Promoting Green Chemistry through the Green Screen for Safer Chemicals

Alternatives Assessment
DTSC Workshop
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www.cleanproduction.org

Outline

- Comparative Chemical Hazard Assessment
- Origins of the Green Screen for Safer Chemicals
  - How it Works
  - Example (PBT)
  - How it has been applied
- How it compares to other programs
- Strengths and Limitations
- What's next?

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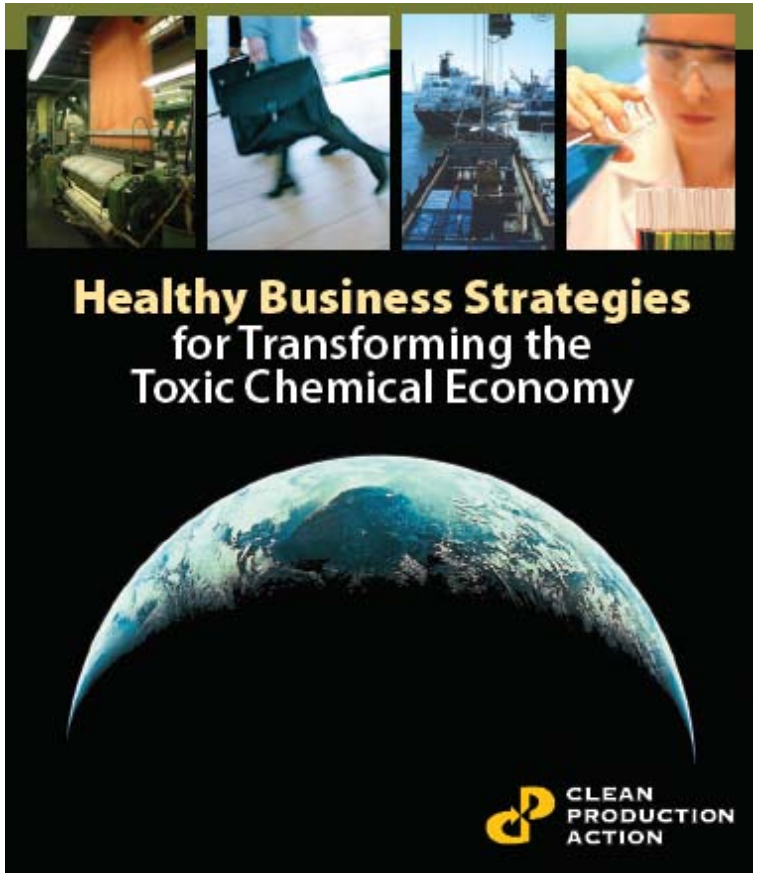

How can businesses transition from the toxic to the green chemical and sustainable materials economy?

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BUSINESS-NGO WORKING GROUP

FOR SAFER CHEMICALS AND SUSTAINABLE MATERIALS

OUR MISSION To promote the creation and adoption of safer chemicals and sustainable materials in a way that supports market transitions to a healthy economy, healthy environment, and healthy people.

OUR ISSUES

- **Safer chemicals**
- **Sustainable materials**
- **Policy initiatives**

http://www.bizngo.org/

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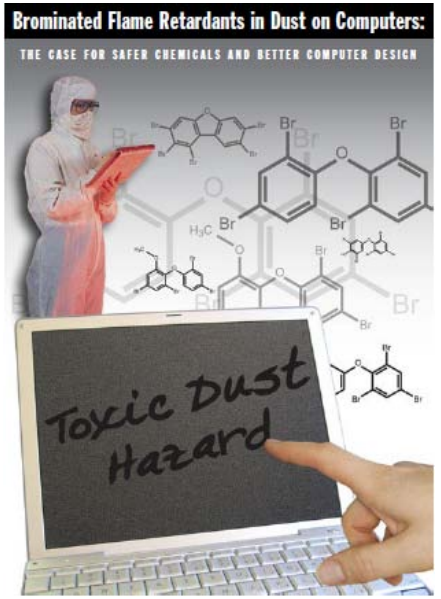
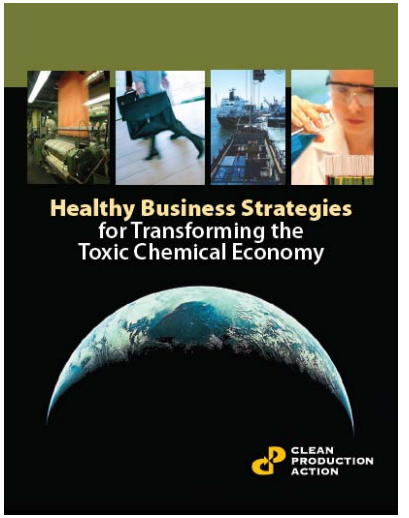
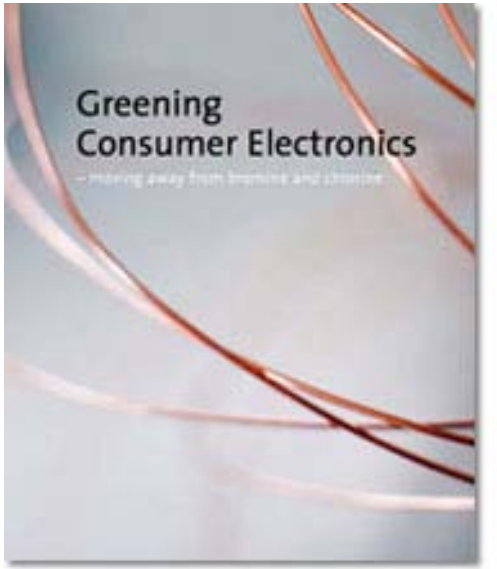
We work with leaders in the electronics industry and other sectors to advance safe product design







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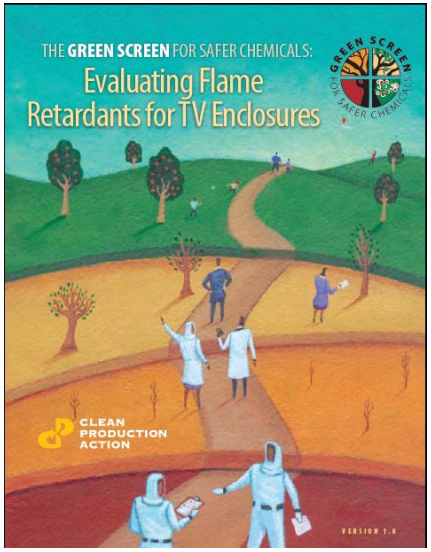
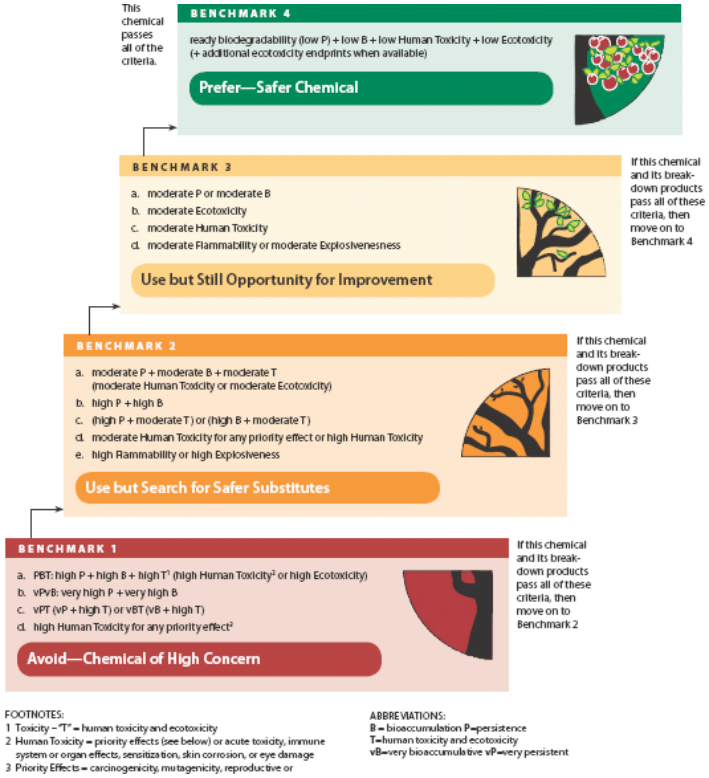
The Green Screen for Safer Chemicals :

A Decision Support Tool for Identifying Safer Chemicals





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Demonstrating the Value of Comparative Chemical Hazard Assessment

- Risk assessment addresses *probability* and helps to answer, *"Is it safe enough?"*
- Comparative chemical hazard assessment helps to answer, *"Which is safer?"*
  - When comparing chemicals for a **similar functional use**, reducing hazard can support product design and continual improvement

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Risk Assessment vs Comparative Chemical Hazard Assessment to Support Design

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Green Screen for Safer Chemicals

What is it?

