

The Substitution Principle: How to *Really* promote safer chemical use
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Clean Production Action, June 2, 2005
(www.cleanproduction.org)

Substitution means the replacement or reduction of hazardous substances in products and processes by less hazardous or non hazardous substances or by achieving an equivalent functionality via technological or organizational measures.¹

In other words a hazardous chemical can be replaced by a safer or non-hazardous chemical, or the chemical's function in the product or process can be met through product redesign or system change.

How is this different to Pollution Prevention?

Substitution is a paradigm shift in chemical management because it does not attempt to simply limit exposure to hazardous chemicals or attempt to maintain ongoing use of hazardous chemicals through risk assessment and control.

- It is based on comparative assessment of alternatives to problem chemicals.
- It uses inherent hazard assessment as the basis for initial alternatives assessment, not risk assessment. Exposure assessment comes in at a second step once inherently safer materials are ranked.
- It provides a longer term view of the results of phase-out legislation, ie the substitution for the banned chemical has been assessed for 'safer' status.
- It forces innovation, particularly in the development and adoption of Green Chemistry. Green Chemistry integrates environmental and health considerations at the outset of new chemical synthesis to ensure new chemicals are inherently safe. Green Chemists can also predict, based on molecular structure, if a chemical is likely to cause concern, reproductive hazards or persist in the environment, thereby allowing quick screening of existing chemicals.
- It forces innovation in product redesign and system change since substitution can be a process or material change, not just a chemical change. For example the phase out of brominated flame retardants by some IT companies resulted in redesign of the product:- use of metal casings in laptop to obviate the need for chemical flame retardant in plastic housings; separation and isolation of the potential spark source within the main frame.
- It implements the Precautionary Principle. Arguments against the Precautionary Principle commonly centre on what degree of evidence of harm is necessary before action is taken to restrict the use of a substance. When applying the substitution principle, it is not necessary to wait for elusive evidence of cause and effect if alternatives with less hazardous intrinsic properties are available.

Establishing the Substitution Principle as central to chemicals policy

The European Union's new chemical policy, REACH (Registration, Evaluation and Authorization of Chemicals) is in its final drafting stages. NGOs, many downstream users of chemicals and member states have been advocating stronger integration of the Substitution Principle within REACH. Sweden, not surprisingly, is lobbying for substitution within the authorization process as it has had years of experience with this principle within its own chemicals policy.

Without the strong support of the Substitution Principle, it will be difficult for an individual company that is a downstream user to be proactive in substituting substances.
- Skanska AB, response to internet consultation, summer 2003. Skanska is the second largest construction contractor in the world.

In Sweden the principle of substitution is enshrined in Chapter 2 Section 6 of the Environmental Code² which states:

Persons who pursue an activity or take a measure, or intend to do so, shall avoid using or selling chemical products or biotechnical organisms that may involve risks to human health or the environment if products or organisms that are assumed to be less dangerous can be used instead. The same requirement shall apply to goods that contain or are treated with a chemical product or a biotechnical organism.

Case study summary:

Sweden has effectively used the principle in its pesticides regulations. Beginning in 1990 a re-registration every 5 years for pesticides now includes a comparative assessment of substitutes. The year before the re-registration started, 619 pesticides were registered. The introduction of the substitution requirement caused a temporary decrease in numbers and only 343 appeared on the market the year after. Some pesticides were rejected for re-registration; others were substituted with better alternatives and for others the producers did not apply for re-registration because they realised that their products did not fulfil the requirements and would be substituted. The temporary decrease in pesticide use lasted a few years, but today more than 700 pesticides are registered, demonstrating a wider range of products which are safer for human health and the environment.³

Regulations stipulating the phase out or 'sunset' of problematic chemicals have provided the backbone of chemicals policy in Sweden. **The government also directly helps industrial sectors to research and adopt safer materials.** For example the government uses a comparative methodology known as "Seven Steps to Substitution" to explore the feasibility and availability of substitutes. It has also developed the PRIO interactive database which contains both substances that are regulated and those that are not covered by any legislation. PRIO provides data on the intrinsic health properties and environmental properties of substances. Through an interactive website, it allows companies to assess their chemical use, examine the opportunity for risk reduction through substitution and anticipate future legislation.⁴

