The Guide to Safer Chemicals

Implementing the BizNGO Principles for Safer Chemicals

PRINCIPLE #2

Assess & Avoid Hazards

Principle #2 is where organizations take action and replace chemicals of high concern with safer alternatives.

Ideal for Assess & Avoid

The ideal for Principle #2 is that manufacturers use chemicals in products, processes, and feedstocks that are inherently safer for human health and the environment, and purchasers prefer these products, processes, and feedstocks. The box details how the BizNGO Principles for Safer Chemicals define Principle #2. Note that the BizNGO Principles define chemicals of high concern using criteria that are similar to those used by governments to restrict chemicals, such as the REACH criteria for substances of very high concern. Additionally, any chemical that meets GreenScreen Benchmark 1 criteria qualify as a chemical of high concern in *The Guide*.

Intent for Assess & Avoid

The intent for Principle #2 is to compel downstream users to know the hazards of chemicals, and select and implement inherently safer alternatives to chemicals of high concern. A safer alternative includes replacing the chemical with an inherently less hazardous chemical, eliminating the need for the chemical through material change, product re-design, or product replacement; or eliminating the chemical by altering the functional demands for the product through changes in consumer demand, workplace organization, or product use.[1]

Knowing the hazards of a chemical is foundational to selecting a safer alternative. Organizations need to know the hazards of alternatives to know whether or not the alternative is safer or not. For purchasing organizations it is important to signal to suppliers that they need to know the hazards of the chemicals in their products. BizNGO Principle #2 in application does not mean companies must know the hazards of every chemical in every product across at every stage of the product's life cycle. But the application of Principle #2, like #1, does mean that companies commit to continuously improving their understanding of the hazards of chemicals in products and supply chains, identifying chemicals of high concern and potential alternatives, and selecting and implementing safer alternatives.

Context for Assess & Avoid

Assessing and avoiding chemicals of high concern is a challenging task. The complexity of hazard assessments, data gaps on chemical hazards, and limited number of alternatives all work against assessing and avoiding chemicals of high concern.

Evaluating the hazards of a chemical and benchmarking a chemical is a complex exercise. The GreenScreen, for example, includes 18 different endpoints for hazard evaluation, including carcinogenicity, reproductive toxicity, development toxicity, neurotoxicity, ecotoxicity, etc. Those 18 endpoints are then translated into a single benchmark for each chemical, on a scale of red to green. Completing a GreenScreen requires technical expertise. However, once a chemical is GreenScreen assessed, it is easy to understand the result as the chemical will fall into one of four benchmarks (see Figure 2–1. page 30).

PRINCIPLE #2:

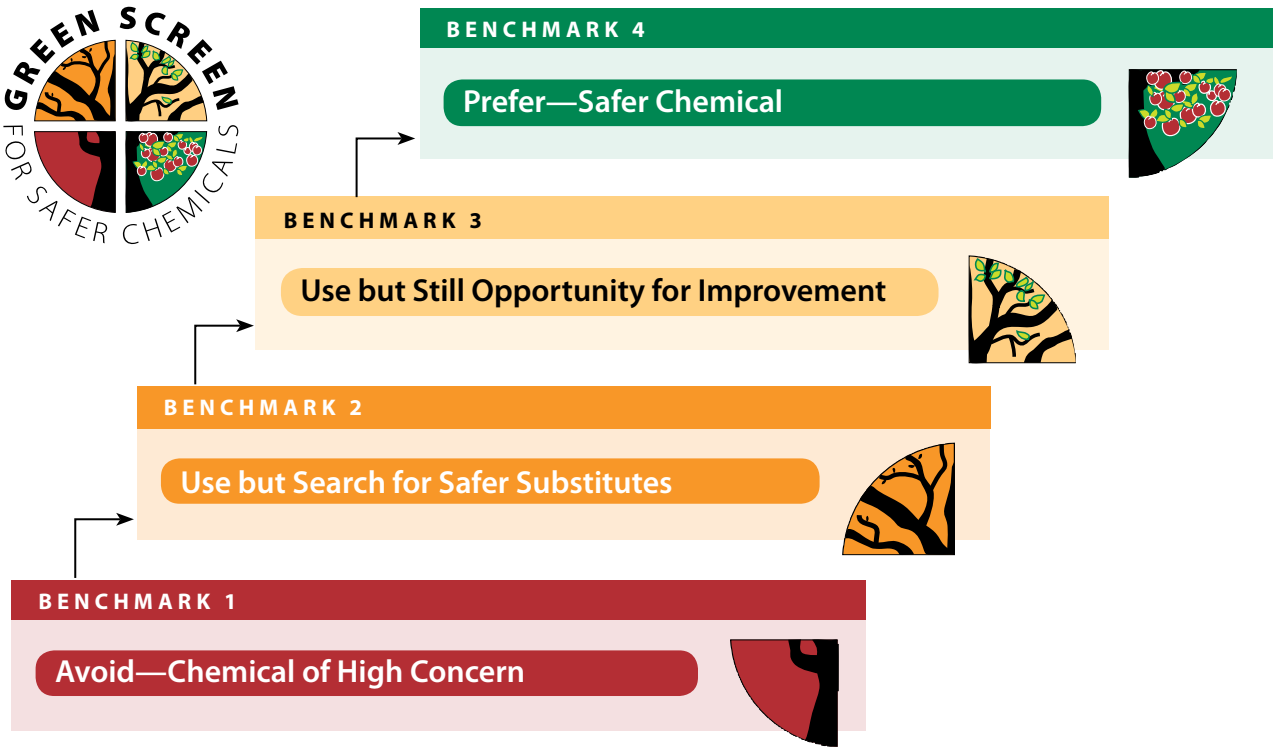
Assess & Avoid Hazards

Manufacturers will determine the hazard characteristics of chemical constituents and formulations in their products, use chemicals with inherently low hazard potential, prioritize chemicals of high concern for elimination, minimize exposure when hazards cannot be prevented, and redesign products and processes to avoid the use and/or generation of hazardous chemicals. Buyers will work with their suppliers to achieve this principle.

"Chemicals of high concern" include substances that have the following properties: 1) persistent, bioaccumulative and toxic (PBT); 2) very persistent and very bioaccumulative (vPvB); 3) very persistent and toxic (vPT); 4) very bioaccumulative and toxic (vBT); 5) carcinogenic; 6) mutagenic; 7) reproductive or developmental toxicant; 8) endocrine disruptor; or 9) neurotoxicant. "Toxic" (T) includes both human toxicity and ecotoxicity.

FIGURE 2–1

GreenScreen for Safer Chemicals: Benchmarks



Source: Clean Production Action GreenScreen for Safer Chemicals Benchmarks

A further challenge to GreenScreen assessments is the lack of hazard data for all endpoints for all chemicals. In fact, very few chemicals on the market have comprehensive empirical data. The Toxics Substances Control Act, the principal statute regulating industrial chemicals in the U.S., does not require chemical producers to generate and disclose comprehensive information on the hazards of and exposures to the vast majority of chemicals in commerce. Given this lack of information, it is difficult to fully evaluate the hazard profile of chemicals, especially chemicals manufactured in smaller volumes. These data gaps can be filled, at least in part, through the use of chemical analogs (chemicals with similar molecular structures), modeling data (computerized models to estimate hazards), and expert judgment. The GreenScreen downgrades the hazard score of chemicals due to data gaps.

When an organization chooses to target a chemical of high concern, a challenge can be in finding available alternatives. Publicly available sources of alternatives include: U.S. Environmental Protection Agency Design for Environment (EPA DfE) Program, Massachusetts Toxics Use Reduction Institute Five Chemicals Alternatives Study, and the European Substitution Portal (SubsPort).

Once alternatives are identified they need to be evaluated for hazards as well as other human and environmental concerns to ensure companies avoid regrettable substitutions—where the alternative is equally or worse for human health or the environment than the chemical it replaced. A question then emerges of how to do that assessment. The common tools for assessing alternatives are life cycle assessment (LCA) and risk assessment. Concerned that the inherent hazards of a chemical and its alternatives are diluted in these assessment tools, BizNGO developed the Chemical Alternatives Assessment Protocol. The BizNGO Protocol is a "decision framework for substituting chemicals of concern to human health or the environment with safer alternatives." It "describes a process for identifying alternatives to a chemical of concern, screening out equally hazardous alternatives, and selecting an alternative that is technically and economically viable and does not have the potential for causing significant environmental or human health impacts." The Protocol highlights the primacy of hazard assessment in relation to life cycle assessment and risk assessment by positioning it as a step before LCA or exposure assessment (see Step 4 in Figure 2–2, page 31).