- Comparative chemical hazard assessment tool
- Builds on USEPA DfE CAA approach
- Uses criteria based on national and international precedents (Globally Harmonized System for Classification and Labeling (GHS), EPA and OECD)
- Makes use of all available toxicological data, QSAR, expert judgment and use of analogs; indicates weight of evidence
- Looks at particular hazards and *combinations* of hazards for an overall chemical benchmark score

http://www.cleanproduction.org/Greenscreen.php

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CPA's Green Screen for Safer Chemicals

What is it?

- Incorporates life-cycle thinking with a focus on use and end-of-life phases in product life-cycle
- Open source, transparent and publicly accessible method
- Can be applied to chemicals in products and processes

http://www.cleanproduction.org/Greenscreen.php

Origins of the Green Screen -- Convergence

1. How to integrate hazard considerations into assessments of alternatives to decaBDE used to flame retard television casings

1. How to build on DfE Flame Retardancy Partnership and provide decision support

GREEN SCREEN FOR SAFER CHEMICALS

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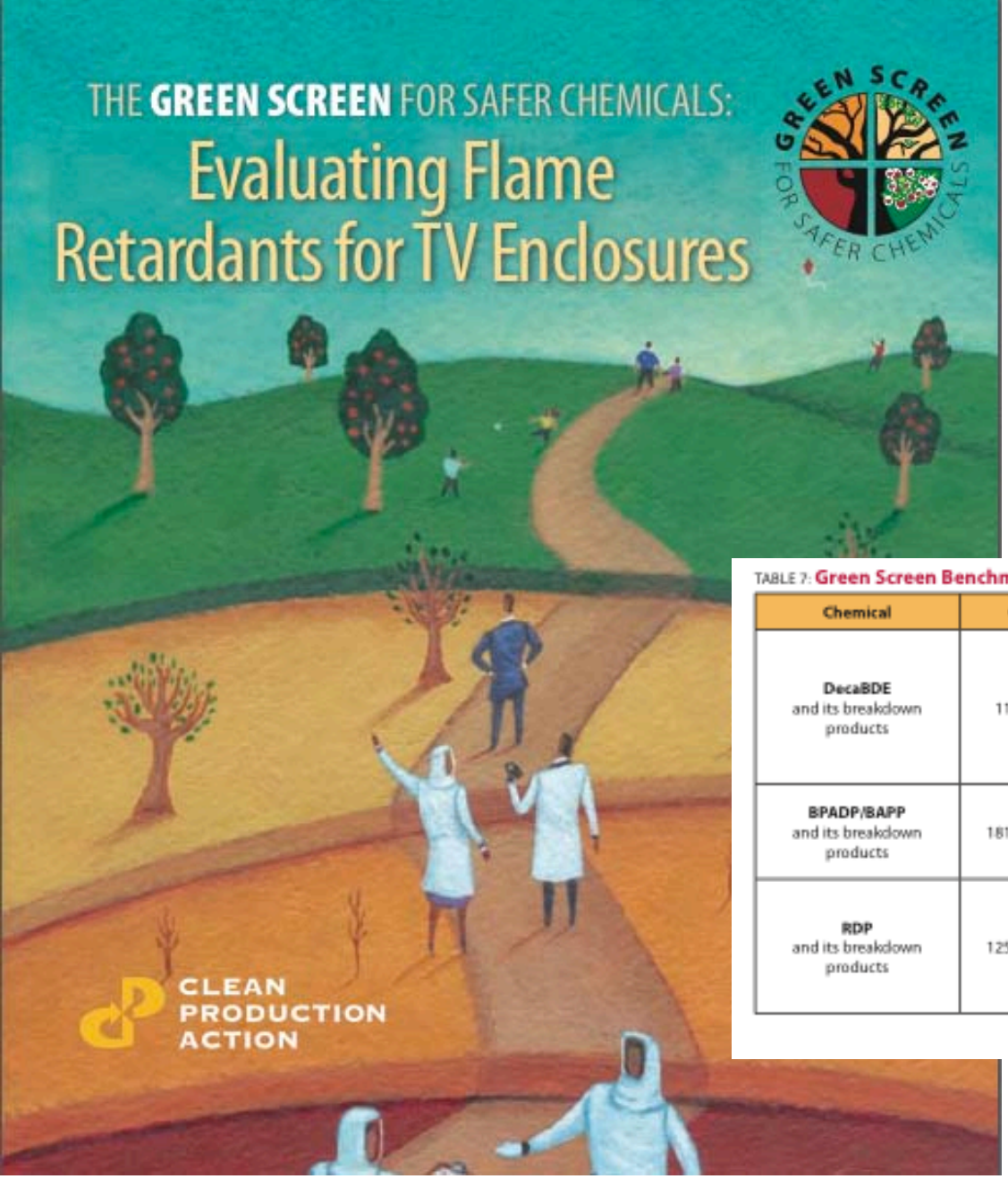

Demonstrated that an available alternative was relatively safer

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	Breakdown products stop decaBDE at Benchmark 1: • 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	Breakdown product and formulation contaminant, bisphenol A, is of high concern for endocrine disruption—stopping BPADP at Benchmark 1(d)	Benchmark 1: Avoid—Chemical of High Concern
RDP and its breakdown products	125997-21-9	• 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

http://www.cleanproduction.org/library/Green_Screen_Report.pdf

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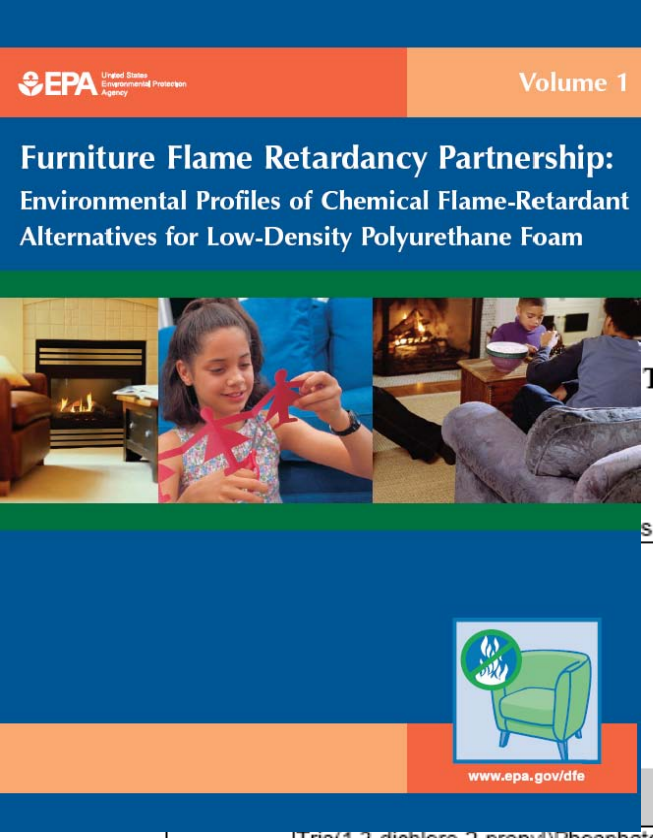