The Substitution Principle is further clarified and enhanced by the sustainability goal of a non-toxic future within Sweden's chemical policy. The country has set fifteen environmental quality objectives adopted by Parliament in 1999 and which provide a coherent framework for environmental programmes and initiatives at national, regional and local level.⁵ Government and industry now work towards these timelines and the government publishes yearly assessment reports on the web to see if progress is being made.⁶ Indeed, the generational goal to eliminate hazardous substances by 2020 is the basis and much of the impetus for the overhaul of Europe's chemical management.

"These two principles [precaution and substitution] are important principles in the Swedish national chemical policy and has proven to be a good basis for chemical control. Tetra Pak is therefore supportive to building the REACH system on these two fundamental principles. Precaution and substitution need to be introduced early in the text as guiding principles for the whole policy

- internet submission by Tetra Pak on REACH June 2003, Public comment period

In both Germany and in the UK (UK Control of Substances Harmful to Health (COSHH) Regulations) the substitution of hazardous produces (where possible) is obligatory in the workplace. The German federal environment ministry also recommends substitution as the method for dealing with endocrine disrupting chemicals. In 1999 the UBA stated: *Substances whose endocrine potential has been shown in in vivo tests, but where the available data is (as yet) insufficient for legal restriction or prohibition, should be named publicly in blacklists, and made subject to a substitution requirement under the Hazardous Substances Ordinance. Such a list could provide sufficient incentive to substitute, even where there is only a suspicion of danger.*⁷

The Canadian Environmental Protection Act defines pollution prevention as a range of options but gives no priority to the substitution principle. This may entrench chemical users into ongoing hazardous chemical use.

Do we in Canada also promote substitution of hazardous chemicals by safer chemicals? The Canadian Environmental Protection Act is there *"to protect the environment and human health in order to contribute to sustainable development by identifying and managing risks from existing sources of pollution, and preventing the creation of new pollutants."* This implies we cannot rectify the mistakes of the past – eg if a toxic chemical was synthesized and used widely in commerce, we can only 'identify and manage the risks'

We also define no clear vision of a non-toxic future with measurable benchmarks. We lack a programme that works towards the mass adoption of green chemistry and often we opt for hazard management based on emission controls.

Our primary tool to realize the adoption of safer chemicals is that of pollution prevention planning, triggered within CEPA by the designation of a chemical to be CEPA toxic (Schedule 1 of the Act). The definition of P2 is "the use of processes, materials, products....that avoid or minimize the creation of pollutants and waste..." There is no

explicit reference to actual material substitution. The response to a CEPA toxic substance could therefore, just as easily be an end of pipe control which simply minimizes emissions.

Even substances designated for 'virtual elimination' will not necessarily trigger the search for safer alternatives and substitute materials since virtual elimination is defined as "reduction of the quantity or concentration of the toxic substance in an emission, effluent, or waste released to the environment, so that the quantity or concentration is below a level set by the Ministers of the Environment and Health." It seems obvious that a chemical target for 'elimination' should predicate the search and adoption of safer materials, but again, this is not stipulated in the definition. Of the 68 chemicals put on the Toxic Substances List only one chemical has been targeted for virtual elimination.

The problem with pollution prevention versus Substitution Principle: Summary case study – PERC use in drycleaning.

The recent regulations on PERC (Tetrachloroethylene) Use in the Drycleaning sector have led more to 'innovative end of pipe control' rather than a transition to alternative cleaning agents that are less hazardous.

