An Analysis of Corporate Restricted Substance Lists (RSLs) and Their Implications for Green Chemistry and Design for Environment

November, 2008

Companies are increasingly being called upon to demonstrate the safety of their products, particularly their chemical constituents. In the face of concerns about environmental and public exposures to some chemicals, many regional and national governments have issued regulations restricting or prohibiting such chemicals. Further, given the often slow pace of government regulations in response to emerging science, many companies have taken actions to restrict chemicals of elevated concern in their products and processes, in an effort to foresee future regulations or public opinion. Finally, given the general lack of information on many chemicals in commerce, some companies have developed screening programs and criteria to guide hazardous materials restrictions. The result has been the creation of multiple corporate and sectoral lists of restricted materials.

Despite the development of these lists and publication by certain sectors or companies, there has been no effort to date to pool restricted substances lists across sectors and companies to better understand the types of chemicals restricted and rationale for their restriction. The Lowell Center for Sustainable Production (the Lowell Center) issued a call to companies in the Green Chemistry and Commerce Council (GC3) for lists of chemicals that firms have deemed restricted in some way, based on concerns about negative environmental or health impacts or some other factor. The Lowell Center also did an Internet search for lists of chemicals of concern or restricted substances that have been made publicly available by individual companies or by representative associations. With the assurance that all information would be kept confidential and would be non-attributable to any particular company, 19 lists of restricted substances were made available for analysis: 15 from individual companies and 4 from industrial sectors. The Lowell Center compiled these restricted substance lists by substance name, and when made available, by CAS number. Notes were made as to the sector restricting the chemical (textiles, electronics, etc.), the type of restriction (restricted above a certain threshold, banned for use, etc.), and when given, the reasons behind the restriction (regulation, corporate policy, etc.). The 19 lists compiled represented the following chemical use sectors: retail (2); electronics (3); textiles (1); apparel (3); building products (1); consumer products such as soaps, detergents, etc. (2); automotive (2); flooring (1); commercial cleaning products (1); aerospace (1); pharmaceuticals (1); and personal care products, such as cosmetics, and retail (1).

Findings

Below we present findings from our analysis of the restricted materials lists. The actual compiled list is in Appendix 1. These findings are divided by: (1) general observations; (2) types of restrictions; (3) rationale for restrictions; and (4) drivers for chemical restrictions.

General Observations. Depending on the firm, restricted substance lists varied in detail from very basic (chemical name without CAS and casual rational for its restriction) to more detailed (chemical name, CAS number, restriction by use, by the country in which the product will be sold, and reason for restriction). Some substances were restricted as a category (phthalates,

brominated flame retardants, etc.), but the majority were restricted as individual substances. Some companies listed the same substance multiple times in their restriction list depending on how it was used; for instance, the substance lead (II) chromate might appear on a list once as a "hexavalent chromium compound" and again as a "lead compound." In this instance, when CAS numbers assured that the same substance was indeed listed multiple times, it was entered into the master list as one consolidated entry.

Chemical nomenclature was a reoccurring issue in this analysis. CAS numbers are intended to give each distinct chemical its own identification number, an important feature when the same substance can be known by several different names. In instances where firms supplied a list of chemical names (or classes) without CAS numbers it is possible that the same chemical is listed more than once in the master list that was created. Additionally, several entries in the master list are of a category, for instance, "phthalates," while several individual phthalates are also listed. Because of this trend toward duplicative entries it is difficult to know the exact number of substances listed across all of the firms participating. However we estimate that between 700 and 800 individual chemicals had been identified as having a use restriction of some kind.

Types of Restrictions. In general, the restriction lists gathered for this project were not standardized in any way. They varied greatly by company and sector in terms of what substances were covered, allowable levels in a product, and the level of detail for the information provided. However, there is significant overlap across sectors in individual chemicals and types of chemicals restricted, such as ozone depleting substances. This makes sense as these types of chemicals are/were widely used across sectors and are now subject to government regulations globally. Nonetheless, a restricted chemical may have different allowable levels depending on its use. Antimony in apparel, for instance, is restricted to 30mg/kg in natural fibers, but 260 mg/kg in polyester. Many of the substances where the chemical use data was provided were flame retardants, dyes and pigments, and solvents.