DfE Table 4-1 (aka "The Matrix")

Table 4-1 Screening Level Toxicology and Exposure Summary

N = No
Y = Yes
P = Yes for pure chemical

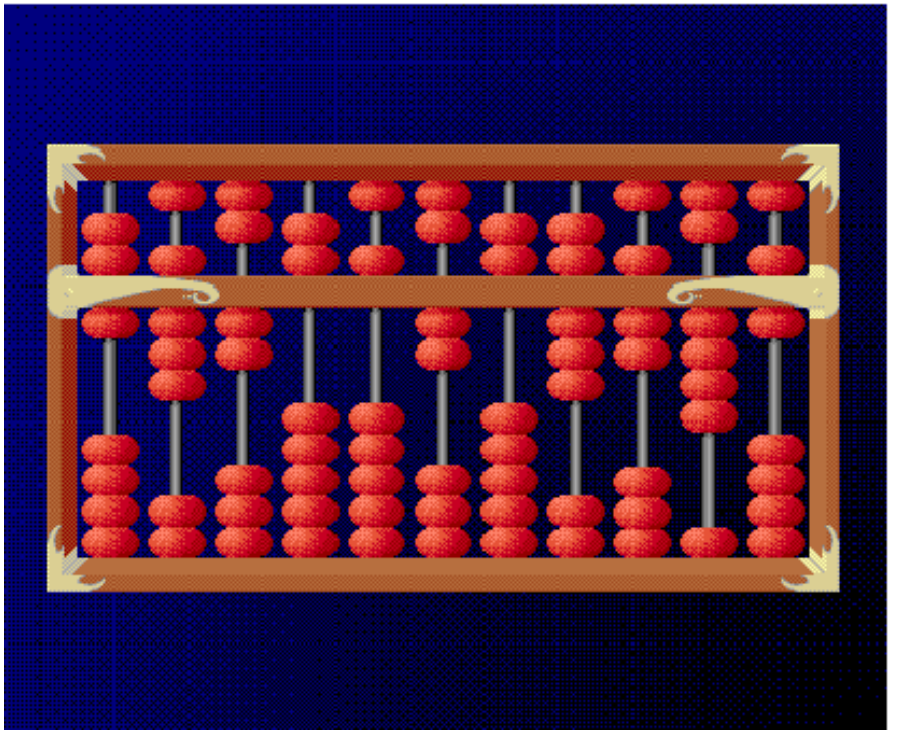
*Ongoing studies may result in a change in this endpoint
▲Persistent degradation products expected[2]

sing estimated values and professional judgment (Structure Activity Relationships)

		% in Formulation[3]	Human Health Effects							Ecotoxicity		Environmental		Potential Routes of Exposure						
														Worker			General Population			
			Cancer Hazard	Skin Sensitizer	Reproductive	Developmental	Neurological	Systemic	Genotoxicity	Acute	Chronic	Persistence	Bioaccumulation	Inhalation	Dermal	Ingestion	Inhalation	Dermal	Ingestion	Aquatic
	Tris(1,3-dichloro-2-propyl)Phosphate CAS # 13674-87-8	95%	M	L	M	M	L	M	M	M	M	M	L	N	Y	Y	N	Y	Y	Y
Albemarle	ANTIBLAZE 182 and ANTIBLAZE 205																			
	Proprietary A Chloroalkyl phosphate (1)		M	L	M	M	L	M	M	M	M	M	L	N	Y	Y	N	Y	Y	Y
	Proprietary B Aryl phosphate		L	L	M*	M*	M	M*	L	H	H	L	M	N	Y	Y	N	Y	N	N
	Triphenyl Phosphate CAS # 115-86-6		L	L	L	L	L	M	L	H	H	L	L	Y	Y	Y	Y	Y	Y	Y
Albemarle	ANTIBLAZE V500																			
	Proprietary C Chloroalkyl phosphate (2)		M	M	M*	M*	L	M	L	M	M	M	L	N	Y	Y	N	Y	Y	Y
	Proprietary B Aryl phosphate		L	L	M*	M*	M	M*	L	H	H	L	M	N	Y	Y	N	Y	N	N
	Triphenyl Phosphate CAS # 115-86-6		L	L	L	L	L	M	L	H	H	L	L	Y	Y	Y	Y	Y	Y	Y
Albemarle	SAYTEX RX-8500																			
	Proprietary D Reactive brominated flame retardant		L	M	L	L	M	M	L	M	M	L▲	L	N	Y	Y	N	N	Y	Y
	Proprietary B Aryl phosphate		L	L	M*	M*	M	M*	L	H	H	L	M	N	Y	Y	N	Y	N	N
	Triphenyl Phosphate CAS # 115-86-6		L	L	L	L	L	M	L	H	H	L	L	Y	Y	Y	Y	Y	Y	Y

Need for a Structured Decision Logic

- Don’t just count H’s (or M’s or L’s) …..



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Green Screen for Safer Chemicals
How to do an assessment

1. Collect data and fill out hazard summary table
   - For parent chemical and feasible transformation products (degradation, metabolites, moieties, etc. depending on EOL)
   - Indicate weight of evidence (i.e. test data versus estimated values) (**H**, *h*)
2. Apply the benchmarks
3. Consider the context and compare alternatives
4. Take action

Green Screen for Safer Chemicals

Green Screen hazard endpoints

Environmental Fate	Environmental Toxicity	Human Health Priority Effects	Human Health Non-Priority Effects	Physical Properties
Persistence	Acute Aquatic Toxicity	Carcinogenicity	Acute Toxicity	Reactivity
Bioaccumulation	Chronic Aquatic Toxicity	Mutagenicity - Genotoxicity	Systemic or Organ Effects	Flammability
Evidence of long range transport		Reproductive toxicity	Immune System Effects	Particle size, form, (i.e. respirable)
Found in env and bio-monitoring studies		Developmental toxicity	Corrosion or Irritation of Skin/Eyes	Mobility (i.e. solubility)
		Endocrine Disruption	Sensitization of Skin/Respiratory System	Moieties; degrad products, metabolites
		Neurotoxicity/Neurodevel tox		