PERC has been listed on the Priority Substances list since 1989 due to its ubiquitous presence in groundwater and its toxicity to humans. It is toxic to the liver and the central nervous system, can accumulate in the body and is probably carcinogenic to humans. The compound induces leukaemia in rates and increases risk for oesophageal cancer, non-Hodgkin's lymphoma and cervical cancer. It is found in the breath and breast milk of lactating women who work in drycleaning establishments and has been found to contaminate bread, meat and butter from neighbouring shops.⁸

In 2000 PERC was added to the CEPA 1999 list of toxic substances and in February 2003 regulations were drawn up. However the **purpose of the Regulations is to reduce PERC releases to the environment from dry cleaning facilities – not to push for substitution** through tax credits, training or research and development. Although the NOPP and Canadian Centre for Pollution Prevention have information and a database on some alternatives to PERC the voluntary uptake by industry has been minimal due to lack of awareness of available substitutes. Indeed the Regulations mention nothing of substitute solvents or processes but mandate that reductions of emissions will be attained by requiring newer, more efficient (and expensive) dry-cleaning machines, minimizing spills of PERC and managing the collection and disposal of residue and waste water.⁹ In effect the long process of listing PERC as CEPA toxic has resulted in end of pipe controls and has entrenched drycleaners and consumers into on-going hazardous chemical use and exposure.

This situation was validated by a trip to my local drycleaner in Montreal who told me that Feds had visited his establishment, told him he had to invest in a multi-thousand dollar upgrade PERC recycling machine but gave him no information on alternatives such as Wetcleaning or liquid carbon dioxide machines. "I know this stuff is killing me," he told me, "but it's my living." There is no trade association in Quebec or P2 outreach to give

him and others information or training on alternatives. A subsequent call to Environment Canada in Quebec revealed that an initial factsheet had been made available but in short, the dissemination of information and training had fallen through the cracks and was now inactive.

Yet alternatives exist, as Environment Canada's own research has found. The disconnect has been due to lack of active dissemination of information on alternatives to perc, increased cost of wet cleaning and CO2 machines with no subsidies available to increase their uptake, the ongoing use of 'dryclean only' labels in clothes and a general lack of awareness on the part of drycleaners and customers alike about the serious health threats from perc exposure. There is no dedicated and ongoing training throughout Canada on alternative methods of cleaning. If there is, drycleaners do not know of it. Yet, decreasing the emissions from drycleaning machines will not prevent exposure in the workplace nor will it prevent exposure in the home from direct offgassing from 'cleaned' clothes. In International Committee of Textile Care is voting this year on whether to establish a Wet-cleaning label for clothes to remove one of the significant barriers to wetcleaning uptake.

Financial incentives could be brought in to support training and uptake of safer technology. Through the Canada Small Business Financing Program (CSBFP) of Industry Canada, the Government of Canada created the Capital Leasing Pilot Project and the Small Business Loans Program to assist small businesses, including dry cleaners, in financing fixed assets and other materials. A dry cleaner may apply to a financial institution or a participating leasing company of its choice for a loan or lease under these programs at prime rate.. If the application is granted, the federal government will guarantee 85% of the lender's losses in the event of default. However the loan seemingly only applies to perc emission reduction machines as this is what has been stipulated in the regulations. It is crucial that these small business loans be revised to encourage the adoption of safer drycleaning techniques. Others incentives could be brought in.

Will Brominated Flame Retardants (PBDEs), once designed CEPA-toxic, be replaced by other brominated chemicals? Will CEPA strive for emission control or actual substitution?

At the very least, we recommend that where synthetic chemicals are found in elevated concentrations in biological fluids such as breast milk and tissues of humans, marine mammals or top predators, regulatory steps be taken to remove them from the market immediately.

— Royal Commission on Environmental Pollution, UK - Chemicals in Products, 2003

Polybrominated biphenyl ethers (PBDEs) are now ubiquitous contaminants in our environment and Canadians now have the second highest levels globally of these chemicals in our bodies. PBDEs, called the PCBs of the 21st century, are linked to nervous system disorders, thyroid dysfunction and reproductive damage to the developing fetus. Health Canada has extensively documented its ongoing increase in the environment and in human populations but to date there is no way forward as to how, or

indeed if, PBDEs will be phased out of production and use in Canada. A recent CTV study of PBDEs in food created some minor furore within the House of Commons demanding action by the government to ban these chemicals with a response from Health Canada that studies were still underway. How much evidence is needed to take action?