In general, information about a chemical's use was not provided as part of the restriction lists (such data are included in Appendix 1 when readily available). This makes developing a use based categorization of restricted chemicals challenging. Such data on uses are not readily available, for example in government databases. Some government product registries, such as those in the Scandinavian countries or data to be collected under the European Union's Registration, Evaluation and Authorization of Chemicals (REACH) legislation may help to fill in these gaps. In general, today such data can only be collected through significant industry research – for example using the Chemical Economics Handbook. In some cases, substances may have fairly similar uses across sectors, such as solvents. However, some substances, such as formaldehyde, are used in tens or hundreds of applications making understanding the uses restricted in a particular sector challenging.

Rationale for Restrictions. Most companies did not include their reasoning for restricting a substance. When a reason for a restriction was given, more often than not companies noted that it was due to a regulatory obligation, either in the nation of manufacture or of sale. Some companies and sectors noted basing their restrictions on the strictest restriction in the world, ensuring compliance worldwide. Where regulation was cited as the reason for a restriction, the regulation came from one or more of the following governments: California state (Proposition 65

specifically), Canada, China, European Union (including RoHS and OSPAR), Finland, Germany, Japan, the Netherlands, and Switzerland. When regulation was not given as the driver to restrict a substance's use, those companies that noted them identified environmental, animal cruelty, or human health concerns as the rationale for restrictions. Often restrictions, particularly for firms selling directly to consumers or with a brand image, occur due to public or scientific concerns, what might be termed as scientific and social concern.

Drivers for Restrictions. Our analysis identified three key drivers for chemical restrictions at the firm level: regulatory drivers, marketing drivers, and advocacy drivers.

Regulatory Drivers

As noted, regulation appears to be the most influential driver in firms identifying a chemical as a restricted material. Regulations can be restrictive or proscriptive. For example, many states and localities have preferential purchasing regulations that specify types of products to be purchased, which may lead to a company restricting a particular material to maintain or increase market share. Some restrictions occur in the context of media specific regulations (air, water, waste), while others are part of broad chemicals or product regulations (which may be sector specific in nature). Several laws/policies appear to have a strong influence on materials restrictions (a compilation of particular lists that are commonly used by firms is in Appendix 2):

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65). Proposition 65 was passed as a protective measure to keep known carcinogens, mutagens, and reproductive toxins (CMRs) away from the pubic. The California Executive Office publishes annually an updated list of these chemicals, which are prohibited from any knowing release into state waterways or onto any terrain which way lead to the subsequent contamination of drinking water. The Act also states that a person may not be exposed to substances classified as a CMR without being given clear and reasonable warning. Products containing substances listed as CMR must therefore be labeled as such.[1]

Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS.) The RoHS Directive places restrictions on certain chemicals used in new electrical and electronic equipment sold in the European Union (EU): lead, mercury, cadmium, hexavalent chromium, and polybrominated diphenylether (PBDE) and polybrominated biphenylether (PBB) flame retardants. The law entered into force in 2006 and applies to firms manufacturing in the EU and to firms manufacturing elsewhere, but who wish to sell their products there.[2] RoHS requires that firms show due diligence in preventing excessive amounts of relevant substances from entering the marketplace. To accomplish this, steps must be taken to ensure the materials and production processes include mechanisms to prevent regulatory infractions, including consideration of the use of restricted chemicals from the design of products through the end of their useful life.[3] Similar restrictions on hazardous substances regulations have come in force in China and Korea.