Introduction to Green Screen

Green Screen Version 2.0 Example: CMR Hazard Thresholds

Hazard	High (H)	Moderate (M)	Low (L))
Carcinogenicity See Test Methods	•GHS Category 1A (Known); OR •GHS Category 1B (Presumed); OR •On specified list(s)	•GHS Category 2 (Suspected): OR •On specified list(s)	•Meets USEPA DfE Master Criteria for Carcinogenicity
Mutagenicity/ Genotoxicity See Test Methods	•GHS Category 1A (Known); OR •GHS Category 1B (Should be regarded as); OR •On specified list(s)	•GHS Category 2 (Possible): OR •On specified list(s)	•Meets USEPA DfE Master Criteria for Genetic Toxicity
Reproductive & Developmental Toxicity (R/D) including Developmental Neurotoxicity (DNT) See Test Methods	**•Reproductive or developmental effect as defined in GHS (i.e. GHS Cat 1 or 2) or developmental neurotoxic effect as defined by the USEPA Risk Assessment Guidelines for the following guidance doses (LOAEL's):** Oral < 50 mg/kg-bw/d Dermal < 100 mg/kg-bw/d Inhalation (vapor) < 1.0 mg/L/d Inhalation (dust/mist/fume) < 0.1 mg/L/d Inhalation (gas) < 50 ppm/d; OR **•On specified list(s)**	**•Reproductive or developmental effect as defined in GHS (i.e. GHS Cat 1 or 2) or developmental neurotoxic effect as defined by the USEPA Risk Assessment Guidelines for the following guidance doses (LOAEL's):** Oral ≥ 50 - < 250 mg/kg-bw/d Dermal ≥ 100 – < 500 mg/kg-bw/d Inhalation (vapor) ≥ 1.0 – < 2.5 mg/L/d Inhalation (dust/mist/fume) ≥ 0.1 – < 0.5 mg/L/d Inhalation (gas) ≥ 50 – < 250 ppm/d; OR **•On specified list(s)**	**•Meets USEPA DfE Master Criteria for Reproductive and Developmental Toxicity** **•No Reproductive or Developmental Effects (including Developmental Neurotoxic effects)** i.e. not GHS Cat 1 or 2; OR **•Reproductive or developmental effect as defined in GHS (i.e. GHS Cat 1 or 2) or developmental neurotoxic effect as defined by the USEPA Risk Assessment Guidelines above the following guidance doses (LOAEL's):** Oral ≥ 250mg/kg-bw/d Dermal ≥ 500 mg/kg-bw/d Inhalation (vapor) ≥ 2.5 mg/L/d Inhalation (dust/mist/fume) ≥ 0.5 mg/L/d Inhalation (gas) ≥ 250 ppm/d; OR **•On specified list(s)**

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Introduction to Green Screen

Example: Supporting lists Carcinogenicity

List Abbreviation	List Type		List Category	Hazard	Benchmark
NIOSH	Authoritative	A	Occupational Cancer	H	0
NTP-C	Authoritative	A	Known to be a human carcinogen	H	0
NTP-C	Authoritative	A	Reasonably Anticipated to be a human carcinogen	H	0
IRIS (1999, 200	Authoritative	A	Carcinogenic to humans	H	0
IRIS (1999, 200	Authoritative	A	Likely to be carcinogenic to humans	H	0
IRIS (2005)	Authoritative	B	Suggestive evidence of carcinogenic potential	M	1
IRIS (1999, 200	Authoritative	A	Not likely to be carcinogenic to humans	L	N/A
IRIS (1999)	Authoritative	B	Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential	M	1
IRIS (1996)	Authoritative	A	Known/likely human carcinogen	H	0
IRIS (1986)	Authoritative	A	Group A - Human Carcinogen	H	0
IRIS (1986)	Authoritative	A	Group B1 - Probably human carcinogen	H	0
IRIS (1986)	Authoritative	A	Group B2 - Probably human carcinogen	H	0
IRIS (1986)	Authoritative	B	Group C - "Possible human carcinogen"	M	1
IRIS (1986)	Reference		Group D – "Not classifiable as to human carcinogenicity"? (can be either not likely or a data gap)	Unknown	
IRIS (1986)	Authoritative	A	Group E - "Evidence of non-carcinogenicity to humans"	L	N/A
IARC	Authoritative	A	Group 1: Agent is carcinogenic to humans	H	0
IARC	Authoritative	A	Group 2A: Agent is probably carcinogenic to humans	H	0
IARC	Authoritative	B	Group 2b: Possibly carcinogenic to humans	M	1
IARC	Reference		Group 3: Not classifiable as to carcinogenicity to humans	Unknown	N/A
IARC	Authoritative	A	Group 4: Probably not carcinogenic to humans	L	N/A
PROP 65	Authoritative	A	Known to the state to cause cancer	H	0
EU CMR List	Authoritative	A	Carcinogen Category 1: "known"	H	0
EU CMR List	Authoritative	A	Carcinogen Category 2: "should be considered carcinogenic to humans"	H	0
EU CMR List	Authoritative	B	Carcinogen Category 3: "possibly carcinogenic to humans" (listed as Carc. Cat. 3)	M	1
EU DSD	Authoritative	A	R45 "May cause cancer"	H	0
EU DSD	Authoritative	A	R49 "May cause cancer by inhalation"	H	0
EU DSD	Authoritative	B	R40 "Limited Evidence of Carcinogenic Effects"	M	1

Notes:

1. All supporting lists relating to EU Regulations will be updated in v2.0 to reflect changes consistent with the REACH and CLP legislation (including hazard statements and changes in nomenclature for CMR categories).

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Collect Data and Fill Out Hazard Summary Table

For the Parent Chemical and Its Feasible Transformation Products

TABLE 5: **Hazard Profiles of Phosphorous-based and DecaBDE Flame Retardants (and their breakdown products)**

Chemical	Chemical Abstract Servies Registry Number (CAS#)	% in Formulation	Human Health Effects													Ecotox.		Fate		Breakdown Products	
			Priority Effects																		
			Carcinogenic	Mutagenic	Reproductive	Developmental	Endocrine Disruption	Neurological	Acute Toxicity	Systemic/Organ Effects	Sensitization (skin)	Sensitization (respiratory)	Irritation/Corrosion (skin)	Irritation/Corrosion (eyes)	Immune System Effects	Acute	Chronic	Persistence	Bioaccumulation	Metabolites	Degradation Products
Bisphenol A diphosphate (BPADP/BAPP) - CAS# 181028-79-5																					
Phosphoric acid, (1-methylethylidene) di-4, 1-phenylene tetraphenyl ester	5945-33-5	~85	L	L	L	L	nd	L	L	M	L	nd	L	M	L	L	L	H	L	nd	phenol + bisphenol A
Phosphoric acid, bis[4-[1-[4-[(diphenoxyphos-phinyl)oxy]phenyl]-1-methylethyl]phenyl] phenyl ester	83029-72-5	~11	L	L	L	L	nd	L	L	M	L	nd	L	M	L	L	L	vH	L	nd	phenol + bisphenol A
Triphenyl Phosphate	115-86-6	<3	L	L	L	L	nd	L	L	M	L	nd	L	M	L	H	H	L	M	nd	diphenyl phos-phate + phenol
Breakdown Products																					
Bisphenol A: contaminant and degradation product	80-05-7		L	L	M	M	H	nd	L	M	M	M	L	H	M	M	M	L	L		
Phenol: contaminant and degradation product	108-95-2		L	M	L	L	L	M	M	H	L	L	H	H	M	M	M	L	L		
Diphenyl phosphate	838-85-7	*insufficient data for evaluation*																			
Resorcinol bis(diphenylphosphate) (RDP) - CAS# 125997-21-9																					
Phosphoric acid, 1, 3-phenylene tetraphenyl ester	57583-54-7	65-80	L	L	L	L	nd	L	L	M	L	nd	L	M	L	L	H	M	H	nd	phenol + resorcinol
Phosphoric acid, bis[3-[(diphenoxy-phosphinyl)oxy]phenyl] phenyl ester	98165-92-5	15-30	L	L	L	L	nd	L	L	M	L	nd	L	M	L	L	L	H	L	nd	phenol + resorcinol
Triphenyl Phosphate	115-86-6	<5	L	L	L	L	nd	L	L	M	L	nd	L	M	L	H	H	L	M	nd	diphenyl phos-phate + phenol
Breakdown Products																					
Phenol	108-95-2		L	M	L	L	L	M	M	H	L	L	H	H	M	M	M	L	L		
Resorcinol	108-46-3		L	L	L	L	M	M	M	nd	M	nd	M	M	nd	M	M	L	L		
Diphenyl phosphate	838-85-7	*insufficient data for evaluation*																			
Decabromodiphenyl ether (decaBDE) - CAS# 1163-19-5																					
DecaBDE	1163-19-5	97	M	L	L	M	M	M	L	L	L	nd	L	L	nd	L	L	vH	M	penta-to nona-BDE	tri-to nona-BDE
Breakdown Products																					
PentaBDE	32534-81-9		nd	L	M	M	H	M	L	H	L	L	M	M	nd	H	H	vH	vH		
OctaBDE	32536-52-0		nd	L	M	H	M	M	L	H	L	nd	L	L	nd	L	L	vH	M		