“Brominated flame retardants should not be used where suitable replacements are available, and future efforts should encourage the development of further substitutes.”

— World Health Organization’s International Programme on Chemical Safety, (1999)
Environmental Health Criteria 205: Polybrominated dibenzo-p-dioxins and dibenzofurans

In comparison, in 1989 Germany agreed to voluntarily cease production of PBDEs due to human health concerns and within the European Union new electronic products must not contain PBDEs as of July 2006. Levels of PBDEs in the Swedish public declined a year after the government regulated the phase out of PBDE use in industry in 1999.¹⁰

Government initiative to Research the Alternatives

To speed the phase out of PBDEs, Germany, Denmark and Sweden have extensively researched the available alternatives to brominated flame retardants. Working with the limited studies available, both the Danish and German governments have issued reports that evaluate the human health and toxicity data for a wide range of flame retardants, including those BFRs targeted for phase out. The German Environmental Protection Agency used the substitution principle to assess and rank thirteen flame retardants based on toxicity to humans and the environment and their suitability to work within closed loop material systems.

Both reports conclude that the use of halogen free flame retardants is a good first step forward in making the product safer. However more research is needed to fill in the data gaps on environmental and human health profiles where necessary.

Substitution of BFRs and other chemical classes of high concern is already happening among progressive companies and these case studies have been extensively documented.¹¹ A variety of reasons exist for why some companies are searching for safer substitutes while other don’t and these include regulatory drivers such as the recent European Directive on the Restriction of Hazardous Substances in electronic equipment, increased public awareness, demands from downstream users or clients, liability issues, competitive advantage and company ethics.

However, there are also barriers and the development and adoption of safer substitutes is happening only slowly, in a piecemeal fashion and in some sectors not at all. An extensive overview of the incentives and barriers to substitution prepared for the European Union concluded that well-designed regulatory signals are needed because market forces alone often fail to provide a competitive advantage for the safer product, particularly where the markets are “too far away” from consumer awareness to be influenced by the potential demands of consumers.¹²

Some recommendations to better integrate the substitution principle:

At the very least, we recommend that where synthetic chemicals are found in elevated concentrations in biological fluids such as breast milk and tissues of humans, marine mammals or top predators, regulatory steps be taken to remove them from the market immediately.

— Royal Commission on Environmental Pollution, UK - Chemicals in Products, 2003

- **Adopt the Substitution Principle within CEPA and within provincial jurisdictions. Make all persistent, bioaccumulative and toxic compounds and equivalent chemicals of concern, a priority trigger for mandatory Substitution planning and implementation.**

This needs to happen at both product and industry sector level. CEPA deals with industrial sectors when the trigger of a 'CEPA toxic' substance could mandate the implementation of a pollution prevention plan. The Proposed Notice on users of of Nonylphenol (NP) and its Ethoxylates (NPEs) and its relationship to the pulp and paper and detergent industry has set the stage for some good substitution planning within industrial sectors. Other industrial sectors of concern, particularly those using chemicals on the Toxic Substances List, should be the focus of substitution research and implementation.

- **Stimulate the research and adoption of safer alternatives via mandatory Substitution Assessment Planning and Technical support**

Planning works, as evidenced by the success of the Massachusetts Toxic Use Reduction Planning requirements as well as a host of cleaner production projects. Here over 550 companies had to assess toxic use reduction options with technical help supplied by university and government experts. Toxic use reduction strategies included material substitution and product reformulation. Within ten years, industry has reduced the use of toxic chemicals by 40%, by-product waste by 58% and toxic emissions by 80%. A cost benefit analysis reveals that the same companies saved a total of USD 14 million.¹³

Until companies actively search for safer chemicals, there is a well observed tendency to try to manage hazardous chemical use. A reliance on voluntary initiatives will not prevent exposure to chemicals of high concern. Several studies have shown that voluntary actions have severe limitations. Recently, the OECD published a report¹⁴ pointing out some of the major problems with voluntary as opposed to obligatory schemes. In particular they point out that "free riding" is a significant problem among many collective voluntary approaches. The OECD further note that the economic efficiency of voluntary approaches are generally low because they fail to equalize the costs between all producers and environmental targets are set on individual sectors rather than at a national level.

