

The Green Screen for Safer Chemicals: A Substitution tool for Driving Innovation and Greener Chemical Choices



Clean Production Action
www.cleanproduction.org

Substitution problems



- Companies currently avoid black list substances (OSPAR lists, EU lists, SIN list, ...REACH authorisation list BUT how to know a replacement chemical is safer? (many harmful chemicals not on lists)
- Risk assessments complicated, incomplete, problematic
- REACH Implementation Guide not yet available for authorisation process including guidance on analysis of alternatives and substitution plan or how third parties may prepare and submit information on alternatives

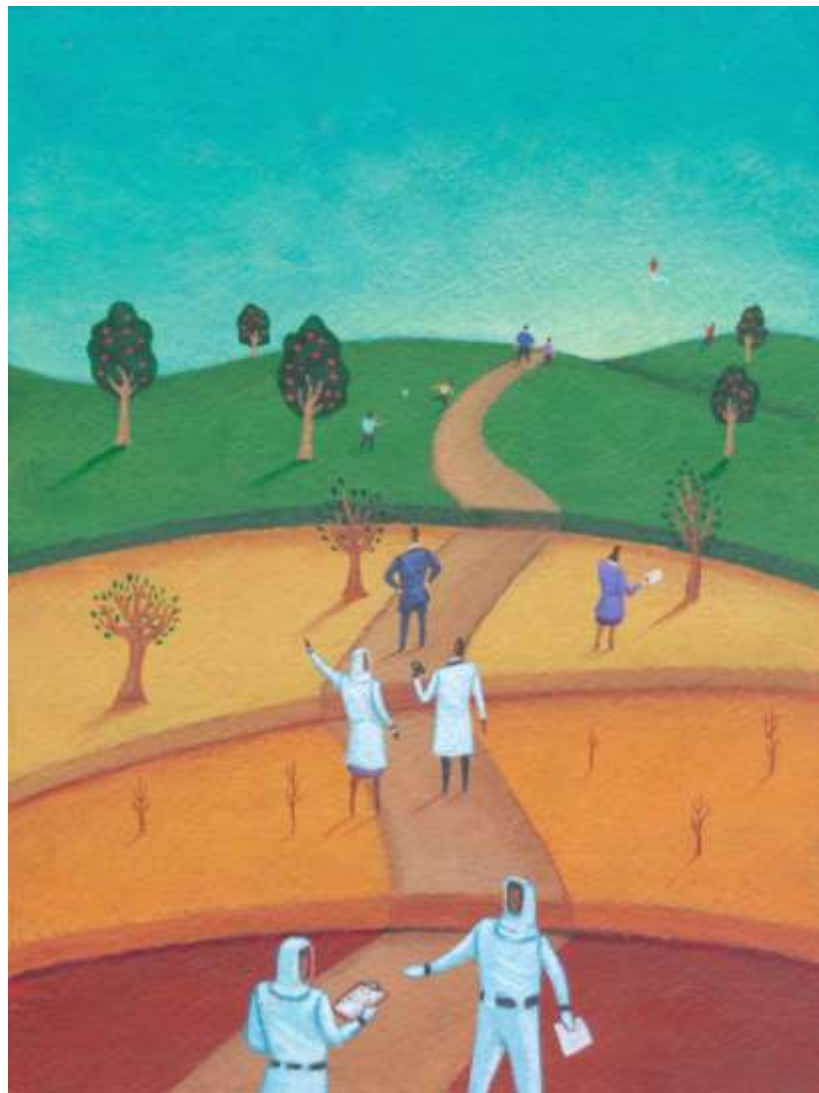
The Green Screen Method



- Defines progress to green chemicals
- Scientifically rigorous
- Builds on USEPA Design for the Environment hazard assessment protocols
- Open, transparent and publicly available
- Highly protective of human health and the environment



Green Screen for Safer Chemicals



- Provides a roadmap to green chemistry through four benchmarks
- Drives continuous improvement and innovation
- Focuses on inherent hazards of chemicals (not risks)

