

Outline

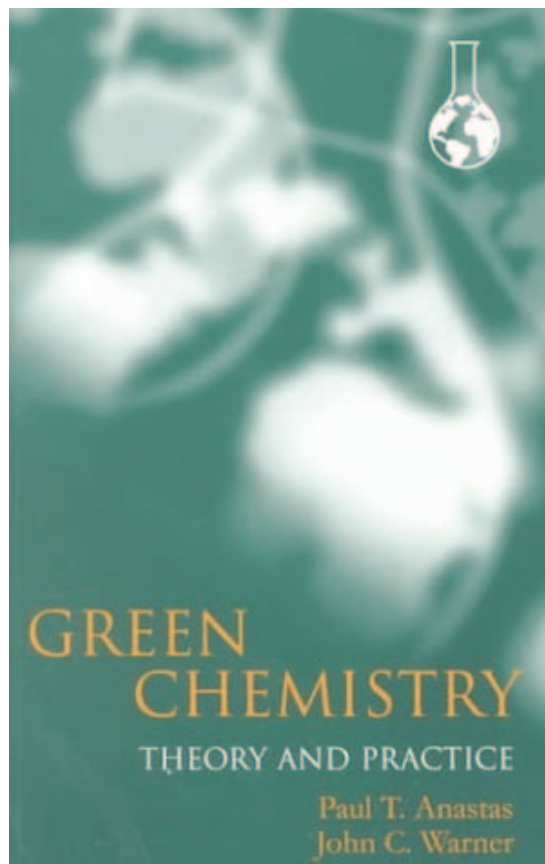
- Key Concepts and Precedents for Comparative Chemical Hazard Assessment
- The GreenScreen™ for Safer Chemicals
 - How It Works
 - Application Highlights

12 Principles of Green Chemistry

focus on reducing inherent hazard

$$\text{Risk} = f(\text{Hazard, Exposure})$$

Green chemistry is the design of products and processes that reduce or eliminate the use or generation of hazardous substances.

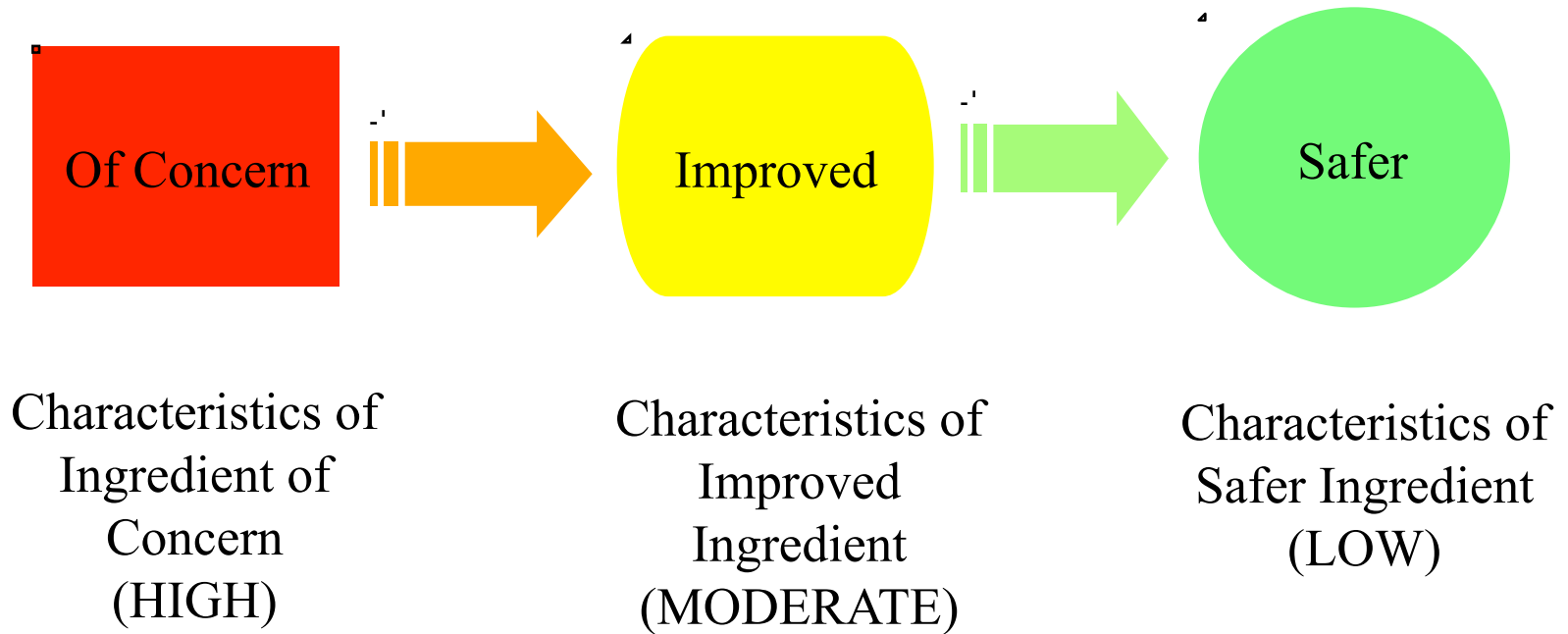


- #3. Less hazardous chemical syntheses**
- #4. Design safer chemicals and products**
- #5 Use safer solvents and auxiliaries**
- #10 Design chemicals and products to degrade after use**
- #12. Minimize the potential for accidents**