For this reason, the Substitution Principle cannot be implemented simply as a general policy statement, since this will be an insufficient driver for change. Instead it needs a clear mandatory imperative to drive it.

Mandatory planning requirements break this stalemate. The assessment should be based on comparative assessment of a wide range of criteria. If no suitable substitute is available then ongoing use of a chemical of high concern would be time-limited to allow research or market development of the safer material. This demand, is echoed by many member states within the EU who have experience with substitution planning.

- **Promote and invest in Green Chemistry R&D**

Planning requires technical support in safer alternatives. Canada needs to aggressively implement Green Chemistry courses within university chemistry departments and provide R&D funding for green chemistry innovation. The chemical industry needs to embrace the Principles of Green Chemistry and urgently transform to inherently safer catalysts, and processes. This can now be done but the political and institutional will is lacking. A workshop and training could be organized to expose business chemical users, students, provincial leaders, advocacy groups to the current availability of green chemistry as well as its future potential. (Our organization is holding the first public meeting and training on Green Chemistry in Autumn 2004 in Washington, DC together with the Institute for Green Chemistry). We need to radically transform the way in which chemistry is taught in our universities.

- **Make alternatives assessments widely available**

“In order to promote the development of cleaner products that do not contain brominated flame retardants, the Programme for Cleaner Products will continue to support the development, testing and assessment of alternatives, as well as the dissemination of knowledge to manufacturers about the possibilities for using the alternatives.”
— Danish EPA, Action Plan for Brominated Flame Retardants, 2001

Alternatives to PBDEs is essential for small and medium scale companies to move to safer chemical use. But who will do these assessments? The US Design for Environment recently held a workshop on alternatives to. Recently our group commissioned a comprehensive overview of alternatives to Deca-PBDE. State and Provincial legislatures need this information to push substitution. A recent workshop on Substitution hosted by the Lowell Center for Sustainable Production (April 2005) attended by leading company representatives called for better and standardized criteria to rank the safety of alternatives. This is a priority for businesses and offers a unique initiative for green chemists, government regulators and consumers. It is also essential that public have access to, and workers are involved in, alternatives assessment methodology. Just as life cycle assessments should be transparent about the assumptions used in comparing products, the comparative assessments – to be successful – should have buy-in from the workers on the floor. Public access helps engage consumers in product choice.

Also, where necessary, mandatory training on safer, innovate chemicals within industrial sectors, such as alternatives to PERC, should become a national requirement. Training can be mandated under CEPA or by provincial jurisdictions who have a broader training

mandate. Finally active dissemination of information is crucial. When dealing with chemicals of high concern we would suggest that it is the ethical duty of government regulators to actively push safer alternatives. A passive reliance on demand from downstream chemical users and SMEs, or consumers, who are often unaware of inherent hazards, has shown to be highly ineffective.¹⁵

- **Change the focus from emission control to integrated product policy.**

It has been estimated that decisions made at the design stage of a product's development influence up to 80% of its environmental impacts over its lifecycle. In other words, if designers were to improve the nature and amount of materials and energy that they specify, they could reduce by fourfold the overall sustainability burden of products, processes and even systems.¹⁶

To demonstrate how a new product-oriented environmental policy works in practice, the European Commission has selected two pilot projects focused on mobile phones and wooden garden furniture to expand the practicalities of implementing Integrated Product Policy. The projects form an integral part of the Commission's activities to increase the availability and purchasing of more sustainable products throughout the Single Market.¹⁷