Apply the Benchmarks

v1.0

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 Explosivenesness

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

Use but Search for Safer Substitutes

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

BENCHMARK 1

a. PBT: high P + high B + high T[1] (high Human Toxicity[2] 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 effect[2]

Avoid—Chemical of High Concern

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

FOOTNOTES:
1 Toxicity – "T" = human toxicity and ecotoxicity
2 Human Toxicity = priority effects (see below) or acute toxicity, immune system or organ effects, sensitization, skin corrosion, or eye damage
3 Priority Effects = carcinogenicity, mutagenicity, reproductive or

ABBREVIATIONS:
B = bioaccumulation P=persistence
T=human toxicity and ecotoxicity
vB=very bioaccumulative vP=very persistent

Consider the Context, Compare Alternatives and Take Action

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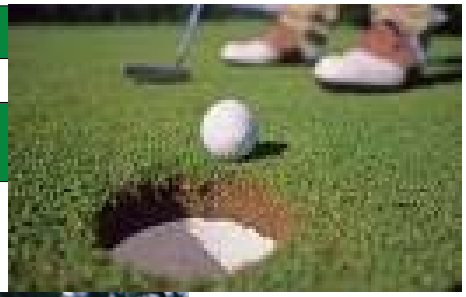
Think of it as a way for a company to improve his/her golf game…and lower their handicap.

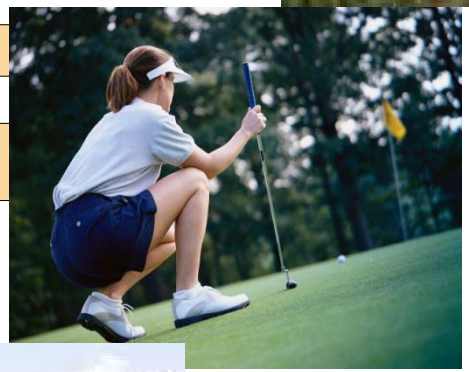
Benchmark 4

Prefer – Safer Chemical



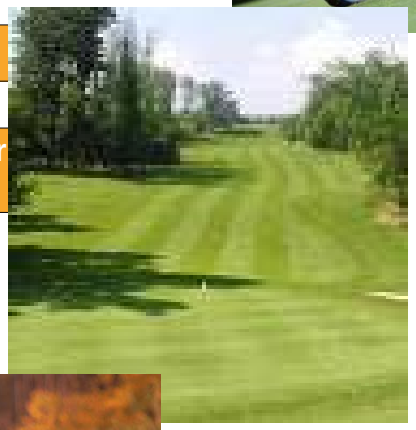
Benchmark 3

Use but Still Opportunity for Improvement



Benchmark 2

Use but Search for Safer Substitutes



Benchmark 1

Avoid – Chemical of High Concern

You really want to blast your way
out of this hazard! – and get back on course

Example

Determine if a chemical is a Benchmark 1 PBT

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PBTs – What Are They?

Persistent

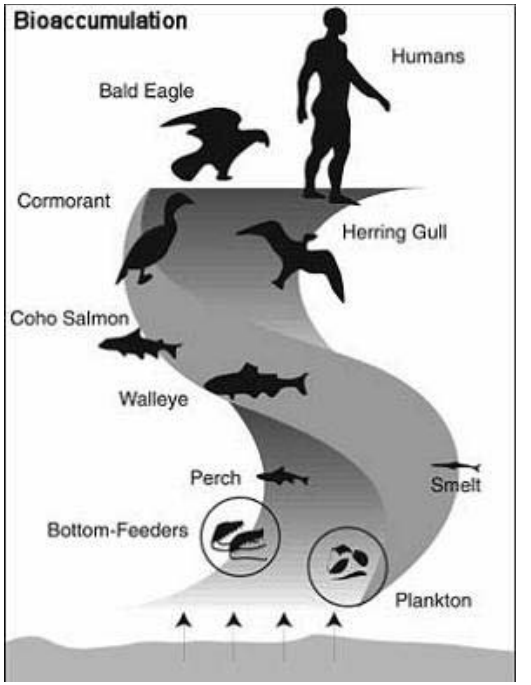
- They are durable and remain in the environment for a long time without breaking down (persistent).
- PBTs can travel long distances and generally move easily between air, water and land.
- Degradation includes oxidation, biodegradation, UV/photodegradation, hydrolysis

Bioaccumulative

- Animals and people accumulate PBTs in their bodies, primarily from the food they eat. As these chemicals move up the food chain, they increase in concentration, and linger for generations in people and the environment (bioaccumulate).

Toxic

- Exposure to PBTs linked to a wide range of toxic effects in fish, wildlife, and humans, including effects on the nervous system, reproductive and developmental problems, immune-response suppression, cancer, and endocrine disruption.



From: http://www.ecy.wa.gov/programs/swfa/pbt/

CLEAN PRODUCTION ACTION

Example Assessment
Step 1: Collect data and fill out hazard summary table

1a. Collect data
- Search literature to get measured data values
- Where measured data are not available, run estimation models such as USEPA's EPI Suite or PBT Profiler or use analogs and professional judgment to fill data gaps

1b. Compare data to hazard threshold values to assign a hazard level (very high, high, moderate, low) and weight of evidence judgment

USEPA EPI Suite

Models and Expert Judgment May Be Used to Supplement Test Data

EPA/OPPT/Exposure Assessment Tools and Models/Estimation Program Interface (EPI) Suite Version 3.12 (August 17, 2004)

http://www.epa.gov/oppt/exposure/pubs/episuite.htm

U.S. ENVIRONMENTAL PROTECTION AGENCY

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You are here: EPA Home » Chemical Safety and Pollution Prevention » Pollution Prevention and Toxics » Exposure » Estimation Program Interface (EPI) Suite Version 3.2 (February, 2007)

- Exposure Home
- What Is an Exposure Assessment?
- OPPT's Exposure Assessment Guidance
- Specialized Priority Setting Tools
- Screening Level Tools
- Higher Tier Tools
- Glossary
- Frequently Asked Questions

Estimation Program Interface (EPI) Suite

What Does EPI Suite ™ Do?

- The EPI (Estimation Programs Interface) Suite™ is a Windows®-based suite of physical/chemical property and environmental fate estimation programs developed by the EPA's Office of Pollution Prevention Toxics and Syracuse Research Corporation (SRC). EPI Suite™ uses a single input to run the following estimation programs: KOWWIN™, AOPWIN™, HENRYWIN™, MPBPWIN™, BIOWIN™, BioHCwin, KOCWIN™, WSKOWWIN™, WATERNT™, BCFBAF™, HYDROWIN™, KOAWIN and AEROWIN™, and the fate models WVOLWIN™, STPWIN™ and LEV3EPI™. ECOSAR™, which estimates ecotoxicity, is also included in EPI Suite™.
- EPI Suite™ is a screening-level tool and should not be used if acceptable measured values are available.
- A clear understanding of the estimation methods and their appropriate application is very important. Click on the Help tab in EPI SuiteT for detailed information on the methods and models in it.

How Do the Individual Models that Make up EPI Suite™ Work?