Chemical Functionality

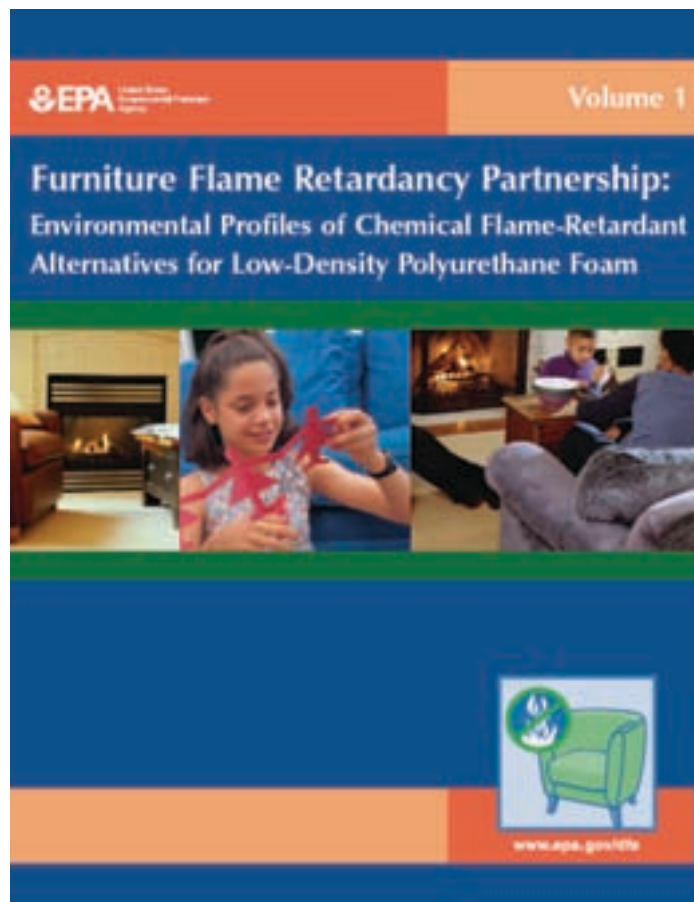
- The functionality of a chemical is the job it performs in a formulation, material or product;
 - Function is related to chemical structure and physical chemical properties
- Functional use classes for cleaning products:
 - *Surfactants*
 - *Solvents*
 - *Chelating & sequestering agents*
 - *Fragrances*
 - *Colorants*
 - *Preservatives*