- **Green Procurement.** Providing the incentive for rapid uptake of safer alternatives is successfully expressed in green procurement guidelines. Big consumers, such as group purchasing organizations for hospitals, have successfully demanded safer substitute chemicals and materials from their suppliers.¹⁸
- **Financial incentives.** An assessment of Canada's subsidies, tax incentives and tax breaks for chemical producers and downstream users of chemicals must ascertain if we are truly promoting innovation in safer materials and green chemistry adoption.
- **Public Access to information on chemical use in products**

Crucial to advancing sustainable product design and the use of safer chemicals is public access to information on products. Unfortunately all products have the potential to release a toxic substance during use if they contain hazardous materials. Research has shown household dust to be a ubiquitous source of exposure to priority substance list chemicals from common household products.¹⁹

Some countries are now setting up Product Registers to facilitate consumer access to information about chemicals in products. Denmark has lead the way with its Independent Information Centre for Environment & Health (IMS) which was established in January 2003 and is financed by the Ministry of The Environment for a period of three years, 2003-2005. The composition of the Board is a mix of industry, consumer and health and environment representatives.²⁰ The public can search on line for brand name products made without brominated flame retardants. The list is updated

as new information comes in. The list is not a regulatory requirement for companies to join but consumer demand has made it highly popular. Germany has examined priority products for IPP study such as laundry detergents and given the public information on product types.²¹

If consumers and major buying agencies are to stimulate the demand for cleaner products, information must be accessible. Some companies are putting their chemical policy up on their websites, but many do not. Environmental NGOs are now specifically targetting companies' chemicals policy as part of their advocacy for substitution.

At present public access to information on the CEPA database is limited to CAS numbers of chemicals on various lists. No information is given on how these chemicals are used, their environmental and health data, what industrial sectors use them or which products contain them. In effect the information is of very limited use and will not stimulate public demand for safer chemicals use in products. Even the C2P2 online database gives no information to the public about product policy or chemical use in products. Canada could emulate the Danish experience thus engaging public interest and demand for safer products.

Appendix: BROMINATED FLAME RETARDANTS: TIMELINE OF LEGISLATIVE INITIATIVES

- 1989 Germany Industrial users voluntarily agree to a phase-out of PBDEs.
- 1989 Netherlands Industrial users voluntarily agree to a phase-out of PBDEs and PBBs.
- 1989 EU Prohibits use of tris (2,3 – dibromopropyl)-phosphate and PBB in textiles intended for contact with the skin; implemented in 1997 in Ministry of Environment and Energy Statutory Order 1042.
- 1992 OSPAR Places BFRs on List of Chemicals for Priority Action; recommends urgent elimination of PBDEs and PBBs.
- 1993 Germany PBDEs banned due to dioxin regulations.
- 1995 North Sea Environment Ministers 46 commit to BFR substitution with less hazardous alternatives.
- 1999 Sweden Swedish Chemicals Inspectorate (KemI) recommends phase-out of PBDEs and PBBs within five years with eventual phase out of all BFRs as part of a nontoxic future.
- 1999 World Health Organization Recommends that BFRs “should not be used where suitable replacements are available.”
- 2000 OECD Joint Meeting of the Chemicals Committee and Working Party on Chemicals accepts bromine industry's voluntary agreement to end PBB production.
- 2003 Austria Advocates ban on deca-BDE.
- 2003 EU Examining possible action on HBCD and TBBPA.
- 2003 Norway Pollution Control Authority requires companies to submit reduction and phaseout plans for BFRs.
- 2003 Netherlands Prohibits production of bis (2,3-dibromopropyl) tetrabromobisphenol A TBBPA.
- 2004 EU Ban on penta- and octa-BDE marketing and use in all products takes effect.
- 2004 EU Deca-BDE currently undergoing debate decision expected late – 2004.
- 2004 Norway Ban on penta- and octa-BDE takes effect.
- 2005 Norway Planned ban on deca-BDE.
- 2005 Norway Planned ban on HBCD and TBBPA if no EU action.

