning sector each used more than 50 t/y and together accounted for 180 t, 8 facilities each used between 10 t/y and 50 t/y and together accounted for 160 t, and about 86 facilities each used between 1 and 10 t/y and together accounted for 240 t in 1995. These approximate 100 facilities essentially accounted for the total 600 t that was estimated as used for cleaning applications in the manufacture of plastic and foam products.

The Chair advanced the proposal for a 50 % emission reduction in DCM by 2003 at existing facilities that use DCM in cleaning applications. This reduction is considered attainable in manufacturing applications such as those at Mirolin based on replacing some of the DCM with alternate solvents. The Chair stated that Environment Canada would initially consider applying this reduction goal to facilities using more than 10 t/y of DCM and would reserve extending the requirement to other facilities with lower annual usage. Environment Canada would undertake to write to the 11 facilities affected in this regard as well to request their participation in the ARET program.

The Chair noted that when Environment Canada had contacted a number of facilities, significant changes in use patterns had taken place since 1995 when data were gathered through Environment Canada's Section 16 Notice under CEPA. Others are planning to phase out DCM as shown in **Table 10**.

Table 10: DCM reductions in cleaning applications since 1995[1]

Company	Products	1995 Use (t)	Reductions to November 1997	Estimated Future Annual Use (t)
1	acrylic bathroom units	69	reducing size of containers and suppressing emissions has reduced emissions about 8 t	40-60
2	fibreglass truck hoods	65	reduction of about 42 t for cleaning hoses by process changes and replacing DCM with acetone	0
3	molded foam cushions	50	15 t reduction (planning to replace low pressure PU injection molding machines with high pressure machines)	0
4	molded foam cushions	31	same strategy as company 3	0
5	foam ceiling products	20	same strategy as company 3	0
6	plastic parts manufacturer	22	DCM eliminated from most plastics cleaning operations; uses about 0.5 t per year	0
7	molded foam products	20	DCM eliminated by replacing low pressure PU injection molding machines with high pressure machines	0
8	molded foam products	16	DCM eliminated by replacing low pressure PU injection molding machines with high pressure machines	0
9	fibreglass recreational vehicles	15	DCM eliminated by switching to terpene-based cleaning products	0

10	polymer cables	10	DCM eliminated	0
11	plastic automobile parts	10	DCM eliminated	0
Total		328	total use has been reduced about 158 t or 48% from 1995	total use reductions of about 82% to 88% relative to 1995 use

[1] For companies that used more than 10 tonnes of DCM in 1995

Some manufacturers of molded polyurethane foam and plastics products reported phasing out DCM since 1995 as a result of manufacturing technology changes. Others reported that they have switched to alternate solvents while others have made process modifications to minimize use. Some companies in the plastics manufacturing sector, however, consider DCM essential for cleaning residual resin retained in lines and spray guns and on machine components, molds and tools.

DCM is commonly used to flush the mixing chamber of low-pressure urethane reaction-injection molding machines to remove residual polyurethane resin during the production of molded foams. Many of the larger Canadian molded foam manufacturers are replacing low-pressure machines with high-pressure impingement mixing technology that minimizes the need for cleaning. In high-pressure machines, the mixing chamber is mechanically cleaned.

Although no representatives from the molded polyurethane foam manufacturing sector attended this sector meeting, the Chair stated that a recommendation would be advanced in Draft No. 2 of this report to minimize the DCM used to clean injection foam molding machines by replacing existing low-pressure machines with high-pressure machines by 2007. For new facilities constructed after January 1, 2000, a recommendation would be advanced for new machines to be of the high-pressure type.

4.3.6.2 Economic impacts on the cleaning sector

The assessment of technical control options and costs made by CHEMinfo Services were based on scenarios of 50 % and 100 % reductions in DCM use. The former reduction was based on replacing half of DCM-based cleaning solvents with other solvent blends. The 100 % reduction was based on completely eliminating DCM and replacing it with alternate solvents while recognizing that in some applications hydrocarbon-based cleaning formulations would be used, which would require retrofit expenditures on fire protection measures. Annual costs were estimated at about $2.1 million and $4.2 million respectively.

During the stakeholder discussions and from telephone communications between Environment Canada and the companies, it is apparent that most have plans to substantially eliminate or completely phase out DCM. The impacts of these actions, if implemented, will far exceed the 50 % reduction being proposed in the recommendations of this report for facilities that used more than 10 t of DCM annually in 1995.

For cleaning applications in all manufacturing sectors, the cost impacts on market revenues and profits are difficult to assess meaningfully because the solvent is used in diverse applications. The diverse product markets make it virtually impossible to isolate the revenue and profit data from the more general SIC codes used in the Statistics Canada data. If the plastics and metal fabrication markets were considered, for which Statistics Canada data are available, the impact on total profits would be less than 0.5 %. It is recognized that this is a rough impact assessment.

4.3.6.3 Economic impacts of labeling consumer aerosol products

The cost estimates made by CHEMinfo Services did not include the provision for product labeling that is being recommended as a result of the stakeholder consultations. The contractor had assessed the costs of eliminating DCM in all aerosol products while the stakeholder discussions resulted in the recommendation to eliminate DCM only for pesticide consumer products.

Consequently, the economist for Environment Canada assumed that the costs of a labeling program would be similar to the annual cost of $225,000 estimated by CHEMinfo Services for the labeling and education program associated with consumer paint strippers. The costs of a labeling program would account for about 5 % of total revenues of about $4.4 million estimated as the sales of aerosol products containing DCM. Assuming a profit margin of about 7 %, the impact would be about 72 % on profits of about $311,000 in 1995.

4.4 General comments of industry and CEN

At the third issue Table meeting October 20-22 1997 the representative for the Halogenated Solvents Industry Alliance Inc. commented that Draft No. 1 of this report, dated September 15, 1997 had not adequately conveyed some of the health and safety issues associated with alternate solvents. For some solvents, their flammability and known toxic hazards present barriers to their use by creating risks possibly greater than those posed by dichloromethane.

For other solvents such as nMP, published scientific information on their toxicology is not as extensive or as well understood as for DCM. Therefore, government should ensure that scientific assessments are conducted on alternate solvents, a particularly important consideration for products used by consumers.

The representative for HSIA and other industry representatives maintain that scientific studies published after the federal government's *Priority Substances Assessment Report on Dichloromethane* in 1993 support the conclusion that the specific carcinogenic effects found in experimental laboratory animals can not be translated to a similar cancer risk to humans. While these findings are widely recognized within the scientific community, the federal government, according to industry's views, is unyielding in its conclusion that DCM is a potential carcinogen.

The Health Canada representatives maintain that after reviewing the more current published research papers, its scientists found no basis for changing the Department's initial finding that DCM poses a potential cancer risk to humans. The degree of concern over DCM, however, is lower than for other similar chemicals the Department has assessed as carcinogenic to humans. Nevertheless, it is prudent for government to take control actions.