Green Chemistry Principles promote hazard-based chemicals choice:-- Green Screen builds on this

1. Principles of Green Chemistry..

”most effective way to reduce exposure risk is to reduce inherent hazard”

2. Useful approach for chemical comparisons in same product groups

3. REACH authorisation is based on hazard approach for SVHC

4. A fundament tool in the substitution toolbox



Risk = Hazard + Exposure



Reduce Hazard



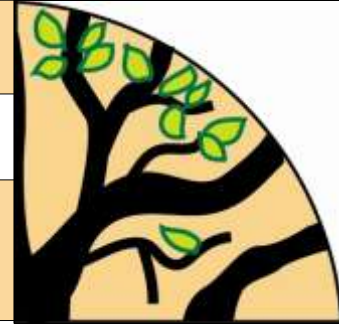
Benchmark 4

Prefer – Safer Chemical



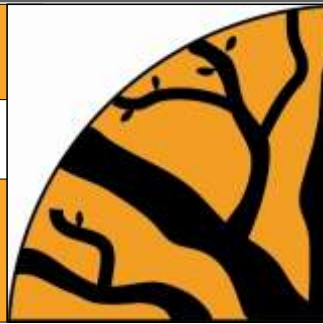
Benchmark 3

**Use but Still Opportunity
for Improvement**



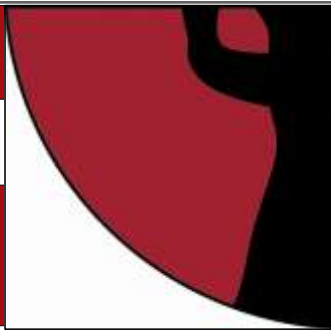
Benchmark 2

**Use but Search for Safer
Substitutes**



Benchmark 1

**Avoid – Chemical of
High Concern**



Benchmark 1 incorporates REACH authorisation criteria + degradation products

BENCHMARK 1

- a. PBT: high P + high B + high T¹ (high Human Toxicity² or high Ecotoxicity)
- b. vPvB: very high P + very high B
- c. vPT (vP + high T) or vBT (vB + high T)
- d. high Human Toxicity for any priority effect³



If this chemical and its break-down products pass all of these criteria, then move on to Benchmark 2

Avoid—Chemical of High Concern

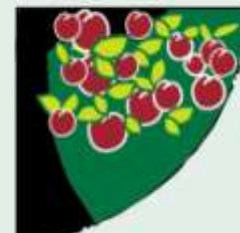
- a. **PBT** = high Persistence + high Bioaccumulation + high Toxicity
- b. **vPvB** = very Persistent + very Bioaccumulative
- c. **vPT** or **vBT** = (very Persistent or very Bioaccumulative) + Toxic
- d. **high Human Toxicity** for any “priority effect”

This chemical passes all of the criteria.

BENCHMARK 4

ready biodegradability (low P) + low B + low Human Toxicity + low Ecotoxicity (+ additional ecotoxicity endpoints when available)

Prefer—Safer Chemical



BENCHMARK 3

- a. moderate P or moderate B
- b. moderate Ecotoxicity
- c. moderate Human Toxicity
- d. moderate Flammability or moderate Explosiveness

Use but Still Opportunity for Improvement



If this chemical and its break-down products pass all of these criteria, then move on to Benchmark 4

BENCHMARK 2

- a. moderate P + moderate B + moderate T (moderate Human Toxicity or moderate Ecotoxicity)
- b. high P + high B
- c. (high P + moderate T) or (high B + moderate T)
- d. moderate Human Toxicity for any priority effect or high Human Toxicity
- e. high Flammability or high Explosiveness



If this chemical and its break-down products pass all of these criteria, then move on to Benchmark 3

Use but Search for Safer Substitutes

BENCHMARK 1

- a. PBT: high P + high B + high T¹ (high Human Toxicity² or high Ecotoxicity)
- b. vPvB: very high P + very high B
- c. vPT (vP + high T) or vBT (vB + high T)
- d. high Human Toxicity for any priority effect³



If this chemical and its break-down products pass all of these criteria, then move on to Benchmark 2

Avoid—Chemical of High Concern

How use the Green Screen?