- 2006 EU ROHS 1 Directive takes effect banning penta-, octa-, and deca-BDE in all electrical and electronic equipment sold or imported into the EU.
- 2006 Maine Ban on penta- and octa-BDE.
- 2008 Maine Ban on deca-BDE.
- 2008 California USA Ban on penta- and octa-BDE.
- 2020 OSPAR Phase-out goal for all brominated flame retardants.

¹ Oko-Institute e.v, (2004) Never Change a Running Process?

² <http://www.regeringen.se/content/1/c4/13/48/385ef12a.pdf>

³ Rosander, Per. 2003. Substitution in Swedish Pesticide Regulations. Chemical Secretariat, Stockholm.

⁴ . The steps presented are based on the document 'sju steg till substitution' ('seven steps to substitution') and the method presented in the Prevent document Kemiska hälsorisker (Chemical health risks) See more details at http://prio.kemi.se/templates/PRIOEngframes_970.aspx

⁵ <http://www.miljomal.nu/english/english.php>

⁶ <http://www.miljomal.nu/english/objectives.php>

Summary of the timeline:

By 2010 products will carry health and environmental information on any dangerous substances they contain. Newly manufactured products will as far as possible be free from:

- carcinogenic, mutagenic and reproductive toxic substances, by 2007, if the products are intended to be used in such a way that they will enter natural cycles;
- new organic substances that are persistent and bioaccumulative, as soon as possible, but no later than 2005;
- other organic substances that are very persistent and very bioaccumulative, by 2010;
- other organic substances that are persistent and bioaccumulative, by 2015;
- mercury by 2003, and cadmium and lead by 2010

⁷ UBA (2001) Chemicals in the Environment which interfere with the Endocrine Systems of Humans and Wildlife – Pollution, Effects, Control Strategies.

⁸ IARC (1995) Tetrachloroethylene (Group 2A) IARC Summaries and evaluation. VOL:63 (p. 159); ATSDR (2000) Toxicological profile for tetrachloroethylene.

⁹ Environment Canada. Compliance Guide for Dry Cleaners. June 2003

¹⁰ McPherson, A; Thorpe, B. (2004) Brominated Flame Retardants in Dust on Computers: The case for Safer Chemicals and Better Computer Design. Available at www.cleanproduction.org

¹¹ Thorpe, Beverley. (2003) Safer Chemicals Within Reach. Greenpeace Environmental Trust UK. Also at www.cleanproduction.org

¹² Lohse, Joachim et al. Never Change a Running Process? Substitution of Hazardous Chemicals in Products and Processes: Definition, Key Drivers and Barriers. Greener Management International. Issue 41, 2003.

¹³ www.turi.org

¹⁴ OECD. Voluntary Approaches for Environmental Policy. Effectiveness, Efficiency and Usage in Policy Mixes. 2003

¹⁵ As witnessed by the EC brochure on drycleaning which mentions wetcleaning but which did not garner requests for more information from drycleaners. Similarly, the surprised response of the polyurethane foam industry in the USA to the realization that PBDEs were toxic, demonstrates the lack of communication about hazards, international phase out legislation and available alternatives.

¹⁶ Dewberry, M and C Sherwin. Visioning Sustainability through Design. Greener Management International, Issue 37, Spring 2002.

¹⁷ European Commission press release. Commission and industry initiate projects for greening products. June, 2004. Brussels - <http://europa.eu.int/comm/environment/ipp/040625pressrelease.pdf>

¹⁸ see Health Care Without Harm at www.no-harm.org

¹⁹ Greenpeace UK. Consuming Chemicals. Greenpeace Environmental Trust. 2003 www.greenpeace.org.uk also see www.safer-products.org

²⁰ More information on the centre: <http://www.miljoegsundhed.dk/artikel.asp?artikelID=3754&kategoriID=281>

²¹ German Federal Ministry for the Environment <http://www.umweltbundesamt.de/uba-info-daten/daten/wasch/index.htm>