In comments on Draft #2 of this report, the HSIA in a January 28, 1998 letter reiterated its position that alternative paint stripping solvents may pose an equal or greater health risk than does DCM. N-methyl pyrrolidone testing at this time has shown that this solvent poses significant reproductive and developmental harm to exposed individuals according to EPA's final assessment report. Information on dibasic esters is lacking although testing for health effects is underway. The industry stakeholders continue to maintain that virtually all paint stripping solvents pose some type of health, safety or environmental risk. The lack of relative risk information and the lack of scientific information on the toxicity of alternate solvents were again raised as barriers if the federal government were to consider phasing out dichloromethane in a number of applications, most particularly for consumer paint stripping products.

In an e-mail dated November 14, 1997, the CEN conveyed to Environment Canada a number of comments on the recommendations for control actions as presented in Draft No. 1 of this report. The central comment was that CEN would prefer government to establish absolute reductions in the total quantity of DCM in commerce rather than setting goals based on controlling releases to the environment. Although CEN cautiously supports the control strategies being proposed, which will rely largely on voluntary actions by industry through participation in the ARET program, the CEN recognizes, nevertheless, that regulatory intervention is incorporated within the control strategy should companies fail to achieve the desired emission reductions. In particular, the CEN does not support the course of action being proposed for commercial paint stripping because this sector is a large user of solvent and the development of operating guidelines will accomplish little in reducing DCM use and environmental releases.

4.5 Projected reductions in DCM releases

As shown in **Table 11**, the projected emission reductions resulting from the proposed control actions would reduce total annual emissions from all DCM applications to about 3,060 t. This quantity represents a reduction of about 50 % in total 1995 emissions of about 6,300 t.

It is anticipated that these reductions will be achieved largely through a phase-out in the current uses of DCM rather than through the application of emission control technology, which generally would be too costly to consider for most applications. Most of the projected emission reductions will occur as a result of process or solvent changes in the PU foam, pharmaceutical, adhesives, cleaning and aircraft paint stripping sectors.

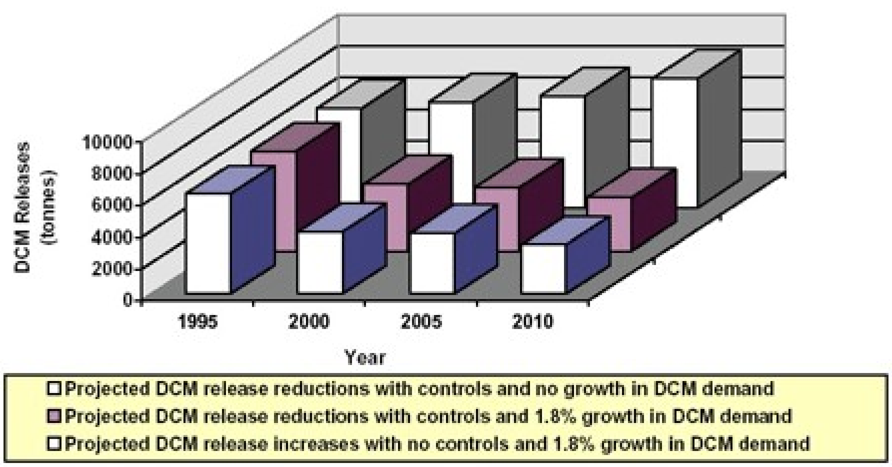
When analyzing the emission reductions resulting from the recommendations in this report, it is important to keep in mind that the control actions are referenced to year 1995. The emission reduction goals that are being proposed, in the case of industrial activities, operate on the level of production activities at that time. As the industrial output of companies grows the use of dichloromethane and attendant environmental releases are expected to increase as well. Accordingly, **Figure 3** displays the projected emissions in future years under three scenarios: (1) no control actions are implemented, (2) control actions (either through voluntary non-regulatory initiatives or regulatory initiatives) are implemented and DCM use increases at an average rate of 1.8% annually and (3) control actions are implemented and DCM use remains constant through to 2010.

Table 11: Projected DCM reductions relative to 1995 (tonnes)

Application	Use in 1995	Emission 1995	Use Reduction	Projected Emissions		
				2002	2005	2006/2007
Paint stripping - consumer	1200	1200	240	960	960	960
Commercial paint stripping:						
- furniture	1000	900	180	720	720	720
- auto	100	90	-	90	90	90
- other industrial	300	270	-	270	270	270
Flexible PU foam	1300	1300	~1300	650	650	~0
Pharmaceutical	600	600	540	60	60	60
Paint stripping - aircraft	200	160	-	80	35	35
Chemical intermediates	300	30	-	30	30	30
Adhesives:						
- domestic manufacture	800	800	560	240	240	240
- imported products	200	200	-	200	200	200
Cleaning:						
- molded PU & plastics	600	300	330	130[1]	130	80
- other	300	200	-	200	200	200
Laboratories	300	15	-	15	15	15
Aerosols:						
- consumer	100	100	20	60	60	60
- industrial	100	100	-	100	100	100
Total	7400	6265	3170	3805	3760	3060

1. 11 facilities, which individually use more than 10 t/y DCM, collectively used 330 t and emitted 150 t in 1995. These facilities plan to eliminate DCM except one facility, which expects to reduce its use to 40-60 t. Emissions will be reduced to about 20 t by 2003. An additional estimated 50 t of DCM emissions would be eliminated when low-pressure foam injection molding machines are replaced with high-pressure machines. Flushing of these machines used an estimated 150 t of DCM and emissions were about 50 t in 1995.

Figure 3: Projected reductions in DCM emissions



In the absence of any future environmental control actions total DCM demand at a 1.8 % annual growth rate is projected to increase use and emissions to about 9,600 and 8,200 t respectively by 2010.

5. Collateral Considerations

- 5.1 **Accelerated Reduction and Elimination of Toxics Program (ARET)**
- **5.2 Horizon technologies**
- **5.3 Source emission control standards versus ambient air quality standards**

5.1 Accelerated Reduction and Elimination of Toxics Program (ARET)

The ARET program is a multi-stakeholder initiative dedicated to decreasing the adverse effects of toxic substances on human health and the environment. As a voluntary nonregulatory program, it serves to promote voluntary actions by industry to accelerate the reduction or elimination of releases of 117 toxic substances, including 30 that persist in the environment and bioaccumulate in living organisms.

ARET evolved from a proposal by leading industry executives and environmentalists to the federal Minister of Environment in late 1991. This group proposed a cooperative, non-regulatory framework to first identify, then reduce or eliminate the most significant toxic substances. The Minister responded by launching a group known as the ARET Stakeholders Committee, which includes representatives from the resource and manufacturing industry sectors, health and professional associations, and federal and provincial governments.