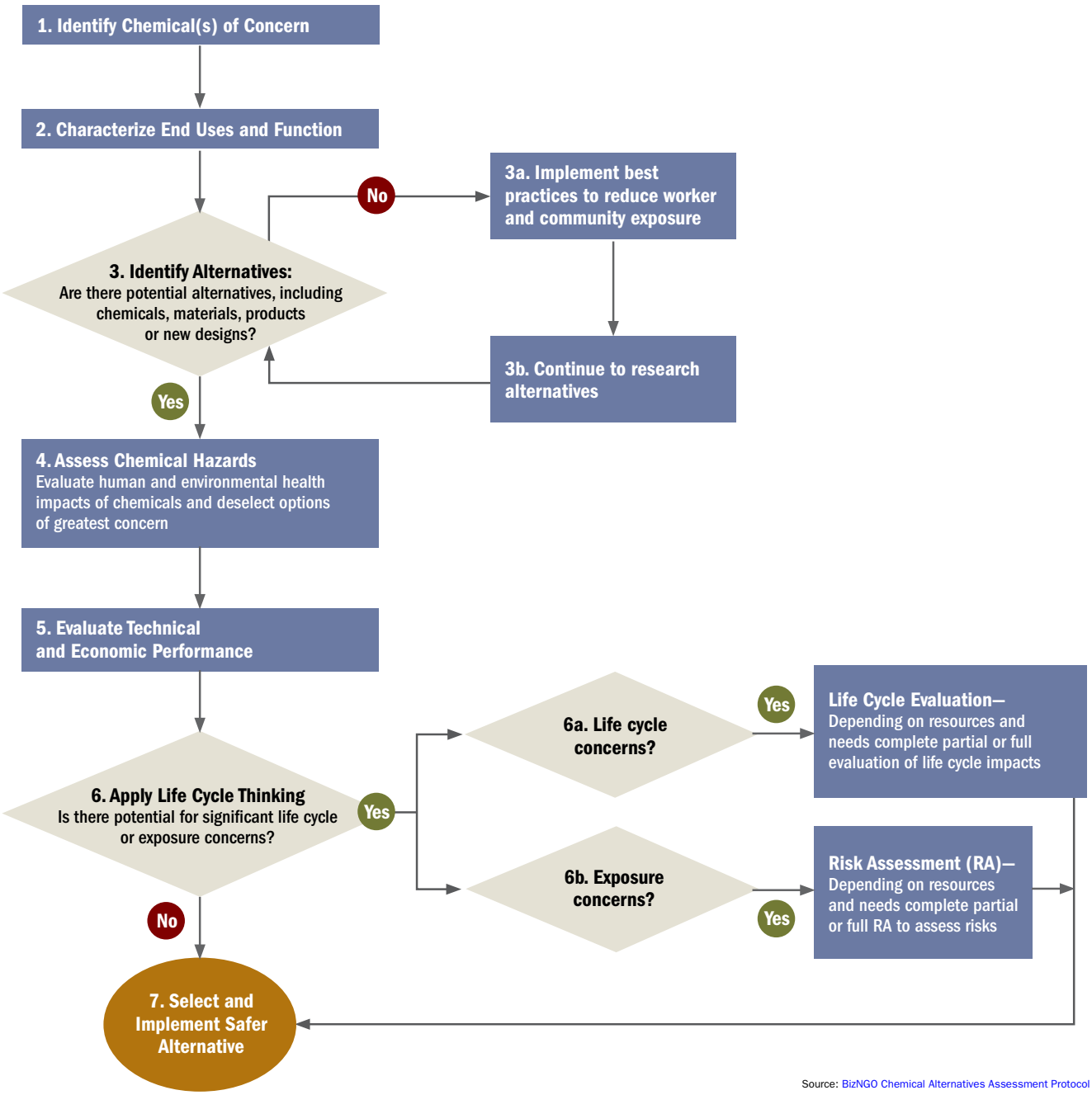
From the alternatives assessment some alternatives will hopefully emerge that are safer, healthier, and more environmentally preferable, as well as technically and economically viable, to the existing chemical of high concern. Companies then select the safer alternative(s) and either manufacture it or require their suppliers to use it. Companies can specify the preferred solutions they want from suppliers and/or specify the criteria by which suppliers evaluate their alternatives to a chemical of high concern.

Benchmarks to Knowing Chemicals in Products, Processes, and Feedstocks

Figure 2–3 summarizes the four benchmarks beyond compliance (Baseline) to assessing and avoiding chemicals in products, processes, and feedstocks.

FIGURE 2–2

BizNGO Chemical Alternatives Assessment Protocol



Source: BizNGO Chemical Alternatives Assessment Protocol

The trajectory of the benchmarks progresses from avoiding some chemicals of high concern on a restricted substances list (RSL) at Trailhead to implementing programs to identify other chemicals of high concern and safer alternatives at Base Camp to selecting and implementing alternatives at High Camp and Summit.

BizNGO Principle #2 benchmarks apply to all downstream users, from formulators to manufacturers to specifiers to purchasers. The language in the benchmarks is not perfectly aligned to every sector. Architects, for example, are specifiers of products. They can "specify" safer alternatives but will not "implement" those alternatives. And purchasers will rely on suppliers to meet specifications.