- KOWWIN™:Estimates the log octanol-water partition coefficient, log K_{OW}, of chemicals using an atom/fragment contribution method.
- AOPWIN™: Estimates the gas-phase reaction rate for the reaction between the most prevalent atmospheric oxidant, hydroxyl radicals, and a chemical. Gas-phase ozone radical reaction rates are also estimated for olefins and acetylenes. In addition, AOPWIN™ informs the user if nitrate radical reaction will be important. Atmospheric half-lives for each chemical are automatically calculated using assumed average hydroxyl radical and ozone concentrations.
- HENRYWIN™: Calculates the Henry's Law constant (air/water partition coefficient) using both the group contribution and the bond contribution methods.
- MPBPWIN™: Melting point, boiling point, and vapor pressure of organic chemicals are estimated using a combination of techniques. Included is the subcooled liquid vapor pressure, which is the vapor pressure a solid would have if it were liquid at room temperature. It is important in fate modeling.
- BIOWIN™: Estimates aerobic and anaerobic biodegradability of organic chemicals using 7 different models. Two of these are the original Biodegradation Probability Program (BPP™). The seventh and newest model estimates anaerobic biodegradation potential.

From: http://www.epa.gov/oppt/exposure/pubs/episuite.htm

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Example Assessment

Step 1: Collect Data and Fill out Hazard Summary Table

1a. **Collect data**

- E.g. chlorpyrifos
  - Aquatic Toxicity:
    - Measured values in fish: LC50 = 0.1-1.0 mg/L
    - EU Risk Phrases: R50/53 = GHS Category 1 Acute & Chronic
  - Estimated Persistence (US EPA EPISUITE): 1/2 Life = 360 days soil (76% partition) and 1600 days sediment (20% partition)
  - Estimated Bioaccumulation Potential (US EPA EPISUITE): BCF = 1300

Aquatic Toxicity

Ecotoxicity	Very High (vH)	High (H)	Medium (M)	Low (L)
Acute Aquatic Toxicity 96 hr LC50 (fish) 48 hr EC50 (crustacea) 72 or 96 hr ErC50 (algae	• GHS Category 1 (≤ 1 mg/L) • On specified lists	• GHS Category 2 (>1 to ≤ 10 mg/L) • On Specified Lists	• GHS Category 3 (>10 to ≤ 100 mg/L) • On Specified Lists	• Not classifiable as GHS Category 1-3 (>100 mg/L)
Chronic Aquatic Toxicity	• NOEC or ECx ≤ 0.1 mg/L	• NOEC or ECx > 0.1 to ≤ 1.0 mg/L	• NOEC or ECx > 1.0 to ≤ 10 mg/L • GHS Category 4	• NOEC or ECx > 10 mg/L

E.g. Chlorpyrifos: Aquatic Toxicity

–Measured values in fish: LC50 = 0.1-1.0 mg/L

–EU Risk Phrases: R50/53 = GHS Category 1 Acute & Chronic

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Persistence

	Stockholm Convention	Washington State, US EPA PBT Chemicals Final Rule, IJC Virtual Elimination Task Force, OSPAR PBT definition, and the EU REACH legislation:	IJC Virtual Elimination Task Force	"Biodegradable"
Environmental Fate	Very High (vH)	High (H)	Medium (M)	Low (L)
Persistence (half-life in days)	• Soil or sediment >180 days • Water >60 days	• Soil or sediment >60 to 180 days • Water >40 to 60 days • Potential for long-range environmental transport	• Soil or sediment 30 to 60 days • Water 7 to 40 days	• Soil or sediment <30 days • Water <7 days • Ready biodegradability

E.g. Chlorpyrifos: Estimated Persistence (US EPA EPISUITE)
1/2 Life Soil = 360 days soil (76% partition)
1/2 Life Sediment = 1600 days sediment (20% partition)

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Bioaccumulation

		Washington State and the US EPA PBT Chemicals Final Rule	OSPAR Commission and by GHS	below the OSPAR and GHS thresholds
Environmental Fate	Very High (vH)	High (H)	Medium (M)	Low (L)
Bioaccumulation	• BCF/BAF >5000 • Absent such data, log Kow >5	BCF/BAF >1000 to 5000 • Absent such data, log Kow >4.5-5 • Weight of evidence demonstrates bioaccumulation in humans or wildlife	• BCF/BAF 500 to 1000 • Absent such data, log Kow 4-4.5 • Suggestive evidence of bioaccumulation in humans or wildlife	• BCF/BAF <500 • Absent such data, log Kow <4

E.g. Chlorpyrifos: Estimated Bioaccumulation Potential (USEPA EPISUITE)
BCF = 1300

- Where BAF=bioaccumulation factor; BCF=bioconcentration factor; log Kow=log-octanol water partition coefficient

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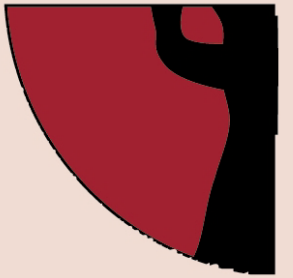
Example Assessment
Step 2: Apply the Benchmarks

BENCHMARK 1

a. PBT: high P + high B + high T[1] (high Human Toxicity[2] 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 effect[3]



Avoid—Chemical of High Concern

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

Chemical	CAS	P	B	T
Chlorpyrifos	2921-88-2	*VH*	*H*	H
Chlorothalonil	1897-45-6	*H*	*L*	H

E.g. Chlorpyrifos = BENCHMARK 1 (based on GS v1.0 Benchmarks)

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Applications: Highlights

Identifying safer substitutes for BFRs, CFRs, and PVC

Platform for their chemical screening program

Basis for state regulatory programs

www.epa.gov/dfe

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Wal-Mart's Principles for Preferred Chemical Intensive Products

Safe Products for Mother, Child, and the Environment

- ***When we suspect that an ingredient in a product or the product itself is capable of causing harm to human health and the environment, we will act to find better alternatives.***

- ***A screening tool has been developed via a multi-stakeholder working group to identify and score products containing the following:***
  - CMRs
  - Endocrine disruptors
  - PBTs
  - vPvBs
  - Chemicals identified on Wal-Mart's "grey list"
  - *And a "watch list" for use to flag potential emerging concerns*

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Wal-Mart's Buyers Screening Tool

- Assist the buyers with a easy to use yet powerful tool to facilitate more informed decisions in selecting products
  - Reduce inherent hazard of products sold
  - Reduce hazardous waste
- Full ingredient disclosure and scoring through a 3rd party to protect confidential formulation info; Buyers see results.
- Screen chemical constituents in similar products against known hazards
- Products scored based on hazard weightings and concentration
- Scoring is used to trigger a request for more information or to prefer a lower hazard alternative

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Flexible Weighting System

Configurability Allow Users to Define Own Criteria

Data Administration - Views - Microsoft Internet Explorer provided by The WERCS, Ltd

https://secure.supplierwercs.com/greenwercs/Administration.aspx

Identified by VeriSign

Data Administration - Views

GreenWERCS™

Wercs® Professional Services

Sign Out

Current View | Groups | Categories | Access Management | Scoring | Advanced Search | Analytics

View Management

Select View: Default Regulation View ...

Categories used in this View:

Name	Axis Group	Weight	Active	Details
Known Carcinogens	Health	10	☑	Details
Reproductive and Developmental Hazards	Health	10	☑	Details
Wal-Mart Grey List	Health	10	☑	Details
Endocrine Disruptors	Health	1	☑	Details
Suspected Carcinogens	Health	5	☑	Details
Mutagenic Hazards	Health	10	☑	Details
Hazardous Waste	Environment	10	☑	Details
PBT Chemicals	Environment	10	☑	Details
vPvBs	Environment	10	☑	Details

Maximum Possible Score: 7600

Save Mapping | Edit Categories

Sustainability Goals	2009	2010	2011
Health	0	0	0
Environment	0	0	0

Save Goals

Scoring Parameters

Maximum Score:	1000
Green Band Maximum:	10
Yellow Band Maximum:	200
Red Band Maximum:	500

Save Parameters | Re-Score All Products

Re-Scoring all Products may take a very long time.
Do this only when necessary.