In 1994, the ARET Stakeholders Committee challenged selected Canadian industries and governments to voluntarily reduce or eliminate their emissions of ARET substances and to set specific emission reduction targets by 2000.

The ARET Committee's first task was to establish criteria for selecting candidate toxic substances. Two thousand substances were screened to develop the ARET list of 117 toxic substances.

ARET's list of substances is divided into two major classes: 30 substances that meet persistence, bioaccumulation and toxicity criteria (referred to as class A substances); 87 substances that meet toxicity, or toxicity and persistence, or toxicity and bioaccumulation criteria (referred to as class B substances). DCM is classified as a class B substance. These toxicity classifications are not the same as the criteria for toxicity specified in CEPA.

The long-term goal is to virtually eliminate releases of the persistent and bioaccumulative toxic substances (class A); and to reduce releases of class B substances to levels insufficient to cause harm to the environment or human health. By the year 2000, ARET aims to reduce releases of class A substances by 90% and class B substances by 50%.

The emission reductions achieved to date are documented in reports published by Environment Canada, *Environmental Leaders 1(1995) and Environmental Leaders 2 (1997)*.

There are 49 substances including DCM that are common to the ARET and NPRI lists. Two hundred fifty NPRI-listed facilities representing about 200 companies that do not participate in ARET emitted approximately 5,000 tonnes of ARET substances in 1995. Of these 200 facilities, the 25 largest emitters of ARET substances accounted for 80 % of the releases (4,000 tonnes) of which DCM accounts for approximately 2,000 tonnes. Polyurethane foam, pharmaceutical and adhesives manufacturers and cleaning applications are among the largest point source users of DCM.

The purpose of the Strategic Options Process is to make recommendations to the Ministers of the Environment and Health on options to reduce DCM emissions in Canada. The ARET program offers an established administrative mechanism to facilities that may voluntarily choose to achieve the goals established by the Issue Table. A facility that intends to participate in ARET is required to submit its plan to the ARET Secretariat. This plan, which is publicly available, must outline the facility's commitments for achieving its pollution prevention goals. Also, facilities must commit to submitting annual reports on the status of their ARET substance releases.

5.2 Horizon technologies

Future options to non-DCM technologies are at various stages of research, development, and demonstration. Three evolving technologies are highlighted below.

One of the most promising technologies is the extension of dry media stripping using wheat starch to whole aluminum aircraft skins. Dry media processes using plastic or wheat starch blasting have been in use for several years, particularly in the removal of paint from components and structural composite skins of aircraft. Wheat starch is considered a better technology than plastic media blasting for whole aircraft because it is less damaging to the thin aluminum skin.

Wheat starch can selectively remove coatings from aircraft surfaces and has been used to strip unsupported aluminum skins as thin as 0.016 inches. A Canadian manufacturer of aviation simulation and control systems has developed a closed-cycle (dust free) manual wheat starch media stripping system for small aircraft and a large semi-automated closed-cycle system is to be tested in the future at facilities owned by a large North American commercial aircraft manufacturer. The fugitive dust generated during the stripping process remains a concern of some airline companies for reasons of workplace air quality as well as cleanliness, which could interfere with the subsequent application of coatings.

Several additives have been developed to modify the reaction chemistry of flexible PU foams. A new additive capable of reducing DCM use as an auxiliary-blowing agent between 70 % and 95 % was tested in 1996 with good results. Five plant trials are scheduled in Canada in 1997. The new softener is believed to be capable of enabling the industry to meet the proposed EPA NESHAP Rule for flexible PU foam production. The NESHAP Rule would result in a 65 %-70 % reduction in DCM emissions through the limitations that it will place on the allowable quantity of DCM to be used in the manufacture of various grades of foam.

CO_2 foam blowing technology has been under development for some time and three CO_2 process patents now exist. Representatives of the Canadian PU flexible foam industry stated that a U.S. firm commercially introduced its CO_2 technology (CarDio™) in 1993.

5.3 Source emission control standards versus ambient air quality standards

During the course of the stakeholder consultations, representatives from the flexible polyurethane foam and pharmaceutical manufacturers strongly suggested that the federal and Ontario government environmental agencies coordinate their efforts in regard to the reductions being sought in DCM emissions. Some of the company representatives claimed that the revised ambient air quality standards for DCM being proposed by the Ontario Ministry of Environment would have the effect of restricting source emissions to the extent of almost precluding any quantity of emissions. In addition, the industry representatives are concerned if the government of Ontario applies its standards within timelines different from those being negotiated for applying source controls through these consultations.

Except for possibly the implementation time-line, it is not expected that the different federal government and Ontario government regulatory regimes will conflict with respect to the pharmaceuticals sector for which a 90 % source emission reduction is being proposed.

The flexible polyurethane foam sector is being presented with a proposal that calls for the elimination of DCM over the long term. In Ontario, a conflict in time-lines may arise over the intermediate 50 % source reduction goal if the Ontario government chooses an implementation date for its ambient air quality standards earlier than the date being proposed by the federal government. Each of the facilities located in Ontario will have to determine if they are able to comply with the revised ambient air quality standards being considered by the provincial agency - an assessment that requires atmospheric dispersion modeling, which has not been done by any of the facilities at this time.

Although the concerns being raised by industry touch on the basic question of compatibility between two different regulatory regimes - one based on source control and the other based on ambient air quality standards - the Issue Table did not address this question in its broader policy context. Such a dialogue, involving as it would, policy and other considerations, was thought to be well beyond the scope of the terms of reference for these consultations.

6. Provincial, Territorial, and other Regulations

- 6.1 **Consumer products regulations**
- 6.2 **Workplace regulations**
- 6.3 **Transportation regulations**
- 6.4 **Canadian ambient air quality, water quality and wastewater standards**
- 6.5 **USA regulations**
- 6.6 **International regulations**
- 6.7 **Household hazardous wastes**

6.1 Consumer products regulations

The *Consumer Chemicals and Containers Regulations* (CCCR) under the *Hazardous Products Act* regulate consumer chemical products at retail. Labeling under these regulations, administered by Health Canada, is based on the product formulation and physical characteristics of the product that determine the type of hazard symbol, precautionary warning and first aid treatment statements. Child resistant product packaging may also be prescribed.

The regulations are being revised with the intention of introducing a hazard-based regulatory scheme that will require labeling according to acute hazards to users based on general hazard criteria. Sub-acute and chronic hazards such as carcinogenicity are not being addressed in the current revisions to the regulations but these additional categories will be included in the CCCR once a globally harmonized criteria system is implemented.

The member states of the Organization for Economic Cooperation and Development (OECD) are negotiating a globally harmonized system for the classification and labeling of chemicals. Criteria for physical, acute and chronic toxicity hazards associated with chemical products are to be completed by the end of 1997. Development of labeling protocols will begin in 1997. The development of the toxicity criteria is anticipated to be completed in 1999 and implementation of the harmonized system by the OECD member countries is expected in the year 2000.