In addition, the European Union's list of restricted substances under its former limitations directive listed about 900 chemicals restricted in a variety of consumer available preparations and products. These restrictions have been carried over into the new REACH regulation. Under REACH, chemicals that are very persistent and very bioaccumulative, are persistent,

bioaccumulative and toxic, are carcinogenic mutagenic or toxic to reproduction, or otherwise extremely toxic will be subject to an authorization process, where firms will have to seek permission for their continued use. The list of Substances of Very High Concern will likely be seen as a defacto restrictions list by many firms. The non-profit Chemical Secretariat in Sweden (KEMI) is developing a Substances of Very High Concern list of its own to present to companies before the REACH list is developed.[4] This first iteration by KEMI includes 267 substances considered to be CMRs, PBTs, and vPvBs.[5]

In that respect, government lists of substances of concern can be an important motivator for firm level restrictions, regardless of a regulatory restriction. Two notable examples include:

OSPAR Convention. The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) was singed in 1992 by 15 European nations to prevent pollution, including hazardous substances from entering the sea.[6] As of 2006, 310 chemicals were listed as being of possible concern,[7] either because they are recognized for being persistent, bioaccumulative, or toxic, or because they show potential to be equally damaging to the marine environment.[8] The Convention has also generated a list of Chemicals for Priority Action, on which heavy metals, brominated flame retardants, and phthalates are listed.[9]

Canadian Environmental Protection Act. The Canadian Environmental Protection Act (CEPA) was passed in 1999 and includes provisions for controlling toxic substances. The Act required the Ministries of Environment and Health to prioritize the almost 25,000 chemicals[10] listed on Canada's Domestic Substance List (a listing of chemicals on the market between 1984 and 1986, used in manufacturing, or manufactured or imported into the country in the amount of 100kg/year or more[11]) based on the relative risk of public exposure, and by each chemical's persistent, bioaccumulative, or toxic properties.[12] Chemicals assessed to be toxic can be placed on a List of Toxic Substances, which while not a guarantee of regulation, does open the door for federal actions, including regulation and plans for pollution prevention and emergency management.[13] The current list contains 85 chemicals, including lead, mercury, vinyl chloride and PBDE flame retardants.[14]

Market Drivers

While not explicitly mentioned in the data supplied to the Lowell Center, it is clear that companies using chemicals in production or selling chemical products can have a strong influence in manufacturing choices. For example, retail giant Wal-Mart, has stated that, "plans to inspire innovation in chemicals used in various product selections" and announced in October of 2007 that the company will begin using their "Preferred Chemical Principles' to establish a clear set of preferred chemical characteristics for product ingredients… to drive the development of more sustainable products for mother, child, and the environment."[15] However, Wal-Mart continues to lack a formal chemicals policy, instead addressing problematic chemicals one at a time and with media attention. As a May 2008 Wall Street Journal article points out that the company's motivation for taking action on chemicals such as lead and other metals, and phthalates is to "restore consumer confidence" following a long list of recalls of toys made in China, and to limit their liability after recalled toys could still be found on store shelves.[16] Wal-Mart's decision to take action on lead and phthalates follows well publicized arguments between

trade associations and environmental and public health advocates over the safety of these chemicals.

Another potential driver for individual firms to take action on potentially problematic chemicals is the role that industry associations can play in restricting substances as an industrial sector. Three of the contributors to the Lowell Center restricted substance list were from trade associations. In each case there was overlap between the chemicals of concern outlined by the industry group and those described in individual company's lists that belonged to that sector. This suggests that when trade associations act to publish restricted chemicals lists, firms represented by these associations may be encouraged to do the same.

Trade associations have a strong interest in staying current with substances governments are classifying as problematic as supply chains and markets are increasingly global. One association specified the need for an RSL due to the disparate nature of their industry, spread over 5 continents. The objectives identified by the organization internally— to provide quality, safety, and low environmental impact products while remaining efficient and low cost— necessitated a proactive approach to compliance. Substances regulated by any government within their supply chain were restricted, but beyond that, any substance projected to be regulated by a government or is associated with significant human or environmental harm needs to be declared. An oversight committee meets annually to evaluate the list against an internal set of criteria, and update it accordingly. The goal of the RSL and the evaluation process is to facilitate communication within the supply chain in as transparent a way as possible.