Informed Substitution and The Continuum of Improvement



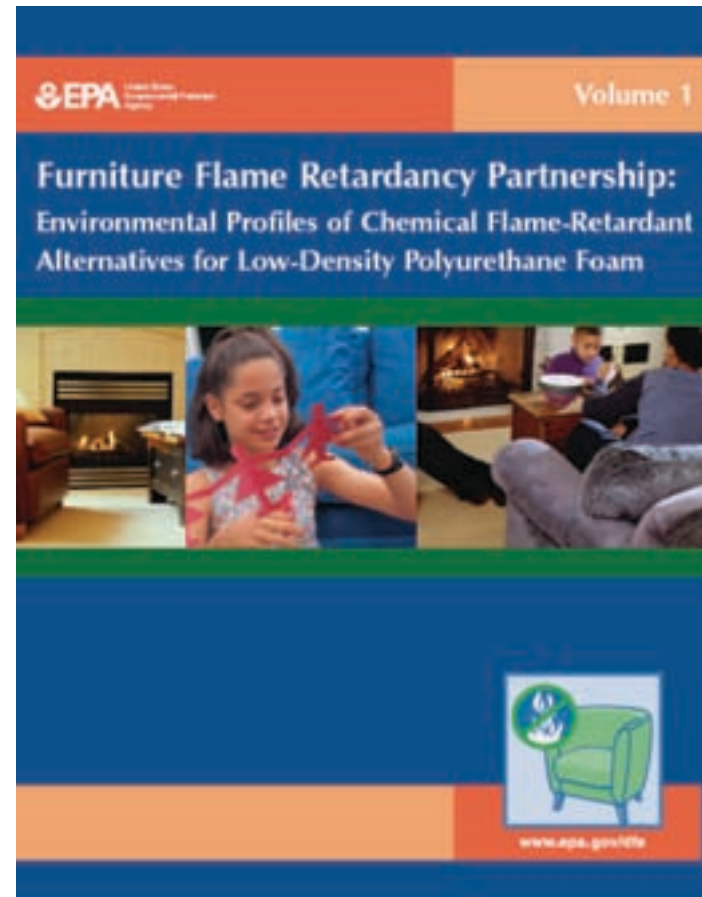
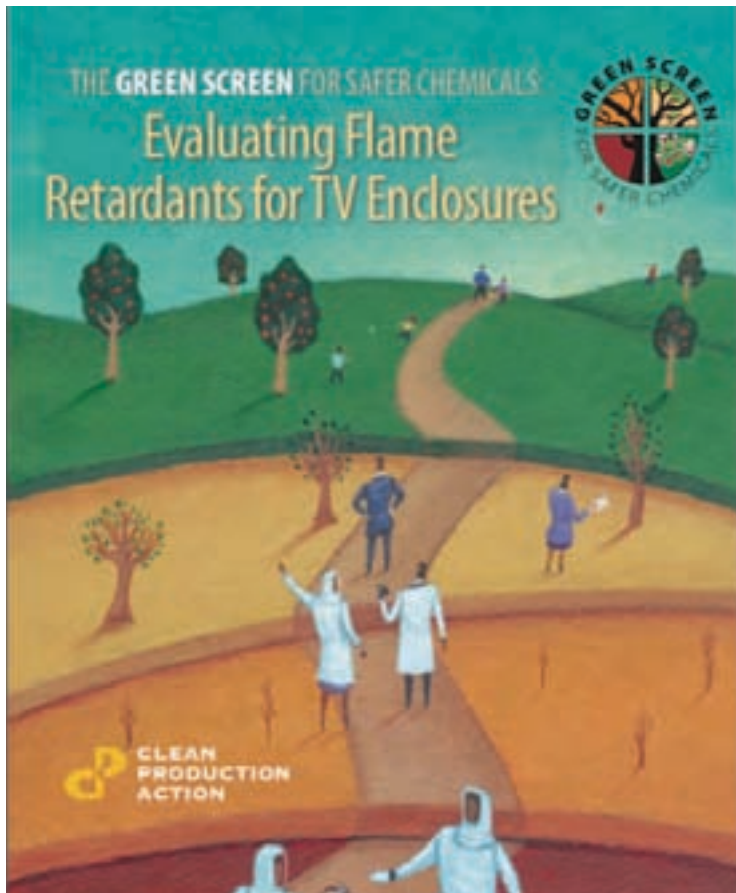
DfE Alternatives Assessment Partnerships

First DfE AA Partnership: Alternatives to penta-BDE in Furniture Foam



1. Final Report includes:
 - Background – functional use, life-cycle and exposure considerations
 - Comprehensive chemical hazard profiles and **hazard summary table**
2. Currently addresses USEPA Action Plan Chemicals
 - Action Plan Chemicals currently include: BPA in thermal paper; decaBDE, HBCD, phthalates, NPEs
 - See: DfE Alternatives Assessment Criteria for Hazard Evaluation*

Origins of the GreenScreen™



What is the Green Screen?



- Comparative Chemical Hazard Assessment approach (CHA) developed by Clean Production Action
- Builds on the DfE Alternatives Assessment and Safer Product Criteria approach
- Considers 18 environmental and human health endpoints;
 - Addresses constituents and breakdown products
- Evaluates chemical hazards for an overall chemical score (Benchmark 1 - 4)
- GreenScreen™ v 1.2 launched October 2011

Publicly Accessible, Transparent, Peer-Reviewed and Reproducible

Clean Production Action

Home

Healthy Business Strategies

Safer Chemicals

» GreenScreen™

» About GreenScreen™

GreenScreen™ v 1.2

» Chemicals Policy

» Green Consumer Electronics

» Green Chemistry

» Flame Retardants

Sustainable Materials


Environmentally Preferable Products

Producer Take Back

Steps to Clean Production

Clean Production Action

Clean Production Action designs and delivers strategic solutions for green chemicals, sustainable materials and environmentally preferable products.



DONATE NOW

Donate Now through the Tides Center, A Network for Good

GREEN SCREEN FOR SAFER CHEMICALS

» Green Chemistry » GreenScreen™ for Safer Chemicals v 1.2

Welcome to the GreenScreen™ for Safer Chemicals v 1.2

We would like to thank the GreenScreen™ [Technical Advisory Committee](#) and the GreenScreen™ [Steering Committee](#) for all of their helpful feedback and input in helping us realize our goal of continual improvement and development of a robust, scientifically based method that is practical and protective of human health and the environment.