The *Canadian Environmental Protection Act* also contains provisions that would enable labeling.

6.2 Workplace regulations

The quality of the workplace environment is regulated through provincial and territorial Workers' Compensation Boards or ministries of labour for commercial and industrial facilities and by Labour Canada for federal facilities.

6.3 Transportation regulations

Most provinces have hazardous waste legislation that applies to the storage, transport, and disposal of DCM wastes. For the most part, provincial legislation for the transportation of dangerous goods is compatible with the federal *Transportation of Dangerous Goods Act* (TDGA). The TDGA governs the transport of DCM as a product and waste. TDGA sets a 5 kg or 5 L criterion for reporting that is adopted in provincial/territorial hazardous waste regulations.

Storage and disposal criteria and regulations are generally not specific to DCM and vary among the provinces/territories.

6.4 Canadian ambient air quality, water quality and wastewater standards

Ontario, Newfoundland and the Montreal Urban Community are the only jurisdictions in Canada that have ambient air quality standards for DCM. In October 1996 the Ontario Ministry of Environment and Energy proposed revising its ambient air quality criteria (AAQC) and point-of-impingement standard (POI) for DCM. The province has proposed a new annual average AAQC of 10 $\mu g/m^3$ and lowering the 24-hour average AAQC from 1,765 $\mu g/m^3$ to 50 $\mu g/m^3$. The POI standard would decrease from 5,300 $\mu g/m^3$ to 150 $\mu g/m^3$. Newfoundland's ambient 24-hour ambient air quality standard is the same as Ontario's. The standards of the Montreal Urban Community include an 8-hour average of 7,000 $\mu g/m^3$ and a 1-hour average of 13,530 $\mu g/m^3$. The Montreal Urban Community plans to revise these standards by 2000.

The Canadian Council of Ministers of the Environment has published Interim Water Quality Guidelines for a number of substances including DCM. For freshwater aquatic habitat the guideline is 98 µg/L and for livestock consumption it is 50 µg/L.

A maximum acceptable concentration of 50 µg/L is prescribed in the *Canadian Drinking Water Guidelines.*

DCM is also included as a parameter in effluent monitoring regulations of the Province of Ontario for the organic chemical manufacturing sector.

6.5 USA regulations

DCM is regulated by various agencies in the United States. These include the U.S. Environmental Protection Agency (EPA), Food and Drug Administration (FDA), Occupational Safety and Health Administration (OSHA), and Consumer Products Safety Commission (CPSC).

As a listed hazardous air pollutant under the U.S. *Clean Air Act*, EPA must regulate DCM emissions by applying maximum achievable control technology. Several *National Emission Standards for Hazardous Air Pollutants* (NESHAP), which have been promulgated or announced since 1995, apply to DCM applications. These include Aerospace Manufacturing and Rework Facilities, Flexible Polyurethane Foam Production, Pharmaceuticals Production, and Wood Furniture Manufacturing Operations.

The Consumer Products and Safety Commission mandated hazard warning labels for consumer paint strippers in 1987.

Under the U.S. *Resource Conservation and Recovery Act* (RCRA), DCM is classified as a hazardous waste and is regulated under the Superfund legislation.

On January 10, 1997, the Occupational Safety and Health Administration (OSHA) published the final rule on occupational exposure to methylene chloride. This rule became effective April 10, 1997 and lowered the existing 8-hour time-weighted average (TWA) exposure from 500 parts-per-million (ppm) to 25 ppm. OSHA also reduced the existing short-term exposure limit (measured over five minutes in any two-hour period) from 2000 ppm to 125 ppm. An "action level" defined as a concentration that would trigger periodic exposure monitoring and medical surveillance was set at 12.5 ppm, measured as an 8-hour TWA.

6.6 International regulations

In 1996, Sweden enacted an ordinance that essentially bans the offering for sale, transfer, or use of DCM-containing products in the course of business activities or to consumers for private use. However, exemptions may be granted on a case by case basis where it can be established that no substitute is available. Within the European Union, efforts apparently are underway by the chemical manufacturing industry to have these regulations repealed.

6.7 Household hazardous wastes

In April 1997 the Province of BC promulgated regulations that mandate manufacturers to provide convenient collection programs for leftover household products such as paint strippers, paint thinners, turpentine, laquers, varnishes, varsol, camp fuels, unused gasoline, and a wide range of household pesticides.

Two cooperating industry associations have received approval from the Province of BC to operate collection depots. The stewardship plan requires that 8 collection depots in the Greater Vancouver and Victoria Regional Districts be in operation by December 31, 1997. Additional collection depots to a total of approximately 35 will be opened in each quarter of 1998 until the entire province is serviced by December 31, 1998.

7. Recommendations

- 1. **Aircraft paint stripping application**
- 2. **Consumer paint stripping application**
- 3. **Commercial paint stripping application**
- 4. **Flexible polyurethane foam blowing application**
- 5. **Pharmaceutical and chemical intermediates applications**
- 6. **Adhesives application**
- 7. **Cleaning applications**
- 8. **Laboratories application**
- 9. **Aerosols application**
- 10. **General recommendations**

The consultations undertaken by Environment Canada and Health Canada with stakeholders have resulted in a set of recommendations to manage DCM that are responsive to the federal government's *Toxic Substances Management Policy*. As a Track 2 substance under this policy, DCM is to be managed to prevent or minimize releases to the environment. In its deliberations, the Issue Table considered a wide range of management tools. Emission reduction options were analyzed in their broadest context that examined the economic impacts of a total phase-out of DCM in all applications, a selected phase-out that could be applied to DCM-based consumer paint strippers and reductions through the application of emission controls at source or of alternate process technologies.

The analyses conducted by Environment Canada show that a general phase-out of DCM could not be justified on economic grounds because costs would significantly exceed benefits. The valuation of monetary benefits from controlling environmental releases of DCM were quantifiable only in relation to the avoided mortality risk associated with the consumer use of DCM-based paint stripping solvents. A monetary valuation of the impact in the environment as determined in the Priority Substances Assessment Report was not possible. Since the only monetary benefit is associated with the avoided mortality risk from consumer uses, the economic analysis showed that the monetary value of the benefits becomes small in relation to the costs that would be incurred if all users were required to phase out DCM.

While the economic analysis showed that a phase-out of DCM might be justified on economic grounds for consumer paint strippers alone, the members of the Issue Table felt labeling was a more appropriate approach. A phaseout would force consumers to use alternate solvents for which the health effects are insufficiently understood at this time. Some of the alternate solvents are not seen as being entirely safe substitutes in consumer applications.