Additionally, as consumers become more sophisticated and increasingly demand environmentally preferable products, a growing number of firms see taking action on problematic chemicals as good business and are working to go beyond what is required to move toward a more sustainable supply chain. Two particular examples include:

- *SC Johnson.* SC Johnson and Son, Inc has established their GreenList program to assess each of the ingredients used in SC Johnson products against a range of information sources, and rate each ingredient on a 0 to 3 scale. Chemicals earning a 0 are restricted substances and any use requires sign off of a high level corporate officer, those earning a 1 are deemed "acceptable", 2 is a rating of "better", and those given a 3 are the "best" substances available. The company is currently evaluating six categories of ingredients which make up the majority of the products on the market: detergents, insecticides, packaging, propellants, resins, and solvents. SC Johnson has been recognized by the US Environmental Protection Agency for being the first company to develop such a program.[17]

- *Nike.* Beginning in the 1990s, Nike began substituting the petroleum-based solvents used in the manufacture of its sneakers to a safer water-based alternative. Through partnerships with consulting agencies, Nike began a "positive list" of chemicals used in manufacture which are not known or suspected to be hazardous to people or the environment. This is a list of preferred chemicals; Nike is working to phase out those chemicals which did not make the list. An example of this commitment is polyvinyl chloride (PVC) which is no longer used in Nike footwear. In 2001 the company set the

goal of "eliminating all substances that are known or suspected to be harmful to human health or the health of biological or ecological systems."[18]

Moving Beyond Lists

Lists of chemicals of concern represent a relatively simple approach to determining which substances should be avoided in product design. For product designers, the certainty and simplicity in such lists is an advantage. As previously noted, the vast majority of substances on restricted substances lists are result of regulatory requirements in some part of the world. These lists tend to be limited to chemicals have undergone some type of government assessment or have raised concern, a small part of the chemical universe. As such, developing such lists in a company or sector represents a compliance strategy and not necessarily a "green chemistry" strategy. As noted in the previous section, some firms are viewing lists as possibly constraining a more holistic approach to safer product chemistry.

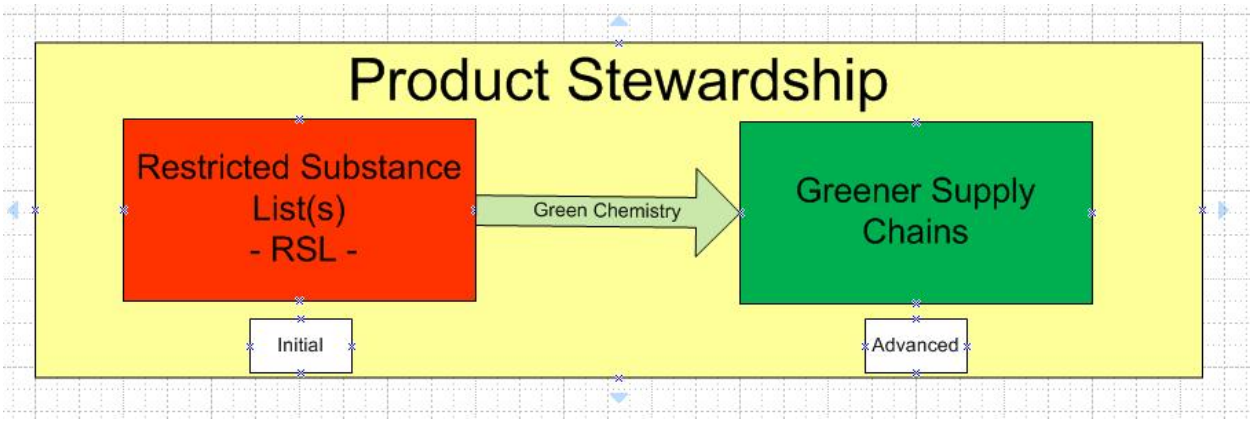
Rather than allocate resources to building lists of individual chemicals restricted for use in specific applications (which limit attention to a broader chemical universe), some companies are instead looking to institute criteria by which their chemical choices can be measured. One consumer product firm, for example, provided a list of 11 standards outlining their commitment to products that are conscious of their impact on the environment, human health, and animal suffering: vegetable derived ingredients, phosphate-free, and without volatile organic compounds are examples of these criteria. Where appropriate, the company ties their criteria to government or other reputable definitions of the standard, for example, products must be "biodegradable as defined by European Union Standard OECD 301," and "not acutely toxic as defined by the Consumer Product Safety Commission or oral, dermal, or inhalation routes of exposure." Given the popularity of environmentally friendly consumer products (many of which use essentially meaningless terms such as "all natural" in marketing), these types of standards which include specific language and definitions endorsed by governments allow the company to have credibility in the marketplace when compared to others.

