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Safer alternatives assessment: the Massachusetts process as a model for state governments

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ABSTRACT

In 2006 the Massachusetts Toxics Use Reduction Institute conducted a study to determine if states could identify safer alternatives to five chemicals of concern. The chemicals investigated included di (2-ethylhexyl) phthalate (DEHP), formaldehyde, hexavalent chromium, lead and perchloroethylene. First, the Institute developed a methodology for assessing alternatives to these five chemicals that allowed it to quickly determine priority uses and alternatives to assess and to research the pertinent decision criteria, which included performance, technical, financial environmental and human health parameters. The methodology included important feedback from stakeholders in the state, which helped to focus and enhance the value of the work. Second, the Institute implemented the methodology over a ten month period. Based on the activities conducted by the Institute, safer alternatives were identified for each of the priority uses associated with the five chemicals studied. This report summarizes the methodology employed and provides examples of the results for one of the five chemicals, namely DEHP. The experience of the Institute and the information contained in this report indicates that alternatives assessment was a useful approach to organizing and evaluating information about chemicals and alternatives.

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1. Introduction

There is growing concern among consumers about the presence of toxic chemicals in the products they use. Studies showing these chemicals' persistence in the environment and potentially harmful effects on humans exposed to them are becoming a common place item in the news. Retailers, anxious to maintain their consumer base, are taking a harder look at the products they are willing to sell in their stores. Manufacturers are concerned about providing safer product formulations that will create a sustainable market share and help them to avoid potential future liabilities and costs. Public health and environmental advocacy groups are diligently working to raise public awareness and understanding of the risks associated with toxic chemicals, an activity which in turn puts more pressure on the retailers and manufacturers.

The tightening pressure to remove toxic chemicals from products has understandably come to the attention of municipal, state and federal governments, who are responsible for protecting their constituents and the environment they inhabit while continuing to promote a more productive economy.

In July 2005, the Commonwealth of Massachusetts requested that the Toxics Use Reduction Institute perform an alternatives assessment for five chemicals identified by a coalition of public health, labor and environment advocacy groups. The chosen chemicals included lead, formaldehyde, perchloroethylene, hexavalent chromium, and di(2-ethylhexyl) phthalate (DEHP). For each chemical, the Institute was charged with identifying significant uses in manufacturing, consumer products, and other applications; reviewing health and environmental effects; and evaluating possible alternatives.

Because the study had to be conducted within a very short time frame (approximately 10 months) for a limited budget the Institute needed to quickly focus its work on the highest priority chemicals and applications. Likewise, for each use studied, the Institute chose a subset of possible alternatives for analysis. The Institute analyzed a total of sixteen different use categories and approximately one hundred different alternatives. Examples presented throughout this article are associated with one of the five chemicals studied, DEHP.

The Institute conducted its research in a phased manner, using the methodology described herein. This report presents the streamlined approach used by the Institute; a method that can be

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adapted for use by other governments and companies interested in quickly identifying safer alternatives to chemicals of high concern.

2. Phase I – understanding the concerns associated with the chemical being studied

To fully assess whether an alternative was indeed both technically and economically feasible for its intended use as well as being safer, the characteristics of that chemical was first identified.

2.1. Profile inherent hazard and exposure of the chemical of concern

Information about potential human health and environmental impacts associated with the use or exposure to the chemicals of concern can be found in a number of sources: public databases, peer-reviewed scientific journals, reference materials, industry trade group and advocacy group resources. The objective was to provide background information on each chemical of concern, highlight the associated environmental, health and safety issues, and provide a baseline against which alternatives may be compared.

The Institute has a long-standing history of focusing its work on the inherent hazards associated with toxic chemicals. However, the US federal government and most companies and trade associations have historically considered "risk" when setting policy about the use of chemicals. Risk assessments include an evaluation of the exposure potential associated with the use of a chemical as well as its inherent hazard. Potential human health and environmental hazards are typically inherent to a chemical and are not influenced by the use or exposure potential associated with the chemical. Table 1 presents the pertinent inherent hazard information associated with DEHP.

The potential for human exposure to a chemical of concern is directly influenced by the manufacturing process and use for specific applications. Physical characteristics of the chemical and the product or material in which it is incorporated influence the potential for exposure to the chemical of concern. For DEHP, the physical characteristics and characteristics that could lead to exposure are summarized in Table 2.

Table 2
Physical characteristics of DEHP influencing exposure potential.

Physical characteristic	DEHP data	Primary sources of information
Water solubility (mg/L)	0.0025	HSDB, 2009
Vapor pressure (mmHg)	1.4×10^{-6}	HSDB, 2009
Octanol–water partition coefficient (K_{ow})	7.6	HSDB, 2009
Flashpoint	215	HSDB, 2009
Migration potential	Possible migration from matrix in lipid soluble	Health Canada, 2002

The Institute used exposure potential information to help determine the priority of specific uses of each chemical, but also to gain more insight into how alternatives compared to the chemicals of concern for specific uses.

2.2. Identify function, uses and use categories

Uses of chemicals range from manufacturing processes to services to consumer products. The first task was to identify the suite of uses for the chemicals of concern. Uses may include use in manufacturing operations (e.g., chemical production), use in non-manufacturing operations (e.g., services such as dry-cleaning), as well as incorporation in consumer and industrial products.

The Institute utilized the following sources when gathering this information:

- Major suppliers of the chemical;
- Major derivatives, components and/or end products that incorporate the chemical or use the chemical as a feedstock, and their manufacturers;
- Major distributors, retailers, or customers of the end product;
- Functionality requirements of chemical or component or end-product users; and

Table 1
Inherent hazard characteristics of DEHP.

Chemical characteristic		DEHP data	Primary sources of data
Environmental criteria	Persistence	• 140 days in sediment • 15 days in water • 30 days in soil • 0.75 days in air	EPA PBT Profiler, 2010
	Bioaccumulation	BCF = 310	EPA PBT Profiler, 2010
	Chronic aquatic (fish) toxicity (ChV)	No effect at 0.0025 mg/L	EPA PBT profiler, 2010
Human Health criteria	Carcinogen	• NTP B2 (Reasonably anticipated to be a human carcinogen) • IARC 3 (Not classifiable as to its carcinogenicity to humans)	• National Toxicology Program Report on Carcinogens, Eleventh Edition, 2010 • International Agency for Research on Cancer, 2010
	Reproductive toxicity	No adverse affect level = 3.7 mg/kg bw/d	NTP, 2005
	Lethal dose (LD50)	• 25–34 g/kg (oral, rat) • 10 g/kg (dermal, guinea pig) • 25 g/kg (dermal, rabbit)	HSDB, 2009
	Irritation	• Dermal • Ocular • Respiratory (mucous membranes)	HSDB, 2009
	Metabolite of concern	Mono(2-ethylhexyl)phthalate (MEHP) classified as a reproductive toxicant	CDC, 2005
	Reference dose	0.02 mg/kg/day	HSDB, 2009
	Target organs	• Eyes • Respiratory system • Central nervous system • Liver • Reproductive system • Gastrointestinal tract	NIOSH Pocket Guide to Chemical Hazards, 2005