1. Identify each chemical in a formulation
2. For each chemical first search lists of high hazard. CPA has developed the Red List (compilation of 1,600+ chemicals that meet the criteria of Benchmark 1)
3. Search for degradation results for each chemical
4. *If chemical is not on a list: user must engage with good toxicologist to use literature reviews, models (eg structure/activity relationships), and review of analogs to determine classification using a weight-of-evidence approach*
5. *Plot each chemical into one of the four benchmarks*
6. *Lowest benchmark of a chemical or its degradation product denotes formulation's final score*

Example: assessment of 3 common flame retardants used in TVs

1. Deca-BDE
 2. Bisphenol A Diphosphate
 3. Resorcinol bis(diphenylphosphate)
- Bromine industry maintains that Deca is the most studied flame retardant and safer substitutes not proven.
 - US states who wished to ban Deca therefore needed proof to show safer substitutes available
 - Commission's initial reversal of Deca ban in RoHS = a big headache for US campaigners and supportive state legislators!

TABLE 6: Green Screen Benchmarks for the Constituents and Breakdown Products of Phosphorous-based and DecaBDE Flame Retardants

Chemical	Reasons for Benchmark	Benchmark Achieved / Stopped by
RDP Constituents and Breakdown Products		
CAS# 57583-54-7	<ul style="list-style-type: none"> high bioaccumulation moderate persistence high chronic ecotoxicity moderate systemic effects and irritation/ corrosion of eyes 	Benchmark 2 / stopped by 2(a),(c)
CAS# 98165-92-5	<ul style="list-style-type: none"> high persistence moderate systemic effects and irritation/ corrosion of eyes 	Benchmark 2 / stopped by 2(c)
CAS# 115-86-6 (triphenyl phosphate)	<ul style="list-style-type: none"> moderate bioaccumulation high acute and chronic ecotoxicity moderate systemic effects and irritation/ corrosion of eyes 	Benchmark 3 / stopped by 3(a),(b),(c)
CAS# 108-95-2 (phenol)	<ul style="list-style-type: none"> high systemic effects, and irritation/ corrosion of eyes and skin 	Benchmark 2 / stopped by 2(d)
CAS# 108-46-3 (resorcinol)	<ul style="list-style-type: none"> moderate acute and chronic ecotoxicity moderate endocrine disruption, neurological effects, acute toxicity, skin sensitization, and irritation/corrosion of eyes and skin 	Benchmark 3 / stopped by 3(a),(b),(c)
CAS# 838-85-7 (diphenyl phosphate)	insufficient data for evaluation	
BPADP (BAPP) Constituents and Breakdown Products		
CAS# 5945-33-5	<ul style="list-style-type: none"> high persistence moderate systemic effects and irritation/ corrosion of eyes 	Benchmark 2 / stopped by 2(c)
CAS# 83029-72-5	<ul style="list-style-type: none"> very high persistence moderate systemic effects and irritation/ corrosion of eyes 	Benchmark 2 / stopped by 2(c)
CAS# 115-86-6 (triphenyl phosphate)	<ul style="list-style-type: none"> moderate bioaccumulation high acute and chronic ecotoxicity moderate systemic effects and irritation/ corrosion of eyes 	Benchmark 3 / stopped by 3(a),(b),(c)
CAS# 108-95-2 (phenol)	<ul style="list-style-type: none"> high systemic effects, and irritation/ corrosion of eyes and skin 	Benchmark 2 / stopped by 2(d)
CAS# 80-05-7 (bisphenol A)	<ul style="list-style-type: none"> high endocrine disruption (and emerging evidence of potentially high concern for reproductive and developmental effects) 	Benchmark 1 / stopped by 1(d)
CAS# 838-85-7 (diphenyl phosphate)	insufficient data for evaluation	
DecaBDE and Breakdown Products		
CAS# 1163-19-5 (decaBDE)	<ul style="list-style-type: none"> very high persistence moderate bioaccumulation moderate cancer, developmental, and neurological; and endocrine disruption 	Benchmark 2 / stopped by 2(a),(c),(d)
CAS# 32536-52-0 (octaBDE)	<ul style="list-style-type: none"> very high persistence high developmental effects 	Benchmark 1 / stopped by 1(c),(d)
CAS# 32536-52-0 (pentaBDE)	<ul style="list-style-type: none"> very high persistence and bioaccumulation high acute and chronic ecotoxicity high systemic organ effects high endocrine disruption 	Benchmark 1 / stopped by 1(a),(b),(c),(d)