Other firms are taking an approach to avoid chemicals with certain types of hazard properties, for example persistence and bioaccumulation or all carcinogens or reproductive toxicants. One electronics company has established specific criteria to guide materials choices, in addition to following legal concerns and market demands, including: Substances with hazardous properties that are a known threat to human health or the environment; substances with hazardous properties that show strong indications of significant risks to human health or the environment; and substances with hazardous properties that are known to biopersist and bioaccumulate in humans or the environment.

More mainstream firms seem to continue to look to government, in part, when outlining their criteria for chemical decision-making. One firm participating in this analysis outlined 5 criteria by which their firm screens their chemicals: 2 criteria were based on federal legislation; 1 based on industry assessments of chemicals; and the other 2 based on potentially problematic categories of chemicals (pesticides, brominated substances). Two other firms based their criteria on endpoints similar to what would be considered by a regulatory agency: acute toxicity, carcinogenicity, its classification as a PBT, whether or not it is a heavy metal, etc.

Despite an increasing focus on development of criteria for chemicals of concern decisions, there is little consistency across sectors or firms on how determinations should be made on which chemicals are of higher or lower concern or even the hazard/toxicity endpoints that should be used in making such determinations. While there is general agreement that substances with some properties (for example persistence and bioaccumulation) should be avoided, for the most part firms have developed their own individual schemes for chemical evaluation and prioritization. Some firms have chosen to use a hazard based approach to making determinations of acceptable/unacceptable chemicals with technological feasibility being the main determinant of whether to substitute or not, while other firms use a more risk-based approach. Within the more risk-based approach some firms undertake extensive exposure assessments while others define uses of higher concern as a surrogate for exposure.

To many leading companies, lists represent the baseline but a more effective approach to green chemistry focuses on the negative, and more importantly positive criteria in more sustainable chemicals. The following chart represents the relationship between restricted substance lists and a more green chemistry based approach.



In this context, green chemistry criteria for chemicals design can more effective green supply chains as it not only focuses on eliminating chemicals of concern (which an RSL focus does) but rather continuous improvement towards chemistries that fulfill the 12 principles of green chemistry across uses.

The Role of Non-Government Organizations

Non-government organizations (NGOs) are also working to create a supportive environment for companies to make the changes necessary to realize their vision of sustainable supply chains. Several non-profits have developed lists of criteria for chemicals of concern or lists of preferred chemicals.

CleanGredients. CleanGredients is an online subscription-based database for the formulators of cleaning products which brings together corporate sustainability goals and broad goals for environmental and public health. The program is intended to assist firms in determining which of their current product ingredients might have environmental or human health risks, and to provide a platform for makers of more benign cleaning ingredients to promote their work.[19] GreenBlue manages CleanGredients and takes care to ensure that stakeholder participation is

maximized, including representatives from industry and industry associations, and government and non-government organizations.[20]

Green Screen for Safer Chemicals. Clean Production Action has developed a chemical evaluation system by which chemicals are assessed on their environmental and human health performance and categorized into one of four benchmarks. Through Green Screen, chemicals pass from one benchmark to the next by meeting a set of criteria specific to each benchmark. To do so, the chemical in question and its breakdown products will need to meet increasingly demanding criteria, and eventually be recognized as a safer chemical.[21] In addition, Clean Production Action is also working to better define what constitutes a hazardous chemical; those that should be avoided because they result in one of several negative health or environmental endpoints.

Conclusions

This article explores the use of Restricted Substances Lists (or RSLs) among a small subset of firms from a number of sectors. While this analysis found more than 900 substances restricted across firms and sectors, we expect that examination of lists from firms in other sectors would identify additional, though not significantly more restricted substances. Those substances restricted tend to fall into a number of particular categories, some of which are consistent across sectors. Our analysis found that it is difficult to know how restricted chemicals are used in particular sectors or the rationale for a particular restriction.