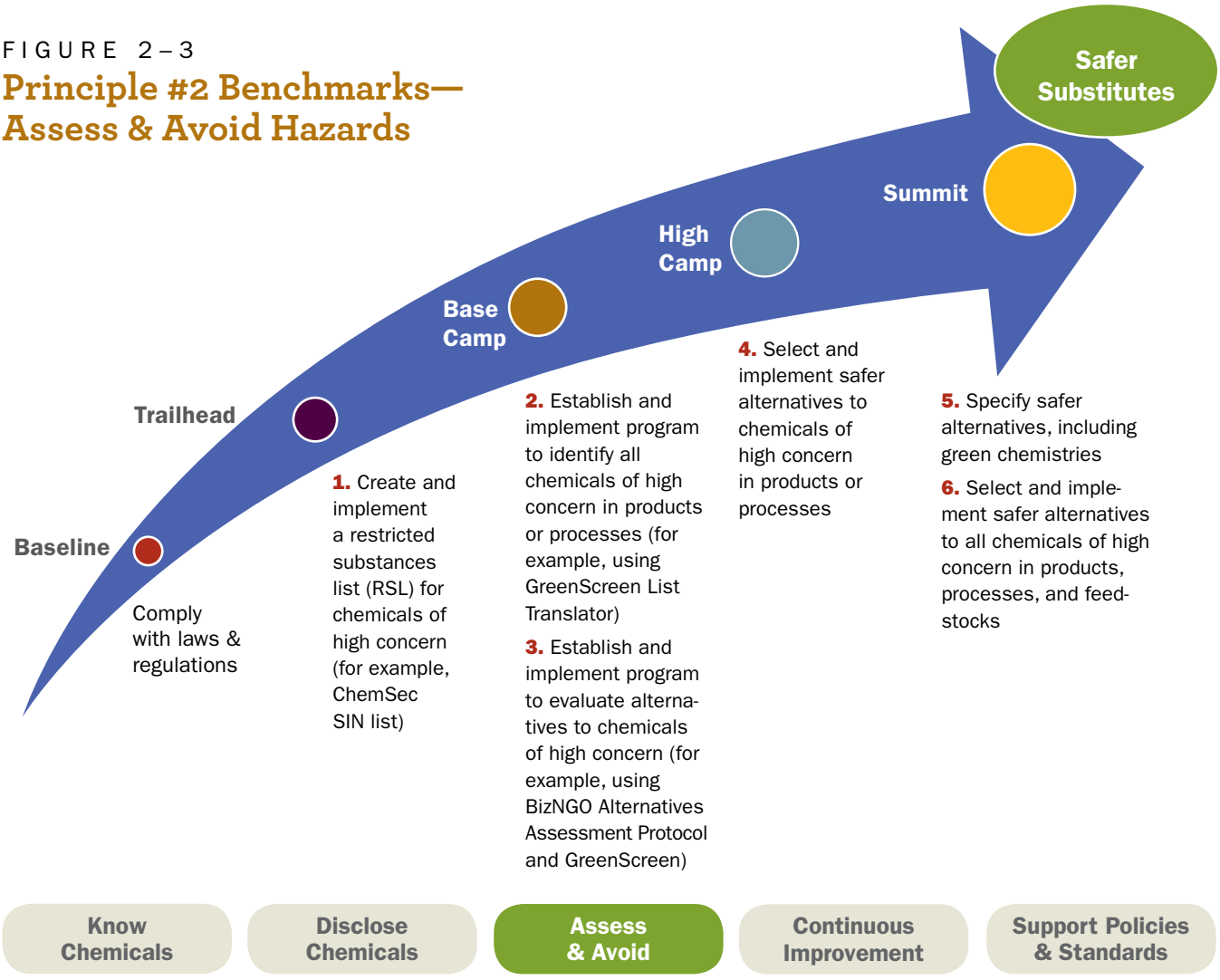
A critical element in the implementation of a safer alternatives program is the frameworks and tools that organizations use to inform their identification of chemicals of high concern, evaluation of alternatives, and the selection and implementation of safer alternatives. The preference of BizNGO is to frameworks (for example, the BizNGO Alternatives Assessment Protocol) and tools (for example, the GreenScreen) that emphasize the primacy of hazard in decision making. As stated in the BizNGO Chemical Alternatives Assessment Protocol, a safer alternative is "one that is less hazardous to human health or the environment than the chemical of concern." The frameworks and tools organizations use will affect the alternatives they select and whether the overall inherent hazards of chemicals in products are reduced by the substitution of currently known chemicals of high concern.

Caveat for this section: It is important to note the authors have a conflict of interest for references to all frameworks, tools, and resources related to Clean Production Action, including the GreenScreen for Safer Chemicals and BizNGO Chemical Alternatives Assessment Protocol.

A critical element in the implementation of a safer alternatives program is the frameworks and tools that organizations use to inform their identification of chemicals of high concern, evaluation of alternatives, and the selection and implementation of safer alternatives.