Powered By

Search Results Graph - Microsoft Internet Explorer provided by The WERCS, Ltd

https://secure.supplierwercs.com/greenwercs/mainview.aspx?P=1007094

Wercs Professional Services, LLC [US]

File Edit View Favorites Tools Help

Search Results Graph

Home Feeds (J) Print Page Tools

Logout | Scoring | Advanced Search | **Administrator Mode**

Highlights - Products displayed: 2855

Best Scored Product

[illegible]

Health: 0

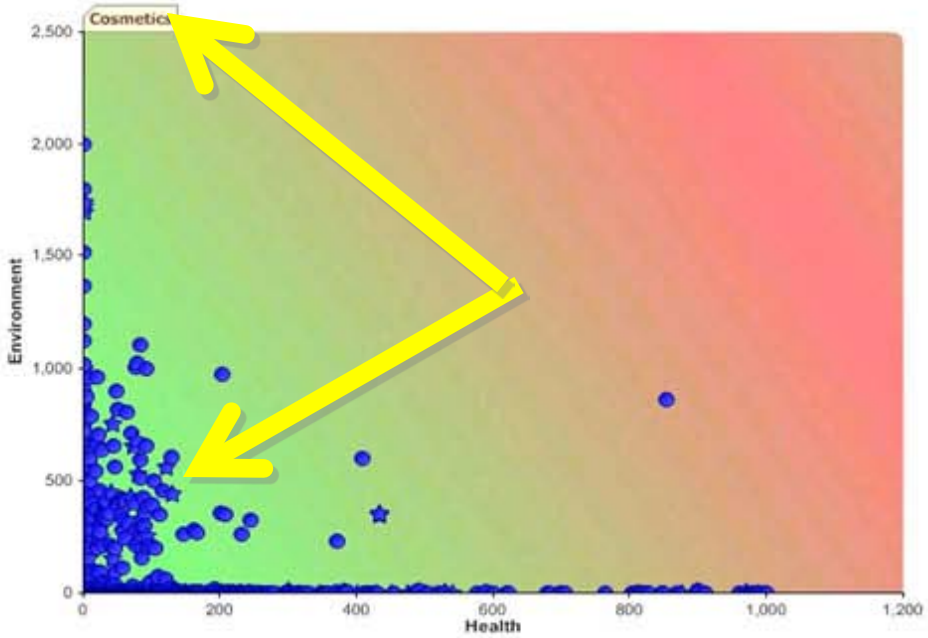
Environment: 0

Worst Scored Product

[illegible]

Health: 0

Environment: 1998



Symbols: Single UPC score displayed as ● Multiple UPC for same score displayed as ★

Categories

Environment	860
Health	854
Hazard Waste Disposal	Yes

UPCs for this Product

074170306019
074170306002
074170305999
074170305982
074170302028

Supplier Details

[illegible]

Notes | Product Details | Details

Scoring details for [illegible]

Health

Endocrine Disruptors : 4
Known Carcinogens : 450
Mutagenic Hazards : 400
Total: 854

Environment

PBT Chemicals : 430
vPvBs : 430
Total: 860

Done | Internet | 100%

Start | Calendar - ... | 93 Reminders | 2 Window... | 2 Microsof... | Search Re... | 2:19 PM

GREEN SCREEN

HP is the world's leading practitioner of the Green Screen tool. This tool, developed by the NGO Clean Production Action, is an open source tool used to identify substances that are inherently less hazardous for humans and the environment. It enables informed decisions to substitute materials eliminated from our products.

HP is championing wider acceptance of the Green Screen within industry, the environmental NGO community and regulatory bodies.

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HP: Considering the Context and Comparing Alternatives Based on Functional Use

Green Screen Assessments of Similar Function Chemical

Common Name	CAS #	Full Name	Benchmark
Preferred			
Design	none	Design material out, dematerialize	4
Substance 0	#####-##-#	Chemical name	4
Use but still opportunity for improvement			
Substance 1	#####-##-#	Chemical name	3
Substance 2	#####-##-#	Chemical name	3
Use but search for alternatives			
Substance 3	#####-##-#	Chemical name	2
Substance 4	#####-##-#	Chemical name	2
Substance 5	#####-##-#	Chemical name	2
Substance 6	#####-##-#	Chemical name	2
DO NOT USE			
Substance 7	#####-##-#	Chemical name	1
Substance 8	#####-##-#	Chemical name	1
Substance 9	#####-##-#	Chemical name	1
Substance 10	#####-##-#	Chemical name	1
Substance 11	#####-##-#	Chemical name	1
Substance 12	#####-##-#	Chemical name	1

Value of the Green Screen

1. Driver for Green Chemistry
2. Supports business value via comparative hazard assessment and informed substitution
3. An important tool in the toolbox that supports broader sustainability initiatives

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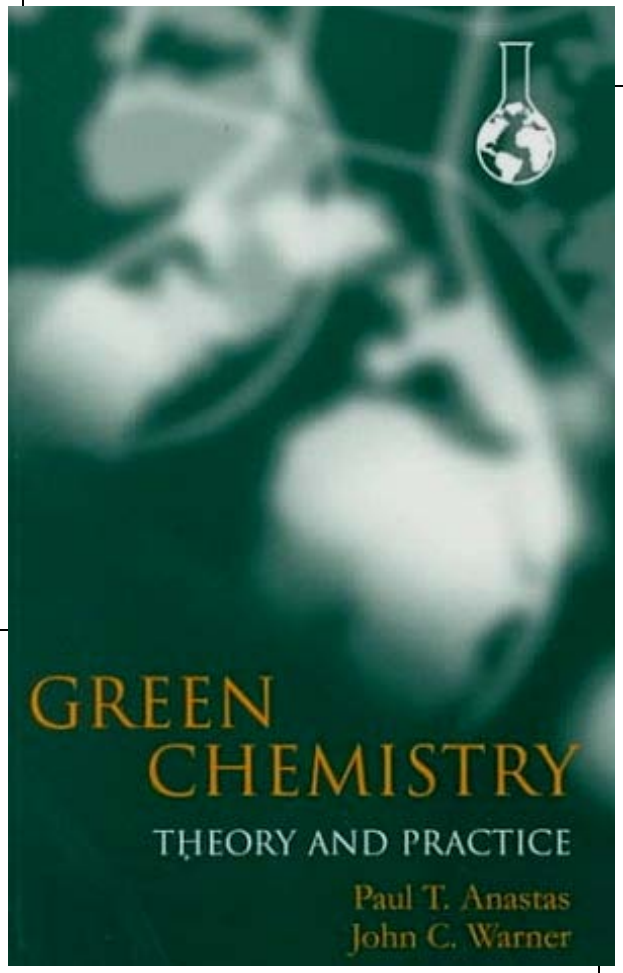
change chemical design so that it is ***"inherently of less risk to human health and the environment"***



#2. Design safer chemicals and products: Design chemical products to be fully effective, yet have little or no toxicity.

#10. Design chemicals and products to degrade after use: Design chemical products to break down to innocuous substances after use so that they do not accumulate in the environment.

#12. Minimize the potential for accidents: Design chemicals and their forms to minimize the potential for chemical accidents including explosions, fires, and releases to the environment.

CLEAN PRODUCTION ACTION

How This Promotes Green Chemistry

- Manufacturers identify chemicals of concern
- Manufacturers talk to their suppliers to find and evaluate feasible substitutes
- Manufacturers may also use internal resources or seek the expertise of green chemists, third party consultants, etc. to create new chemicals and better formulations.
- This drives INNOVATION!