At this site you may download all of the supporting resources and documentation for performing a GreenScreen™ assessment using GreenScreen™ v 1.2. We have also provided example assessments.

GreenScreen™ v 1.2 Hazard Criteria

There are 18 hazard endpoints addressed by **GreenScreen™ Hazard Criteria**:

ENVIRONMENTAL FATE	ENVIRONMENTAL HEALTH	HUMAN HEALTH GROUP I	HUMAN HEALTH GROUP II	PHYSICAL HAZARDS
Persistence	Acute Aquatic Toxicity	Carcinogenicity	Acute Mammalian	Reactivity
Bioaccumulation	Chronic Aquatic Toxicity	Mutagenicity & Genotoxicity	Systemic Toxicity & Organ Effects (incl. Immunotoxicity)	Flammability
	Other Ecotoxicity Studies when available	Reproductive Toxicity	Neurotoxicity	
		Developmental Toxicity (incl. Developmental Neurotoxicity)	Sensitization 1. Skin 2. Respiratory	
		Endocrine Activity	Irritation / Corrosivity 1. Skin 2. Eye	

[Click here to download the GreenScreen™ hazard criteria \(PDF, 115KB\)](#)

Enter search word or phrase

Search

All supporting resources at: <http://www.cleanproduction.org/Greenscreen.v1-2.php>

How It Works



- 1. Assess and Classify Hazards**
- 2. Apply the Benchmarks**
- 3. Make Informed Decisions**

Step 1: Assess & Classify the Hazards

GreenScreen v 1.2 Hazard Endpoints

Human Health Group I	Human Health Group II	Environmental Toxicity & Fate	Physical Hazards
Carcinogenicity	Acute Toxicity	Acute Aquatic Toxicity	Reactivity
Mutagenicity & Genotoxicity	Systemic Toxicity & Organ Effects	Chronic Aquatic Toxicity	Flammability
Reproductive Toxicity	Neurotoxicity	Other Ecotoxicity Studies when available	
Developmental Toxicity	Skin Sensitization Respiratory Sensitization	Persistence	
Endocrine Activity	Skin Irritation Eye Irritation	Bioaccumulation	

Where did the Hazard Endpoints Come From?

Primary Source of Hazard Endpoints

- GHS – Globally Harmonized System of Classification and Labelling of Chemicals
- USEPA Design for the Environment Program Alternatives Assessment Criteria for Hazard Evaluation
- USEPA New Chemicals Program
- OECD Screening Information Data Sets (SIDS)

Notable Additions

- Endocrine Activity
- Physical Hazards
- Prioritization of Human Health Effects for Benchmarking
- Inclusion of feasible transformation products

GreenScreen v 1.2 Hazard Criteria

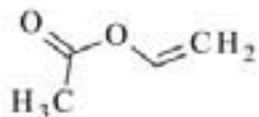
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Reproductive Toxicity (R)	Information Type	Information Source	List Type		High (H)	Moderate (M)	Low (L)	
	Data	GHS Criteria & Guidance <i>Note: GHS Reproductive Toxicity includes both reproductive and developmental effects, while the Green Screen separates them into two distinct hazard endpoints. This classification must be based on reproductive effects alone.</i>				GHS Category 1A (Known) or 1B (Presumed) for any route of exposure	GHS Category 2 (Suspected) for any route of exposure or limited or marginal evidence of reproductive toxicity in animals (See Guidance)	Adequate data available, and negative, no structural alerts, and GHS not classified.
A Lists	EU H-statements	Authoritative			H360F, H360FD, H360Fd	H360Df, H361f, H361fd		
	EU R-phrases	Authoritative			R60	R62		
	NTP-OHAaT	Authoritative			Clear Evidence of Adverse Effects - Reproductive		Clear Evidence of No Adverse Effects - Reproductive	
	Prop 65	Authoritative			Known to the state to cause reproductive effects-Male or Female			
B Lists	NTP-OHAaT	Authoritative			Limited Evidence of Adverse Effects - Reproductive or Some Evidence of Adverse Effects - Reproductive			
					Limited Evidence of No Adverse Effects - Reproductive or Some Evidence of No Adverse Effects - Reproductive			
					Insufficient Evidence for a Conclusion - Reproductive Toxicity			