The reductions in environmental releases and uses of DCM that are being proposed have been based on technical as well as cost considerations. The principle of best available technologies is reflected throughout the recommendations. It is believed that this approach is consistent with the guidance provided by the federal government's *Toxic Substances Management Policy,* which seeks to minimize environmental releases of toxic substances or to eliminate their releases in applications where feasible.

The underlying strategy of the recommendations provides for government regulatory intervention if voluntary actions fail to achieve the desired reductions. The recommendations are broadly supported by the members of the Issue Table. If fully implemented, these actions will result in reducing emissions of dichloromethane about 50 % from about 6,300 tonnes to about 3,100 tonnes.

1. Aircraft paint stripping application

- *1.1 Existing facilities should voluntarily commit to reduce annual emissions 50 % effective January 1, 2002 and 80 % effective January 1, 2006.*

  Emissions would **decrease to about 80 tonnes by 2002 and to about 35 tonnes by 2006** from about 160 tonnes emitted and 200 tonnes used in 1995.

- *1.2 Existing facilities should be mandated to reduce annual emissions 50 % and 80 % effective January 1, 2003 and January 1, 2007 respectively if voluntary actions do not attain these reduction goals.*

- *1.3 New facilities constructed after January 1, 2000 should be mandated to achieve 90 % emission control.*

- *1.4 Facilities that are presently not participating should commit to and participate in Environment Canada's program on Accelerated Reductions and Elimination of Toxics* (ARET).

  The representative of Air Canada has indicated intent to participate in the ARET program.

- *1.5 Facilities that are currently exempted from annual reporting should commit to report dichloromethane to the National Pollutant Release Inventory* (NPRI).

  This reporting mechanism will allow tracking of progress in annual dichloromethane use and environmental releases. For NPRI-exempted facilities that participate in the ARET program, reporting to the NPRI would not be needed.

- *1.6 The appropriate government departments should disseminate information to the aircraft paint stripping facilities on research activities on alternate solvents and paint stripping technologies to enhance awareness of technology developments in this regard.*

2. Consumer paint stripping application

- *2.1 Paint stripping formulations containing dichloromethane sold for consumer use should be labeled to inform consumers of the chronic toxicity and potential carcinogenicity associated with human exposure when these products are improperly used. Labeling should be implemented when future labeling requirements under the Consumer Chemicals and Containers Regulations under the Hazardous Products Act adopt toxicity criteria.*

Changes in use patterns among consumers resulting from labeling is expected to **decrease use and emissions 20 % to about 960 tonnes** from the 1200 tonnes of dichloromethane contained in paint stripping formulations in 1995.

Chronic and sub-chronic toxicity criteria, currently under negotiation by representatives of member states to the Organization for Economic Cooperation and Development, are to be globally harmonized in the 1999-2000 time frame.

- *2.2 If a labeling program is not implemented through the Consumer Chemicals and Containers Regulations, the program should be implemented pursuant to the Canadian Environmental Protection Act, effective January 1, 2000.*

  The industry representatives oppose container labeling if it were applied only to dichloromethane-containing products.

- *2.3 Environment Canada and Health Canada should prepare an information pamphlet to inform consumers about the hazards of the various types of paint strippers and the general safety precautions to be taken when using these products.*

3. Commercial paint stripping application

- *3.1 Work practices guidelines should be developed by 2000 for the safe handling, storage, and use of dichloromethane-based paint strippers in the commercial furniture refinishing and other stripping applications.*

  Good work practices are able to conserve solvent use and minimize environmental releases, resulting in an estimated 20 % solvent use reduction, principally in furniture stripping applications. Dichloromethane emissions would **decrease to about 720 tonnes** from 1,000 tonnes of solvent used and 900 tonnes emitted in 1995. The Halogenated Solvents Industry Alliance has indicated its willingness to assist with developing and distributing these guidelines.

4. Flexible polyurethane foam blowing application

- *4.1 Companies with existing facilities should commit voluntarily to reduce annual process emissions of dichloromethane 50 % effective January 1, 2002.*

  These actions will reduce emissions of dichloromethane associated with its use as an auxiliary blowing agent, as well as the small quantities of solvent used for equipment cleaning, **to about 650 tonnes** from 1,300 tonnes used and emitted in 1995. The Canadian Flexible Foam Manufacturers Association supports this reduction goal, which is to be attained by the member companies of the Association as well as non-member companies.

  This recommendation is intended to apply as a kind of bubble reduction target in the situation where a company owns or operates more than one facility thereby providing flexibility to choose the optimum mix of reductions among its individual facilities.

- *4.2 Existing facilities should be mandated to reduce annual emissions 50 % effective January 1, 2003 if voluntary actions do not attain this reduction goal.*

- *4.3 Existing facilities should eliminate dichloromethane as an auxiliary blowing agent in the manufacture of flexible polyurethane foam by 2007.*

- *4.4 Facilities should commit to and participate in Environment Canada's program on Accelerated Reductions and Elimination of Toxics* (ARET).

  The Association supports this recommendation. Its member companies as well as non-member companies have committed to register with this program.

- *4.5 Facilities that are currently exempted from annual reporting should commit to and report dichloromethane to the National Pollutant Release Inventory* (NPRI).

  This reporting mechanism will allow tracking of progress in annual dichloromethane use and environmental releases. For NPRI-exempted facilities that participate in the ARET program, reporting to the NPRI would not be needed.

- *4.6 New facilities constructed after January 1, 2000 that use dichloromethane as an auxiliary blowing agent in the manufacture of flexible polyurethane foam should be mandated to achieve a process emission performance that would be equivalent to 90 % emission control applied to a conventional dichloromethane foam production process.*

  This interim provision is intended to allow the use of a nominal quantity of dichloromethane in the foam production process, particularly in the production of specialty foams, for which the carbon dioxide process is not fully proven to the extent where dichloromethane can be entirely replaced.

5. Pharmaceutical and chemical intermediates applications

- *5.1 Existing facilities that use dichloromethane in tablet coating processes should voluntarily commit to reduce annual dichloromethane emissions 90 % or install control technology with 90 % capture efficiency, effective January 1, 2002.*

  These actions would **reduce annual emissions to about 60 tonnes** from about 600 tonnes used and emitted in 1995.

- *5.2 Existing facilities should be mandated to achieve 90 % emission control effective January 1, 2003 if voluntary actions do not attain this goal.*

- *5.3 New facilities or production lines constructed after January 1, 2000 that use dichloromethane in the manufacture of pharmaceutical chemicals, other chemical intermediates and in tablet coating should be mandated to achieve 90 % emission control.*

- *5.4 Facilities should commit to and participate in Environment Canada's program on Accelerated Reductions and Elimination of Toxics* (ARET).

  All companies support voluntary action and participation in the ARET program with the exception of one company that prefers not to participate in the ARET program.

- *5.5 Facilities that are currently exempted from annual reporting should commit to report on dichloromethane to the National Pollutant Release Inventory* (NPRI).