FIGURE 2–3

Principle #2 Benchmarks—Assess & Avoid Hazards



Baseline

Baseline is compliance with all laws and regulations.

Trailhead

2.1—*Action:* Create and implement a restricted substances list (RSL) for chemicals of high concern, and make the RSL publicly available on website.

NOTE: Companies select chemicals for their RSL based on a variety of reasons, including: hazard, exposure, likelihood of future regulations, volume of use, pressure from advocacy organizations, institutional customer demand, individual consumer demand, and compliance with certification and ecolabel requirements. It is common for companies to have RSLs beyond legal compliance. These RSLs range in numbers of chemicals from a handful to hundreds.

EXAMPLES

Cradle to Cradle Certified

- Basic certification: No polyvinyl chloride (PVC), chloroprene, or related chemical at any concentration.
- Silver certification: No halogenated hydrocarbon content (<100 ppm); and toxic heavy metal content (lead, mercury, cadmium, hexavalent chromium) is less than 100 ppm.

Kaiser Permanente's purchasing policy specifies avoidance of products that contain: persistent bioaccumulative toxics (PBTs), California Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986) chemicals, halogenated flame retardants, phthalates, PVC, Bisphenol A (BPA), latex, and mercury.

FIGURE 2–3

Principle #2 Benchmarks: Assess & Avoid Hazards

Trailhead (CONTINUED)

Construction Specialties has eliminated PBTs and PVC in its building products.

The Joint Roadmap towards Zero Discharge of Hazardous Chemicals (ZDHC) identifies 11 priority chemical groups elimination/reduction in textile manufacturing.

Perkins+Will specifications prefer products that don't include substances on its lists of concern: Precautionary List, Asthma Triggers and Asthmagens, and Flame Retardants.

The ChemSec SIN List identifies 378 substances of very high concern.

Nike, Inc.'s RSL is dominated by a legislated list of chemicals, but also includes beyond regulatory requirements, such as: no BPA in water bottles and mouth guards; no PVC in apparel, equipment, footwear, and apparel screen prints; and no formaldehyde, trichloroethylene, perchloroethylene, and toluene, among other chemicals, in manufacturing processes.

Base Camp

As organizations move to expand their RSL and to identify safer alternatives they need consistent, replicable systems for identifying chemicals of high concern as well as safer alternatives. Base Camp Actions for Principle #2 are divided into establishing and implementing programs for identifying all chemicals of high concern (Action 2.2) and safer alternatives (Action 2.3).

2.2—*Action:* Establish and implement program to identify all chemicals of high concern in products or processes (for example, using GreenScreen List Translator).

NOTE: Action 2.2 entails developing criteria—such as persistence, bioaccumulation, and ecotoxicity—for creating a broad list of chemicals of high concern. This would enable organizations to create a systematic response to the ever expanding yet different RSLs and create a master RSL based on consistent, replicable criteria.

The absence of consistent, transparent, replicable criteria leads to the chaos of lists best illustrated by Tom Lent of the Healthy Building Network in his presentation on the ever expanding number of different yet somewhat overlapping RSLs being developed and applied in the building sector.[2]

To address the need for a comprehensive list of chemicals of high concern based on replicable criteria, Clean Production Action and Healthy Building Network developed such a list in 2009 based on authoritative lists that meet specific endpoint criteria—such as consistent with the REACH criteria for substances of very high concern. Since then, Maine, Washington, and Minnesota have all compiled broad lists of chemicals of high concern and whittled them down to chemicals of high concern for children.

More recently, Clean Production Action's GreenScreen List Translator references how authoritative lists (for example, the International Agency for Research on Cancer's (IARC) classifications of carcinogenic chemicals) relate to the GreenScreen criteria for a Benchmark 1 – Red—Chemical of High Concern. The results of the GreenScreen List Translator can be accessed through two fee-for-service databases:

- Healthy Building Network's, Pharos – Chemical and Material Library
- The WERCS – GreenWERCS

Another resource for identifying chemicals of high concern and safer alternatives is "ChemHat," the Chemical Hazard and Alternatives Toolbox designed by and for workers to implement their own safer chemicals efforts and advocate for state and federal policies for safer chemicals.

For the most part, companies are moving from Action 2.1-RSLs to Action 2.3-Implement Program to Evaluate Alternatives, and leapfrogging Action 2.2. Nonetheless, creating a systematic process for identifying chemicals of high concern by comparing all chemicals used in products and processes to a comprehensive list of chemicals of high concern (such as those identified through the GreenScreen List Translator) is the most efficient process for quickly flagging chemicals of high concern in products.