Acute Mammalian Toxicity (AT)	Information Type	Information Source	List Type	Very High (vH)	High (H)	Moderate (M)	Low (L)	
	Data	GHS Criteria & Guidance			GHS Category 1 or 2 for any route of exposure	GHS Category 3 for any route of exposure	GHS Category 4 for any route of exposure	GHS Category 5 or adequate data available, and negative studies, no structural alerts, and GHS not classified.
Guidance Values for Animal Data (see GHS for further information)	Oral LD ₅₀ (mg/kg)			≤50	>50-300	>300 - 2000	>2000	
	Dermal LD ₅₀ (mg/kg)			≤200	>200-1000	>100 - 2000	>2000	
	Inhalation-Gas or Vapor LD ₅₀ (mg/L)			≤2	>2-10	>10 - 20	>20	
	Inhalation-Dust/Mist/Fumes LD ₅₀ (mg/L)			≤0.5	>0.5-1.0	>1 - 5	>5	
A Lists	DOT	Authoritative		Class 2.3 Group A, or Class 6.1 Group 1 or Group 2	Class 6.1 Group 3			
	EU H-statements	Authoritative		H300, H310, or H330	H301, H311, or H331	H302, H312, or H332	H303, H313, or H333	
	EU R-phrases	Authoritative		R28, R27 or R28				
B Lists	DOT	Authoritative		Class 2.3 Group B		Class 2.3 Group C		
						Class 2.3 Group D		
	EPA-AMT	Authoritative		Extremely Hazardous Substance				
	EU H-statements	Authoritative		H111				
	EU R-phrases	Authoritative				R20, R21, or R22		
				R23, R24, or R25				
	WHMIS	Screening		D1A Toxic				
			D1B Toxic					

Step 1: Classify the Hazards

Chemical Structure(s):



Identify Applications/Functional Uses:

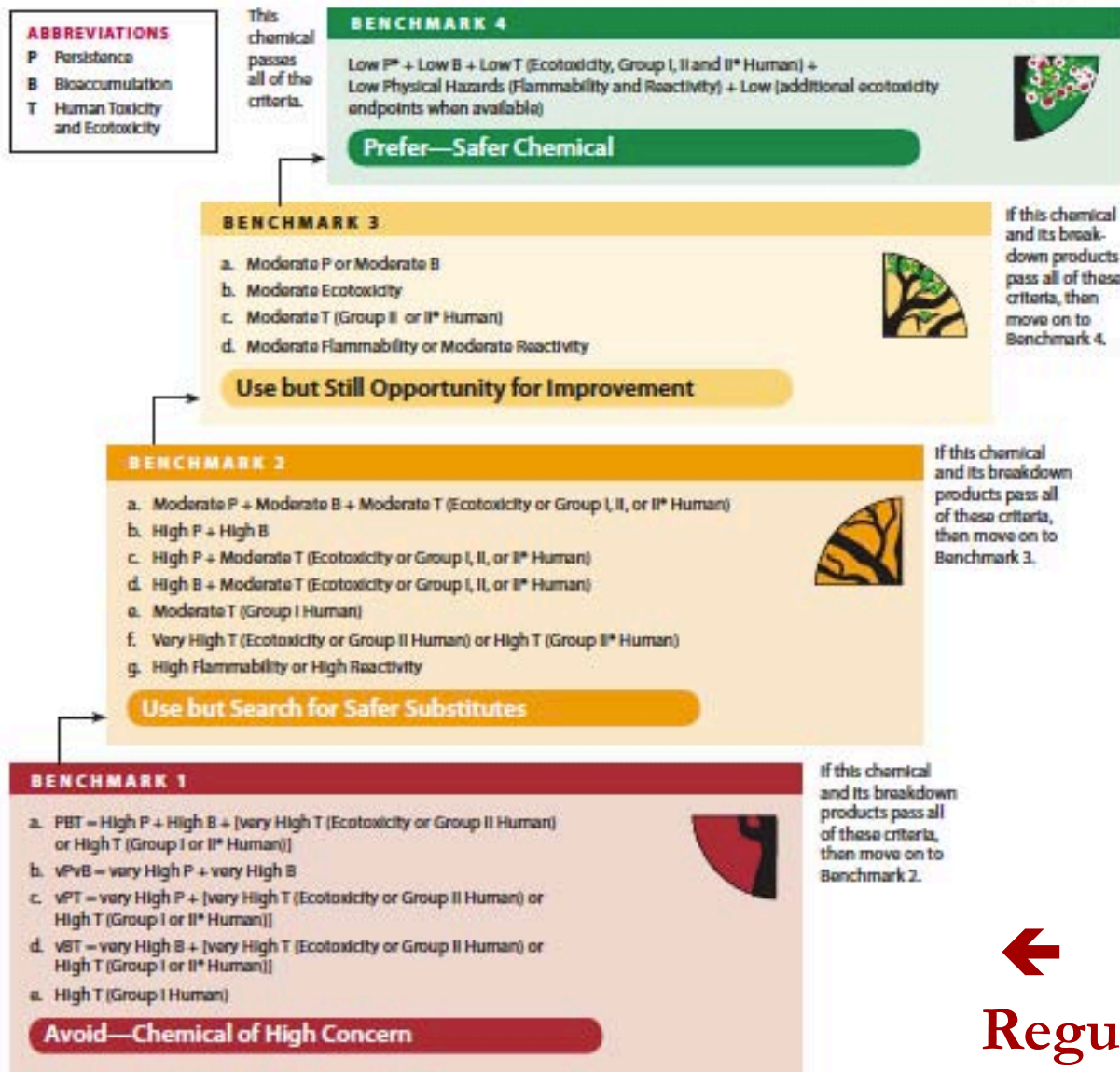
(e.g., Cleaning product, TV casing)