  This reporting mechanism will allow tracking of progress in annual dichloromethane use and environmental releases. For NPRI-exempted facilities that participate in the ARET program, reporting to the NPRI would not be needed.

- *5.6 No further environmental controls are deemed necessary for existing facilities that manufacture chemical intermediates because current process controls capture about 90 % of the emissions.*

  In 1995, dichloromethane use in this sector was about 300 tonnes and emissions were about 30 tonnes.

6. Adhesives application

- *6.1 Manufacturers should voluntarily commit to reduce the dichloromethane content in adhesive products formulated in Canada 70 % effective January 1, 2002.*

  These actions would **reduce annual emissions to about 240 tonnes** from about 800 tonnes used in domestically manufactured products in 1995.

  The Adhesives and Sealants Manufacturers Association of Canada has indicated that its member companies as well as non-member companies support this goal.

- *6.2 Manufacturers should be mandated to achieve a 70 % emission reduction in DCM use January 1, 2003 if voluntary actions do not attain this goal.*

It is anticipated that the solvent reductions, if it becomes necessary to mandate these, would be implemented in the form of limits on the DCM content in adhesives.

- *6.3 Facilities should commit to and participate in Environment Canada's program on Accelerated Reductions and Elimination of Toxics* (ARET).

  The Association supports this recommendation. Member companies as well as non-member companies of the Association intend to register with the ARET program before the end of 1998.

- *6.4 Facilities that are currently exempted from annual reporting should commit to report dichloromethane to the National Pollutant Release Inventory* (NPRI).

  This reporting mechanism will allow tracking of progress in annual DCM use and environmental releases. For NPRI-exempted facilities that participate in the ARET program, reporting to the NPRI would not be needed.

- *6.5 Government should apply the same restrictions on imported dichloromethane-based adhesive products as those made to apply to domestically manufactured products if imported dichloromethane-based products exceed the 1995 imports.*

  About 200 tonnes of dichloromethane were contained in imported products in 1995. The Association is concerned that unfair competitive advantages may arise in the domestic market if future imports of dichloromethane-based adhesives increase.

7. Cleaning applications

- *7.1 Dichloromethane-containing cleaning products and aerosol paint products sold in Canada for consumer use should be labeled to inform consumers of the chronic toxicity and potential carcinogenicity associated with human exposure when improperly used. The labeling requirement should be made effective at a date consistent with the labeling of consumer paint stripping products.*

- *7.2 Existing facilities that use more than 10 tonnes of dichloromethane annually should voluntarily commit to reduce annual emissions 50 % effective January 1, 2003.*

  Dichloromethane use would decrease to about 270 tonnes from 600 tonnes. Emissions would **decrease to about 130 tonnes** annually from about 300 tonnes in 1995 among these eleven facilities.

- *7.3 Existing facilities that use more than 10 tonnes of dichloromethane annually should be mandated to achieve 50 % emission control effective January 1, 2004 if voluntary actions do not attain this goal.*

- *7.4 New facilities that use dichloromethane in any cleaning applications in a quantity greater than 5 tonnes annually constructed after January 1, 2000 should be mandated to require 80 % emission control.*

- *7.5 All facilities should commit to and participate in Environment Canada's program on Accelerated Reductions and Elimination of Toxics* (ARET).

- *7.6 Existing facilities that use dichloromethane for cleaning the mixing chamber of low-pressure reaction-injection molding machines should voluntarily commit to eliminate this use effective January 1, 2007 by converting to high-pressure machines.*

  These actions would **substantially eliminate the emissions** of dichloromethane. Solvent usage for cleaning injection molding machines was about 150 tonnes in 1995 and emissions were about 50 tonnes.

- *7.7 New reaction-injection molding machines used in the production of molded polyurethane foam purchased after January 1, 2000 should be mandated to be of the high-pressure type that minimize the need for cleaning with dichloromethane.*

- *7.8 Facilities that are currently exempted from annual reporting should commit to report dichloromethane to the National Pollutant Release Inventory* (NPRI).

  This reporting mechanism will allow tracking of progress in annual dichloromethane use and environmental releases. For NPRI-exempted facilities that participate in the ARET program, reporting to the NPRI would not be needed.

8. Laboratories application

- *8.1 No further environmental controls are required because current laboratory practices capture about 95 % of the dichloromethane emissions.*

  Emissions were about 15 tonnes of the 300 tonnes used in 1995.

9. Aerosols application

- *9.1 Dichloromethane-containing aerosol products sold in Canada for consumer use should be labeled to inform consumers of the chronic toxicity and potential carcinogenicity associated with human exposure when improperly used. The labeling requirement should be made effective at a date consistent with the labeling of consumer paint strippers.*

  Changes in use patterns among consumers resulting from labeling is expected to result in some conservation of solvent, comparable to the 20 % decrease associated with labeling of consumer paint strippers.

- *9.2 Existing and new consumer pesticide products that contain dichloromethane should not be registered under the Pest Control Products Act effective January 1, 2000.*

  This action would eliminate about 20 tonnes of dichloromethane used in pesticide aerosol containers in 1995.

  Dichloromethane emissions, as a result of Recommendations 9.1 and 9.2, would **decrease to about 60 tonnes** from about 100 tonnes contained in consumer products in 1995.

- *9.3 No control measures are considered necessary for dichloromethane-based products used in commercial and industrial applications since material safety information is prescribed by workplace legislation.*

  About 100 tonnes of dichloromethane were used in commercial products in 1995.

10. General recommendations

- *10.1 Scientific assessments of the environmental and human health toxicity of non-dichloromethane paint stripping solvents should be undertaken. Information from these assessments is necessary before actions to eliminate dichloromethane in paint strippers can be considered.*

- *10.2 The annual quantities of dichloromethane imported as a commodity as well as in formulated products should be tracked.*

Appendix A

Supporting Documents

Environment Canada, Health Canada 1993. Priority Substances List Assessment Report-Dichloromethane (DCM).

Environnement Canada, Santé Canada 1993. Liste des substances d'intérêt prioritaire-Rapport d'évaluation-Dichlorométhane

Environment Canada 1995. Toxic Substances Management Policy

Environnement Canada 1995. Politique de gestion des substances toxiques

Environment Canada 1996. Dichloromethane (DCM) - Background Document for Stakeholder Consultations

Government Notices 1996. Department of the Environment. Canadian Environmental Protection Act. Notice for calendar year 1995 with respect to dichloromethane (methylene chloride) Use Pattern Summary

Levelton Associates 1996. Review of Regulatory Requirements for Dichloromethane in Canada, U.S.A. and other Countries and Control Options for Paint Stripping Operations. Prepared for Environment Canada, Pacific and Yukon Region.