EXAMPLE

An example of an effort to comprehensively identify chemicals of high concern is the Joint Roadmap towards Zero Discharge of Hazardous Chemicals (ZDHC), which plans to:

- Identify and agree upon a screening tool to identify chemical hazards. The screening tool would be used to identify hazardous chemicals beyond the 11 priority chemical groups already identified.
- Establish a plan to evaluate the chemical inventory by intrinsic hazard and establish a sector wide list of hazardous chemicals.

The ZDHC applies to the textile supply chain.

2.3—*Action:* Establish and implement program to evaluate alternatives to chemicals of high concern (for example, using BizNGO Alternatives Assessment Protocol and GreenScreen).

NOTE: Relative to Action 2.2, organizations are putting more effort into initiatives to develop systematic procedures for evaluating alternatives to chemicals of high concern. A significant driver is companies do not want to voluntary phase-out the use of a chemical of high concern and replace it with an alternative that turns out to be another chemical of high concern.

Two essential elements to Action 2.3 are: a) frameworks for assessing alternatives and b) tools for screening out alternatives that are not safer for human health or the environment. No definitive process for performing an alternatives assessment exists. That said, BizNGO's Chemical Alternatives Assessment Protocol recommends a hazard-first approach in evaluating alternatives to chemicals of high concern: first screen out hazards of equivalent or greater concern then proceed to life cycle thinking and exposure assessments if appropriate (see Figure 2-2). But many other frameworks for alternatives assessment are available or under development including:

- U.S. Environmental Protection Agency Design for Environment (U.S. EPA DfE) Program
- Toxics Use Reduction Institute Five Chemicals Alternatives Assessment Study
- Alternatives Assessment Framework of the Lowell Center for Sustainable Production
- German Federal Environmental Agency Guide on Sustainable Chemicals
- Washington State Department of Ecology Alternatives Assessment Guidance Document
- California Proposed Safer Consumer Product Regulations

This guide is not the place to delve into all the tools relevant to alternatives assessment. Good starting points for all tools relevant to alternatives assessment are the U.S. EPA DfE, Washington State Department of Ecology, and California Department of Toxic Substances Control noted above.

Given the primacy BizNGO places on hazard assessment, we highlight methods and tools that include the evaluation of chemical hazards here:

- GreenScreen for Safer Chemicals: publicly available, transparent method, and no cost to use but requires technical expertise.
- Washington State Department of Ecology Quick Chemical Assessment Tool (QCAT): publicly available, transparent method, no cost to use, but requires technical expertise to use. QCAT is a shortened version of the GreenScreen.
- SciVera Lens: proprietary system for evaluating chemical hazards, exposures, and risks.
- Cradle to Cradle Certified: currently a proprietary system (although that may change in the near future) for evaluating chemical hazards, exposures and risks. For a product to be Cradle to Cradle Certified "Basic" or higher all materials and chemicals must be assessed for toxicity to human and environmental health.
- U.S. EPA DfE Program Alternatives Assessment Criteria for Hazard Evaluation: This document details how the US EPA DfE Program evaluates hazard and fate endpoints in its chemical alternatives assessments.

EXAMPLES

Hewlett-Packard (HP) uses an alternatives assessment process that mirrors the BizNGO Alternatives Assessment Protocol and is a leading practitioner of the GreenScreen (see "Assess & Avoid" Vignette #1, page 37).

Nike has possibly the most comprehensive program for evaluating chemicals and materials from feedstock to product (see "Assess & Avoid" Vignette #2, page 38).

FIGURE 2–3

Principle #2 Benchmark: Assess & Avoid Hazards

High Camp (CONTINUED)

High Camp

2.4—*Action:* Select and implement safer alternatives to chemicals of high concern in products or processes.

NOTE: Leading companies, driven by the desire to be competitive and ahead of future regulations, are using tools like the GreenScreen and Cradle to Cradle Certified to, as Cory Robertson of HP states, "use materials no one cares about."[5]

EXAMPLES

Cradle to Cradle Certified Gold products cannot contain any problematic chemicals (assessed by MBDC as "red"). Note that independent evaluation of the validity of this statement is impossible as the MBDC assessments are proprietary and when made public, as in the case of Construction Specialties' certifications, the chemical data are generic and cannot be independently verified.

HP used the GreenScreen to evaluate and select safer alternatives to PVC plastic in power cables and brominated flame retardants (BFRs) in computing products. See "Assess & Avoid" Vignette #1, page 37, for details on these assessments.

Summit

2.5—*Action:* Specify safer alternatives, including green chemistry solutions.

NOTE: The ideal in specifying safer alternatives is that suppliers and purchasers will have complete hazard assessments of the chemical ingredients used in products, processes, and feedstocks. For example if all chemicals were GreenScreen assessed it would be significantly easier for purchasers to specify safer chemistries.

EXAMPLES

HP is moving in this direction by using the GreenScreen to specify preferred alternatives for its PVC-free and BFR-free products from its suppliers.