Vinyl acetate is used in the manufacture of polyvinyl and vinyl acetate copolymers, which are used in water-based paints, adhesives, paper coatings, and applications not requiring service at extreme temperatures. Additionally, it is used in safety glass and hairspray (HSDB 2009).

Green Screen Hazard Ratings: Vinyl Acetate (CAS #108-05-4)																	
Group I Human					Group II Human							Ecotox		Fate		Physical	
C	M	R	D	E	A T	S T	N	Sn S	Sn R	Ir S	Ir E	AA	CA	P	B	Rx	F
M	M	M	M	dg	M	H	dg	dg	L	vH	H	M	M	vL	vL	H	vH

*Hazard levels (vH, H, M, L, vL) in *italics* reflect a lower level of confidence (See Guidance).

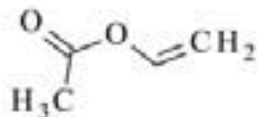
Step 2: Apply the Benchmarks to the Hazard Classifications



← Aligned with Regulatory Drivers

Step 2: Apply the Benchmarks

Chemical Structure(s):



Identify Applications/Functional Uses:

(e.g., Cleaning product, TV casing)

Vinyl acetate is used in the manufacture of polyvinyl and vinyl acetate copolymers, which are used in water-based paints, adhesives, paper coatings, and applications not requiring service at extreme temperatures. Additionally, it is used in safety glass and hairspray (HSDB 2009).

Green Screen Rating¹: Vinyl acetate was assigned a Benchmark Score of 2 based on several hazard ratings, including: Moderate classifications for Carcinogenicity (C), Mutagenicity (M), Reproductive (R) and Developmental (D) Toxicity; High classification for Systemic Toxicity (S) and Reactivity (R); and Very High classification for Skin Irritation/Corrosion (IrS) and Flammability (F). *NOTE: Data gaps (dg) exist for Endocrine Activity (E) (not listed, but not tested), Neurotoxicity (N), and Skin Sensitization (SnS). In a worst-case scenario, if vinyl acetate was assigned a High score for E it would be assigned a Benchmark Score of 1.*

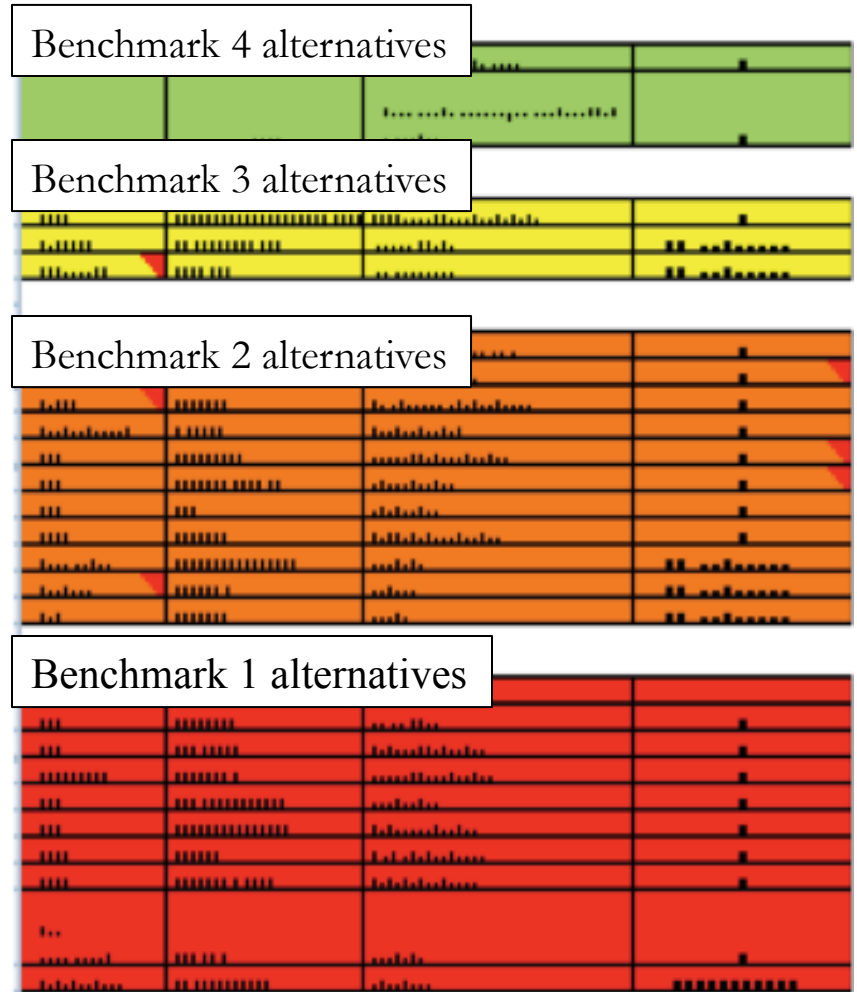
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Group I Human					Group II Human						Ecotox		Fate		Physical		
C	M	R	D	E	A T	S T	N	Sn S	Sn R	Ir S	Ir E	AA	CA	P	B	Rx	F
M	M	M	M	dg	M	H	dg	dg	L	vH	H	M	M	vL	vL	H	vH