Great Lakes United 1997. Comments on the Draft No. 1 of the Strategic Options Report for Dichloromethane. Prepared by Stephane Gingras and the Great Lakes United for the CEN Toxic Caucus, Montreal, November 10, 1997

Health Canada 1997. Estimated Cancer Deaths due to Dichloromethane Exposure from Consumer Paint Stripping in Canada.

Environment Canada 1997. Economic Impact Analysis of Dichloromethane Management Options.

Health Canada, Health Protection Branch 1997. Estimates of Cancer Risk from Dichloromethane-Containing Paint Strippers.

CHEMinfo Services Inc. 1997. Dichloromethane (DCM) Uses in Canada: Review of Control Options and Regulatory Requirements. Prepared for Environment Canada, Pacific and Yukon Region.

Appendix B

Members of the Issue Table on Strategic Options Process for Dichloromethane (DCM)

- 1. **Issue Table Members (*) and Corresponding Members**
  - **DCM Suppliers/Distributors and Chemical Associations**
  - **Aircraft Paint Stripping Application**
  - **Consumer and Commercial Paint Stripping Applications**
  - **Flexible Polyurethane Foam Manufacturing Application**
  - **Pharmaceutical and Chemical Intermediates Applications**
  - **Adhesives Manufacturing Application**
  - **Aerosols, Cleaning, and Laboratory Applications**
- 2. **Support Group Members (*) and other contributors to the Issue Table**

1. Issue Table Members (*) and Corresponding Members

DCM Suppliers/Distributors and Chemical Associations

Brown, Greg	Stanchem Inc., Etobicoke, ON
Edwards, Chris*	Van Waters & Rogers Ltd., Weston, ON
Grierson, David*	APCO Industries Ltd., Toronto, ON
Griffen, Ray*	APCO Industries Ltd., Toronto, ON
Havery, Marv*	Canada Colors & Chemicals Ltd., Don Mills, ON
Kern, Marshall*	Halogenated Solvents Industry Alliance, Sarnia, ON
Lederman, Marty*	APCO Industries Ltd., Toronto, ON
McCurdy, Scott*	APCO Industries Ltd., Toronto, ON
Ow, Sing*	Van Waters & Rogers Ltd., Weston, ON
Risotto, Steve*	Center for Emissions Control, Washington, DC
Roycroft, John*	APCO Industries Ltd., Toronto, ON
Sheldon, Isabel	Phancorp Inc., Toronto, ON
Welby, Jim*	Van Waters & Rogers Ltd., Weston, ON
Wilkinson, John	Vulcan Chemicals Ltd., Washington, DC

Aircraft Paint Stripping Application

R.G. Bartlett	IMP Group Ltd., Aerospace Div., Halifax, NS
Peter Boag	Aerospace Industries Assoc. of Canada, Ottawa, ON
Ceolin, Lissa	Pratt and Whitney Canada, Mississauga, ON
Charles, Loraine*	Transport Canada, Aircraft Services, Gloucester, ON
Cocks, Lewis	National Defense, Air Command HQ, Westwin, MB
Coon, Tony	Executive Aircraft Services, Richmond, BC
Cornish, Jeremy	Intn. Centre for Aviation & Env., Beaconsfield, QC
Cracknell, Alan*	Deane & Co., Mississauga, ON
Dawson, Doug	Air Transport Assoc. of Canada, Ottawa, ON
Decker, Phil	CAE Aviation Ltd., Edmonton, AB
Dicaire, Pierre*	CAE Electronics Ltd., St. Laurent, QC
Edgecombe, Don	National Defense HQ, Ottawa, ON
Feltham, Gail	National Defense, CFB Esquimalt, Victoria, BC
Forcier, Johanne*	Bombardier Inc., Mirabel, QC
Gillespie, David*	Flying Colours Corp., Peterborough, ON
Kiss, Frank*	Canadian Airlines International, Richmond, BC
McLeay, Don*	Air Canada, Montreal, QC
Orr, Andy	PlanePerfection Inc., Goderich ON
Patenaude, Jacques*	Deane & Co., Point-Claire, QC
Randeau, Nathan	Aero Paint Canada Ltd., Sherwood Park, AB
Rocki, Ted	McDonnell Douglas Canada, Toronto, ON
Somani, Andy	Brent Canada Ltd., Stoney Creek, ON
Stokowski, Bob	Regent Industries Inc., Edmonton, AB
Tuzi, Claudia	SPAR Aerospace, Toronto, ON
Wellman, Sandy*	Sky Harbour Aircraft Refinishing, Goderich, ON
Wilkens, Capt. Craig*	Department of National Defense, Ottawa, ON

Consumer and Commercial Paint Stripping Applications

Anacleto, Patty*	LePage Div. of Henkel Canada Ltd., Brampton, ON
Begin, Denis	Universite de Montreal, Montreal, QC
Chaimberg, Mark*	Swing Paints Ltd., Montreal, QC
Clark, Scott*	Clark's Antique Specialty Supply, London, ON
Cruceru, Gabriel*	Techno-Strip Industries Ltd., Brampton, ON
Currie, Jack*	John E. Goudey Mfg. Ltd., Toronto, ON
Dingman, Nancy*	Home Hardware Stores Ltd., Burford, ON
Kovrig, Marina*	Recochem Inc., Brampton, ON
Ingham, John	Thompson Minwax Ltd., Thornhill, ON
Lakhan, Gerry*	Recochem Inc., Brampton, ON
Liaw, Kenny*	ISP (Canada) Inc., Mississauga, ON
Logan, Bill*	Swing Paints Ltd., Montreal, QC
Wilson, John*	Fielding Chemicals Ltd., Mississauga, ON
Zerey, Michel *	Lepage Div. of Henkel Canada Ltd., Brampton, ON

Flexible Polyurethane Foam Manufacturing Application

Dancy, Jeff	Carpenter Canada Ltd., Calgary, AB
Duley, Tony*	Woodbridge Foam Corp., Woodbridge, ON
Himel, Mel	Can. Flexible Foam Mfrs. Assoc., Mississauga, ON

Hounsome, Dave*	Valle Foam Industries Inc., Brampton, ON
Krten, Lena*	Woodbridge Foam Ltd., Woodbridge, ON
Mackinnon, Doug*	Foamex Canada Ltd., Toronto, ON
Vukov, Darryl*	Vitafoam Products Canada, Downsview, ON
Walker, Cathy	CAW Health & Safety Dept., Willowdale, ON

Pharmaceutical and Chemical Intermediates Applications

Charbonneau, Stephanie	Delmar Chemicals Inc., Ville LaSalle, QC
Couillard, Renee-Claude	Rougier Inc., Chambly, QC
Endicott, Bruce*	Can. Drug. Mfr. Assoc., North York, ON
Kube, Douglas*	Eli Lilly Canada Inc., Scarborough, ON
MacKenzie, Douglas*	Wyeth-Ayerst Canada Inc., St. Laurent, QC
MacTaggart, Bruce*	Torcan Chemical Ltd., Aurora, ON
Perry, Grant	Pharmaceutical Mfrs. Assoc. of Canada, Ottawa, ON
Perry, Dr. Richard*	Merck Frosst Research, Dorval, QC
Silins, Maris*	Glaxo Wellcome Inc., Mississauga, ON
Stedall, Michael*	Raylo Chemicals Inc., Edmonton, AB