While most restrictions listed are due to government regulations or policies, there is increasing interest among many firms in going beyond traditional lists into a broader chemicals categorization and prioritization process that focuses on higher and lower concern chemicals. While the basis for prioritization differs across firms, many have established specific criteria, such as persistence and bioaccumulation, for the types of substances they wish to avoid. Some firms have gone on to specify "positive" criteria for chemicals in products they manufacturer.

This analysis is the first of its kind examining corporate chemicals restrictions. A broader cross sectional analysis with attention to types of uses restricted, etc. would be a useful addition to this analysis. Further, comparisons of corporate chemical assessment and prioritization process would provide useful information in an attempt to establish more consistent and broadly applicable processes that can help firms move towards safer chemicals and processes.

---

[1] "Proposition 65,"California Office of Environmental Health Hazard Assessment website http://www.oehha.ca.gov/prop65.html accessed 17 Dec 2007.
[2] RoHS webpage, http://www.rohs.gov.uk/. Accessed 17 Dec 2007.
[3] "Due Diligence" RoHS webpage, http://www.rohs.gov.uk/content.aspx?id=7. Accessed 17 Dec 2007.
[4] International Chemical Secretariat website, "REACH SIN List 1.0". See http://www.sinlist.org/
[5] International Chemical Secretariat website, "What is On the REACH SIN List 1.0?" See http://www.chemsec.org/list/documents/081021_what_is_on_the_sin_list.pdf.
[6] OSPAR Commission webpage, http://www.ospar.org/eng/html/welcome.html Accessed 17 Dec 2007.
[7] OSPAR List of Substances of Possible Concern, http://www.ospar.org/eng/html/welcome.html. Accessed 17 Dec 2007.
[8] OSPAR List of Substances of Possible Concern, http://www.ospar.org/eng/html/welcome.html. Accessed 17 Dec 2007.
[9] OSPAR List of Chemicals for Priority Action, http://www.ospar.org/documents/dbase/decrecs/agreements/04-12e_List%20of%20Chemicals%20for%20Priority%20action.doc. Accessed 17 Dec 2007.

[10] Guide to Understanding the Environmental Protection Act, http://www.ec.gc.ca/CEPARegistry/the_act/guide04/s5.cfm Accessed 18 Dec 2007.
[11] Domestic Substance List Categorization and Screening Program, http://www.ec.gc.ca/substances/ese/eng/dsl/dslprog.cfm.
[12] Canadian Environmental Protection Act website, "Controlling Toxic Substances." http://www.ec.gc.ca/CEPARegistry/the_act/Part5_d.cfm. Accessed 17 Dec 2007.
[13] Guide to Understanding the Environmental Protection Act, http://www.ec.gc.ca/CEPARegistry/the_act/guide04/s5.cfm Accessed 18 Dec 2007.
[14] CEPA Environmental Registry, "List of Toxic Substances" http://www.ec.gc.ca/CEPARegistry/the_act/Schedules_1.cfm Accessed 18 Dec 2007
[15] "Wal-Mart Stores, Inc. Launches Innovative Program to Inspire Use of Preferred Substances in Chemical Intensive Products." www.walmartfacts.com/articles/4556.aspx, accessed Jun. 21 2007.
[16] Pereira, Joseph. "Wal-Mart Raises Bar on Toy-Safety Standards" *The Wall Street Journal online* 14 May 2008; p B1. Available http://online.wsj.com/article/SB121072388800090155.html
[17] "Making Environmental Choices: GreenList." SC Johnson and Sons website, http://www.scjohnson.com/community/greenlist.asp Accessed 19 Dec 2007.
[18] Liroff, Richard, "Benchmarking Corporate Management of Safer Chemicals in Consumer Products: A Tool for Investors with Senior Executives." International Journal of Corporate Sustainability, 12(1) 2005; 25-36.
[19] "About CleanGredients" CleanGrendients website http://cleangredients.org/about Accessed 19 Dec 2007.
[20] "Process and Organizational Model" CleanGredients website http://cleangredients.org/about/process Accessed 19 Dec 2007.
[21] The GreenScreen for Safer Chemicals: Evaluating Flame Retardants in TV Enclosures. Clean Production Action website http://www.cleanproduction.org/library/Green%20Screen%20Report.pdf