*Hazard levels (vH, H, M, L, vL) in *italics* reflect a lower level of confidence (See Guidance).

¹ For inorganic chemicals with low human and ecotoxicity across all hazard endpoints and low bioaccumulation potential, persistence alone will not be deemed problematic. Inorganic chemicals that are only persistent will be evaluated under the criteria for Benchmark 4.

Step 3: Make Informed Decisions

- Compare results by functional use (e.g. flame retardants, plasticizers, etc.)
- Need toxicology expertise to do a GS assessment, but resulting scores can be applied by those without toxicology expertise (e.g. engineers, purchasers)
 - Hazard table allows users to consider specific concerns (worker EHS, specific exposure routes)
- Drives wider adoption of preferred materials
 - Preferred material lists
 - New product development



Step 3: Make Informed Decisions

GreenScreen™ Application Highlights

GREENSCREEN™

HP is the world's leading practitioner of the GreenScreen™ tool.

HP has committed to replace restricted substances only with materials that are better for the environment and human health, and when there is sufficient assurance of required volumes and we have enough time to design and qualify the new material into the product. To assess alternative replacement materials we now use the GreenScreen, a hazard-based assessment framework developed by the nongovernmental organization Clean Production Action.

HP Global Citizens Report



GreenScreen™ for Assessing Replacements for Restricted Substances in Electronics

- Key screening tool that Hewlett Packard (HP) uses for alternatives assessment when replacing a restricted substance
- Enables identification of better materials, not just minimum acceptable
- Green Screen results are only part of decision, but initial hazard screening deselected certain options early in assessment process
- HP continues to use Risk Assessment, LCA, and Carbon Footprint tools to complement



ROHS – And More Regulations Are Coming



DRAFT SAFER CONSUMER PRODUCTS REGULATION



ROHS

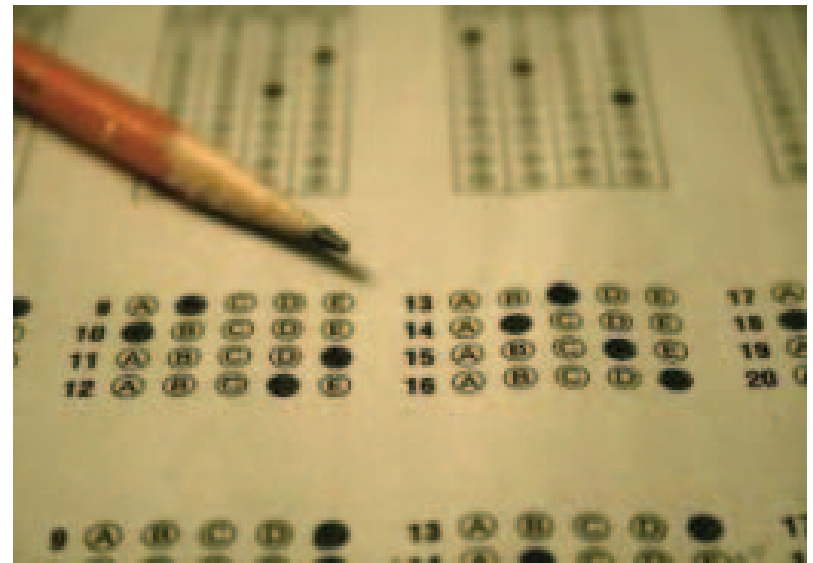
EU Directive 2002/95/EC on the Restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment

• Substance restrictions are now a major class of regulation for finished electronic and other products

- More substances
- More jurisdictions
- More reporting
- Alternatives assessments may be required