Nike has started onto this summit with its Green Chemistry Program.

Formulators such as Method and Seventh Generation specify inherently safer chemicals for their products.

2.6—*Action:* Select and implement safer alternatives to all chemicals of high concern in products processes, and feedstocks.

NOTE: This is Summit. Please let us know if your organization is here and how you managed the ascent.

ASSESS & AVOID HAZARDS: **VIGNETTE 1**

Hewlett-Packard (HP) Implements Alternatives Assessments Using the GreenScreen for Safer Chemicals

HP is embedding chemical alternatives assessments into its chemical substitution initiatives. As HP moves away from chemicals of high concern due to either regulatory or market pressures its goal is to ensure the alternatives are safer. HP is in the midst of phasing out a range of chemicals of high concern in its products, including: phthalates, brominated flame retardants, PVC, antimony, BPA, beryllium/beryllium compounds, and perfluorinated compounds.[6]

As articulated in Lavoie, et al.'s article on "Chemical Alternatives Assessment" (CAA), HP recognizes that:

> Treating all unrestricted substances as equally viable greatly increases the risk of unintended consequences; some replacements could be targeted for future restrictions as well. With the increase in restrictions, there is a growing risk of businesses having to do multiple substitutions and incurring costs multiple times if some level of a CAA is not used to evaluate potential replacement technologies.
>
> Companies are increasingly recognizing the importance of reducing the risk of multiple substitutions by requiring that replacement technologies have better hazard profiles than the substances that they replace. Progressive companies can go farther and use the differentiation provided by CAAs to select environmentally preferable materials, not just minimally or incrementally better ones, thereby ensuring their long-term freedom from chasing chemical after chemical for elimination.[7]

HP's "Integrated Alternatives Assessment" approach to evaluating alternatives to chemicals of concern mirrors the BizNGO Chemical Alternatives Assessment Protocol by taking a "hazard first approach" to screen out potential alternatives to chemicals of high concern. According to a presentation by Helen Holder of HP at the National Academy of Sciences (NAS) Green Chemistry meeting in September 2011, hazard assessments are faster and easier to complete than doing LCAs or risk assessments because:

- Their "Narrower, endpoints are relatively well defined."
- They are "Science-based, [which] facilitates relatively quick chemical assessments."
- They "Can screen out undesirable options before investing time and money."[8]

After evaluating a number of tools, HP selected the GreenScreen as its hazard assessment tool. According to Ms. Holder's NAS presentation, using the GreenScreen in its alternatives assessments helps HP "to identify alternatives that won't be restricted in the future" and "articulate materials goals to suppliers and chemical formulators."[9]

HP used the GreenScreen as part of its phase out of PVC in cable cords and brominated flame retardants (BFRs) from new computing products. According to Cory Robertson of HP in his presentation for the National Pollution Prevention Roundtable Safer Chemistry Challenge, all the alternatives were evaluated using the GreenScreen and HP created an approved material list based on benchmark scores of the PVC-free resin additives.[10] The identities of the PVC-free resin additives are not public and therefore the assessments of the alternatives cannot be independently verified.

HP is implementing a systematic process for evaluating chemicals of high concern, using an "Integrated Alternatives Assessment" with hazard assessments completed using the GreenScreen.

In HP's application of the GreenScreen to BFR alternatives, it does list the alternative substances selected. See HP's case study on SubsPort: "Substitution of brominated flame retardants with non-halogenated alternatives using the GreenScreen™ for safer chemicals alternatives assessment tool."

Overall HP is implementing a systematic process for evaluating chemicals of high concern, using an "Integrated Alternatives Assessment" with hazard assessments completed using the GreenScreen. It is using the GreenScreen to send clear messages to suppliers of intent and goals. HP's work places it squarely within High Camp for Assess and Avoid Hazards and extending up to Summit with its specification of preferred chemistries.

ASSESS & AVOID HAZARDS: **VIGNETTE 2**

Nike—Moving to the Specification of Green Chemistry Solutions

Nike has one of the more comprehensive and in-depth programs among large multinational corporations for managing chemicals in products, processes, and feedstocks. Its programs include a Restricted Substances List (RSL), Green Chemistry Program, Materials Sustainability Index, Considered Index, and Environmentally Preferred Materials.

Nike's RSL applies to both chemicals in products and processes and extends beyond regulated chemicals.[11] See Action 2.1 for details.

The Nike Green Chemistry Program uses a risk-based approach to identify chemicals for elimination in both products and processes. Nike's risk calculation involves an assessment of chemical hazards using the GreenScreen chemical hazard criteria times exposure potential to identify priorities for risk reduction (hazard x exposure = risk).[12] How Nike evaluates alternatives to chemicals of high concern cannot be ascertained by Nike's published literature. Therefore we do not know if Nike uses a similar or different approach to HP's process of using hazard assessment to screen out chemicals of equal or greater concern before proceeding to exposure and/or life cycle assessments.