Each Chemical was run through the Green Screen

Final Benchmarks for Three Flame Retardant Chemicals (& their breakdown products)

TABLE 7: **Green Screen Benchmarks for Phosphorous-based and DecaBDE Flame Retardants**

Chemical	CAS #	Reasons for Benchmark	Benchmark Achieved
DecaBDE and its breakdown products	1163-19-5	<p>Breakdown products stop decaBDE at Benchmark 1:</p> <ul style="list-style-type: none"> • pentaBDE = PBT, vPvB, vPT, vBT, and high concern for endocrine disruption—Benchmarks 1(a),(b),(c),(d) • octaBDE = vPT and high concern for developmental toxicity—Benchmark 1(c),(d) 	Benchmark 1: Avoid—Chemical of High Concern
BPADP/BAPP and its breakdown products	181028-79-5	<p>Breakdown product and formulation contaminant, bisphenol A, is of high concern for endocrine disruption—stopping BPADP at Benchmark 1(d)</p>	Benchmark 1: Avoid—Chemical of High Concern
RDP and its breakdown products	125997-21-9	<ul style="list-style-type: none"> • Chemical constituents have: high persistence or high bioaccumulation and moderate/high toxicity (but not for priority effects)—stopping RDP at Benchmarks 2(a) and 2(c) • Breakdown product, phenol, has high systemic effects—stopping RDP at Benchmark 2(d) 	Benchmark 2: Use <u>but</u> Search for Safer Substitutes

Case Study: Results



- RDP: only flame retardant to pass all criteria under Benchmark 1 of the Green Screen
- The other FRs scored lower on the Green Screen because of concern for their degradation products.
- RDP is not a “green chemical”, BUT it achieves a higher level of human and environmental health and safety than the alternatives. Thus RDP (and its breakdown products), based upon a Green Screen assessment, is a safer chemical.
- This result enabled Washington State and Maine State to proceed with Deca-BDE ban

Interest in Green Screen is growing

- “The **Washington State** Department of Ecology has looked at a number of evaluation tools. Based on this evaluation, we believe that the Green Screen is an excellent tool to be used as part of the process to evaluate chemicals to determine safer alternatives.” – Alex Stone, Senior Chemist – Washington State Department of Ecology
- “An important component of **HP**’s materials substitution efforts is determining that replacement substances have a lower environmental and health impact than the substances identified for possible phaseout. HP engages with ...Clean Production Action, to develop standard methods for evaluating the environmental and health impacts of new substances.



The Green Screen Approach:

Concurrent Strategies for Greening Chemical Inventories

Aim for the Top

Prefer chemical products that are fully assessed and that have low hazard and lifecycle benefits

Practice Informed Substitution

Process of continual improvement; toward more data and better understanding of what is green and sustainable

Bring up the Bottom

Screen all chemicals against criteria for adverse impacts to human health and the environment to move away from the use of the most hazardous chemicals

Wal-Mart's "intends to use" Green Screen approach for their Chemical Intensive Products



Bring up the Bottom

Wal-Mart requires CAS numbers for all CIP formulations. Intends to run suppliers products through software to assess which products fall within high hazard criteria

Now establishing lists, weighting factors and software development tool for buyers to assess if some products in same category are 'safer' – if so will get preferential buying

For more info:

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