Adhesives Manufacturing Application

Antonacci, Joseph	Suzorite Mica Ltd., Boucherville, QC
Borenstein, Lionel	Bakor Inc., Ville St.-Pierre, QC
Brady, Brian*	3M Canada Inc., London, ON
Brise-boise, Raymond	Les Adhesifs Adhpro Inc., Marieville, QC
Brunins, Jay	Normac Adhesive Products Inc., Burlington, ON
Buck, Sol	Sluyter Co. Ltd., Markham, ON
Dickens, Don	Halton Chemicals Ltd., Burlington, ON
Edward, Steven*	Helmitin Canada Inc., Toronto, ON
Kubanek, Mark	Palliser Furniture Ltd., Winnipeg, MB
Leiner, Ernie*	Helmitin Canada Inc., Toronto, ON
Matteo, Joe	Sealrez Inc., St-Eustache, QC
Odynski, Robert	Robson Thermal Mfr. Ltd, Richmond, BC
Schock, Verne*	Zytek Inc., Whitby, ON
Sharko, Peter*	Roberts Co. Canada Ltd., Brampton, ON
Skehill, Peter	Duo-Fast Industries Ltd., Montreal, QC
Tamkei, Chris*	Dural, Div. of Multibond, Etobicoke, ON
Wudrick, Harvey	Select Silicon & Sealants Ltd., Etobicoke, ON
Zerey, Michel *	Lepage Div. of Henkel Canada Ltd., Brampton, ON

Aerosols, Cleaning, and Laboratory Applications

Bowman, Brian	Imperial Rack Ltd., London, ON
Bruce, Graham	ELP Products Ltd., Calgary, AB
Clarke, Rick*	Chemcrest Corp., Winnipeg, MB
Chau, Frank*	K-G Packaging Ltd., Concord, ON
Copping, Robert	Camoplast Inc., Richmond, QC
Corbyn, Peter	Automotive Parts Mfr. Assoc. Toronto, ON
Cox, Wayne	Elastocraft Industries Inc, Mississauga, ON
Edgecombe, Fred	Can. Plastics Ind. Assoc., Mississauga, ON
Fillion, Julie	Pest Man. Reg. Agency, Ottawa, ON
Jolicoeur, Pierre	Rene Mat.Comp., St Eph.deBeauce, QC

Jucker, Ben	Flexicoil Ltd., Saskatoon, SK
Lastoria, Chester*	Novamann (Ont.) Inc., Mississauga, ON
Loescher, Barry	Int. Ass. of Env. Test Labs, Burlington, ON
McDonald, Chris	Fisher Scientific Ltd., Nepean, ON
Nesrallah, Wayne*	Global Upholstery Co., Toronto, ON
Noseworthy, Warrick	Duraprene Industries Ltd., Calgary, AB
Roy, Mary	CCL Industries Inc., Willowdale, ON
Sanalitro, Stefano	Canadian Button Ltd., La Salle, QC
Seneka, Eric	Chimo Polyurethanes Ltd., Nisku, AB
Sisk, Tom*	Mirolin Inc., Etobicoke, ON
Small, Malcolm	Blanco Canada Ltd., Etobicoke, ON
Walker, Robert*	Accutest Laboratories Ltd., Nepean, ON

2. Support Group Members (*) and other contributors to the Issue Table

Banville, Jean-Francois	Environment Canada, Montreal, QC
Chalifoux, Chantal*	Environment Canada, Hull, QC
Ernst, Bill	Environment Canada, Dartmouth, NS
Gingras, Stephane (ENGO)	Great Lakes United, Montreal, QC
Halevy, Marc	Water Tech. Intern. Corp., Burlington, ON
Harris, Peter*	Environment Canada, Hull, QC
Langdeau, Serge*	Environment Canada, Hull, QC
Laperriere, Francine*	Environment Canada, Hull, QC
Lopes, Edwina	Environment Canada, Toronto, ON
MacDonald, Stephen*	Health Canada, Ottawa, ON
Mausberg, Burkhard (ENGO)	Toronto Env. Alliance, Toronto, ON
Morcos, Raouf	Environment Canada, Hull, QC
Munson, Barry	Environment Canada, Edmonton, AB
Proestos, Angelo (Contractor)	CHEMinfo Services Inc., Toronto, ON
Reid, Bill	Ministry of Env., Land, Parks (B.C.), Victoria, BC
Schneider, Uwe*	Environment Canada, Hull, QC
Sensenstein, Robert*	Health Canada, Ottawa, ON
Shapiro, Jacob (Subcontractor)	Shapiro & Associates, North York, ON
Wilson, Doug*	Environment Canada, North Vancouver, BC
Wilkin, James (Contractor)	Levelton Associates, Richmond, BC
Wituschek, Ed (Chair)*	Environment Canada, North Vancouver, BC
Worona, P.W.	Human Resources Dev. Canada, Hull, QC

Appendix C

Public File

All correspondence and records of meetings related to this project are contained in a hard copy file 1027-12-4 at Environment Canada. Members of the public may request access to this file by contacting the following office:

Environment Canada
Pacific and Yukon Region
224 West Esplanade
North Vancouver, British Columbia
Canada V7M 3H7

List of Acronyms

ARET	Accelerated Reduction/Elimination of Toxics program

ATAC	Air Transport Association of Canada
ASMAC	Adhesives and Sealants Manufacturers Association of Canada
CCME	Canadian Council of the Ministers of the Environment
CDMA	Canadian Drug Manufacturers Association
CCCR	Consumer Chemicals and Containers Regulations
CEN	Canadian Environmental Network
CEPA	*Canadian Environmental Protection Act*
CFFMA	Canadian Flexible Foam Manufacturers Association
DCM	Dichloromethane
ENGO	Environmental Non-governmental Organization
HSIA	Halogenated Solvents Industry Alliance, Inc.
HPA	*Hazardous Products Act*
NAFTA	North American Free Trade Agreement
NESHAP	National Emission Standards for Hazardous Air Pollutants (*U.S. Clean Air Act)*
NPRI	National Pollutant Release Inventory
OME	Ontario Ministry of Environment (after October, 1997)
OMEE	Ontario Ministry of Environment and Energy
PMAC	Pharmaceutical Manufacturers Assoc. of Canada
SIC	Standard Industrial Classification
SOP	Strategic Options Process
SOR	Strategic Options Report
VOCs	Volatile Organic Compounds
WTO	World Trade Organization

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