Nike encourages its suppliers to participate in its Green Chemistry Program. To participate, suppliers must evaluate the use of chemicals in their facility and validate their chemical greening efforts for materials or processes.[13] The guidance Nike provides to suppliers on how to evaluate chemicals is not stated, but Nike does specify that suppliers must validate their greening initiatives with Nike staff.

Detailed under Action 1a.9, Nike's Materials Sustainability Index (MSI) evaluates feedstock sources as well as manufacturing processes of materials. The MSI includes numeric scores for materials on chemistry, energy and greenhouse gas intensity, water and land use intensity, and physical waste. The details behind these numeric scores are not publicly available, making it impossible to know how scores were developed for each of the environmental attributes for each material.

Nike is implementing a systematic process for evaluating the chemical inputs into its materials, specifying preferred chemistries and materials, and conveying these metrics to its suppliers along with other opportunities for greening their chemistries.

Nike is moving to the ambitious goals of zero discharge of hazardous chemicals by 2020 (see Action 3.2) and specifying positive lists of chemistries and materials. Its most extensive list of positive chemistries is for PVC and phthalate free screen print inks.[14] As part of its Considered Index, Nike also specifies Environmentally Preferred Materials (EPMs) for organic cotton, recycled polyester, environmentally preferred rubber, leather (improved sustainability through meeting specifications of the Leather Working Group), and synthetic leather (reduce and eliminate solvents).

Overall Nike is implementing a systematic process for evaluating the chemical inputs into its materials, specifying preferred chemistries and materials, and conveying these metrics to its suppliers along with other opportunities for greening their chemistries. Nike's work places it squarely within High Camp for Assess and Avoid Hazards and extending up to Summit with its specification of preferred chemistries and materials.

Principal #2 Endnotes

1 M. Rossi, J. Tickner, and K. Geiser, 2006, *Alternatives Assessment Framework of the Lowell Center for Sustainable Production, http://www.chemicalspolicy.org/downloads/FinalAltsAssess06.pdf* (accessed November 11, 2012).

2 T. Lent and M. Rossi, "Toxic Materials in Buildings", slide #15, presented at CleanMed, April 7, 2011, *http://www.cleanmed.org/2011/downloads/presentations/B-4/B4_Lent.Rossi.pdf* (accessed November 16, 2012).

3 See *http://www.bizngo.org/resources.php*; listed under header: Safer Chemicals—bullet: Red List of Chemicals (accessed November 16, 2012).

4 For an example of the raw data of the state lists go to the Minnesota website, *http://www.health.state.mn.us/divs/eh/hazardous/topics/toxfreekids/highconcern.html#list* (accessed November 16, 2012).

5 C. Robertson, Hewlett-Packard, "The GreenScreen@hp," National Pollution Prevention Roundtable Safer Chemistry Challenge Webinar, November 1, 2012, *http://www.p2.org/wp-content/uploads/robertson-nppr-safer-chemistry-challenge-webinar-nov-2012.pdf* (accessed November 16, 2012), slide 3.

6 See *http://www.hp.com/hpinfo/globalcitizenship/pdf/products_timeline.pdf* (accessed November 16, 2012).

7 E. Lavoie, et al., "Chemical Alternatives Assessment: Enabling Substitution to Safer Chemicals," *Environmental Science and Technology* 44(24) (2010): 9244–9249.

8 H. Holder, Hewlett-Packard, "HP's Search for Green Replacements for Restricted Substances in Electronics," NAS Green Chemistry meeting, September 20–21, 2011, *http://nas-sites.org/emergingscience/files/2011/10/Holder.pdf* (accessed November 16, 2012), slide 13.

9 Ibid, slide 16.

10 Robertson, op. cit., slide 12.

11 Nike, Inc., August 2011, *Nike Restricted Substances List (RSL) and Sustainable Chemistry Guidance (SCG), http://www.nikeresponsibility.com/report/uploads/files/NIKE_INC_Restricted_Substances_Guidance_Aug_2011.pdf* (accessed November 16, 2012).

12 Ibid, p. 44.

13 Ibid, p. 45.

14 Ibid, p. 49.

This is excerpted from *The BizNGO Guide to Safer Chemicals*, a hands-on guide that charts pathways to safer chemicals in products and supply chains for brand name companies, product manufacturers, architects and designers, retailers, and health care organizations.

To view and download the full report and other individual sections, go to *www.BizNGO.org*.

BizNGO is a project of Clean Production Action.

BizNGO
FOR SAFER CHEMICALS AND SUSTAINABLE MATERIALS

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