It is possible to get out of the hazard zone

Business Reasons for Comparative Chemical Hazard Assessment

Reason #1: Replacing materials multiple times is extremely expensive and undesirable

- Regulatory bodies are increasingly using hazard as a screen for substances of concern, so hazard screening is useful an indicator of future restriction

- Want to select alternatives that won't be restricted in the future to avoid multiple substitutions

- Aligns business process with regulatory process

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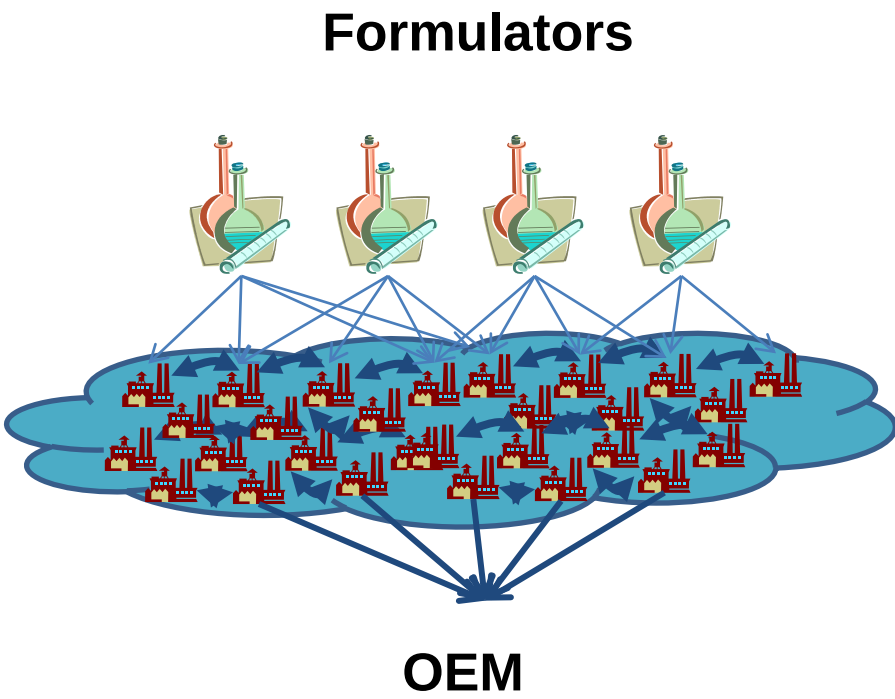
Business Reasons for Comparative Chemical Hazard Assessment

Reason #2: Need to prioritize material substitution programs due to complexity of supply chain management and finite resources to work on these issues

- Want to go after the materials that have the most impact



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Business Reasons for Comparative Chemical Hazard Assessment

Reason #3: It only makes sense to replace materials with alternatives that are indeed better with respect to EH&S

- Need a way to assess alternatives to ensure that they are inherently less hazardous (not just unrestricted)
- Want to be able to select into good materials (not just unrestricted)

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Business Reasons for Comparative Chemical Hazard Assessment

Reason #4: Clearly defined attributes and criteria can help to articulate to suppliers what their customers are looking for; common technical language

- Clearly defined attributes and criteria can drive innovation and green chemistry challenges
  - The DfE Criteria for Safer Chemicals help define what formulators need from their suppliers for DfE recognition

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Limitations of the Green Screen

1. Only as good as the test methods and available data
   - Pushing the limits of regulatory science and guideline studies (e.g. EDCs and neurodevelopmental toxicity)
2. Requires expertise
3. Necessary but not sufficient for sustainability
   - One tool in the toolbox
     - Does one thing well- no tool does everything well

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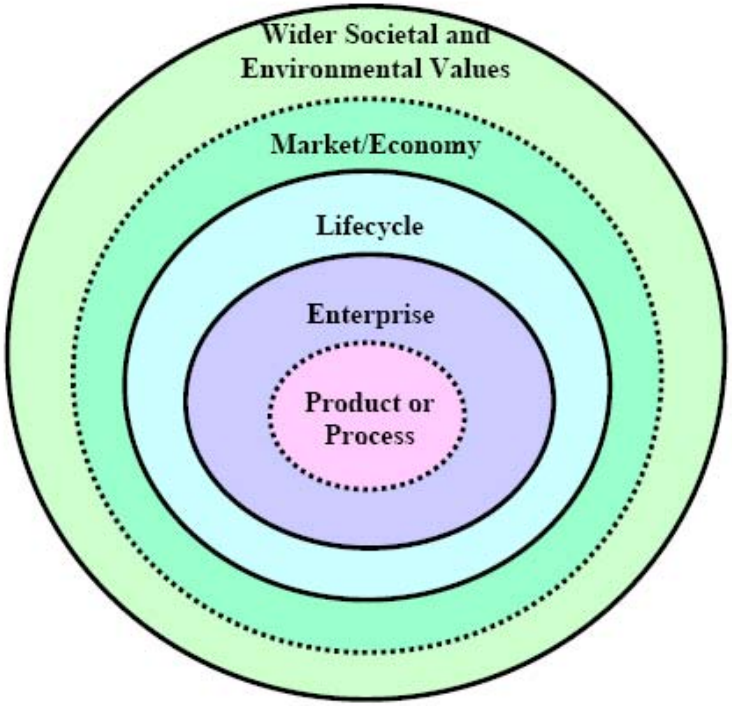
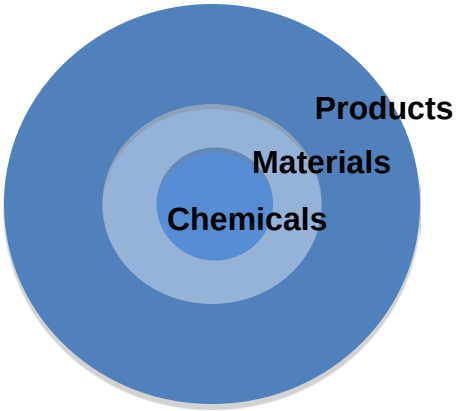
How the Green Screen Compares to Other Tools

1. LCA
2. iSustain
3. TPI Calculator
4. USEPA DfE
    1. Safer Products
    2. Chem Alts Assessment
5. CleanGredients
6. C2C Product Certification
7. Ecolabels
8. Carbon Footprint/Energy
9. Water Footprint
10. Social wellbeing metrics
11. Etc...

CLEAN PRODUCTION ACTION

Replacing Toxics within a Complex System: Multiple Attributes and Transparent Criteria





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Comparative Chemical Hazard Assessment Supports Sustainable Materials Management

- Green Screen does comparative chemical hazard assessment well
- Can be used in combination with other tools and metrics
  - Price, performance, energy, social, water, etc.

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Green Screen: So Whats Next?
Version 2.0 *Draft for review June 2010*

1. Expanding hazard endpoints to more fully align with GHS
2. Updating criteria for EDCs and neuro/neurodevelopmental toxicity
3. Creating additional benchmark (0-4) versus (1-4)
4. Aligning with USEPA DFE General Criteria including:
   - Recommended test methods
   - Recommended models (i.e., cancer, P, B and aquatic toxicity)
5. Modifying criteria to apply to inorganics (i.e., mineral FRs)
6. Developing criteria for data quality and data completeness

Green Screen: What's Next, cont'd?

- Engaged Technical Committee in revision process
- Preparing for peer review (June 2010) *Volunteers welcome!*
- Facilitating ease of use via access through public and educational wiki
  - Links to method and authoritative, screening and reference lists
  - Links to method classification guidance and test methods
  - Links to assessments that have undergone technical review
- Exploring opportunities for augmenting assessment via automation
- Developing agreements with 3rd party profilers to perform GS assessments
- Setting up a Technical Review and verification program
  - Only GS assessments that have been through TR will be posted

Thank you!

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