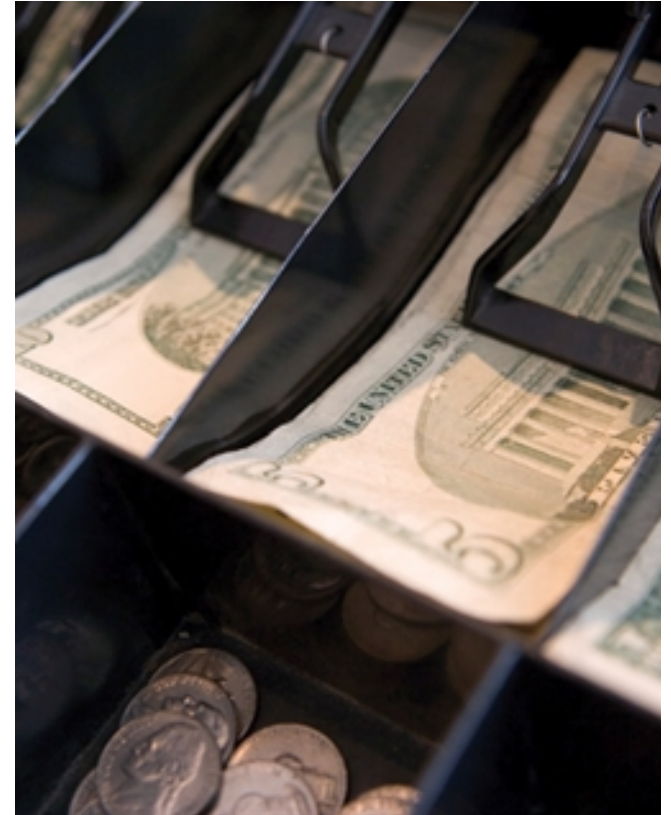
How Many Companies Implement RoHS Restrictions

- Look for substances that are legal
 - All unregulated substitutes equally acceptable
- Base material selection only on:
 - Cost
 - Function
 - Reliability
 - Manufacturability



Business Case for Choosing Low Hazard Materials

- Replacing materials is expensive
 - Want to select alternatives that will not be restricted in the future
- Replacements should have lower environmental impact
 - Avoid unintended consequences
 - Identify preferable materials (not just minimally acceptable)



HP's PVC-Free Power Cord GreenScreen™ Program

1. HP started GreenScreen™ program as a small pilot to learn what works
2. For PVC alternatives, screening was made **mandatory**, in addition to all standard and regulatory requirements
 - 100% of PVC-free power cords screened by suppliers and HP
 - Requires full disclosure under CDA
 - Several approved (> BM1)
 - CHA used as a feature along with cost, performance, risk assessment, LCA, etc.



What if: *PolyOne*

a flexible material could provide flame retardance and superior aesthetics without the use of halogens?

more possibilities >

Our GLS™ OnFlex™ HFFR thermoplastic elastomers help leading wire & cable manufacturers meet market demand for high-performance halogen-free power cords, accessory cords, and injection molded connectors. [Click here to learn more.](#)

ON*flex*™
TPE Compounds



- Supplier of halogen and phthalate-free products that meet performance and regulatory requirements
- PolyOne GLS engaged with GreenScreen via relationship with HP
- Learned from it, and will continue to use the GreenScreen process to develop cleaner, greener products going forward as part of their corporate responsibility

“The more you know about what you are putting into your products, the more likely you are to make better choices in product development”

Jonathan Plisco, PolyOne

Worker Exposure and Intended Use

- GreenScreen is intended to inform decision-making but not to replace it!
- Risk management must always be applied – even for Benchmark 4 chemicals.
- Examples:
 1. **Worker Exposure.** If the use of a chemical is known to lead to worker exposure via inhalation, then it is important to ensure that inhalation data are provided in the GreenScreen report -- even if a Benchmark score can be assigned without it.
 2. **Intended Use.** A chemical may have a relatively high Benchmark score, such as a Benchmark 3. But if the chemical is intended for an eye wash, and the hazard associated with the chemical is eye irritation, then it not likely to be a good choice.

Concluding Thoughts

- Chemical hazard assessment (CHA) is increasingly important for identifying safer chemicals and materials for business and regulatory purposes
- Material selection is not just about cost and performance
 - Chemical hazard is being perceived as a quality feature
 - The presence of hazardous chemicals in a material or product can be considered a defect – especially if it leads to regulatory risk
- There is a need for a CHA method that is science-based, publicly accessible, comprehensive, reproducible and based on best national and international precedents and practices
 - The GreenScreen builds on the USEPA DfE approach. It supports the identification of safer chemicals and materials for use in product design and development and to meet emerging regulatory requirements
- CHA can complement risk assessment and life-cycle assessment; it will never replace the need for such additional tools.
- Next GreenScreen training (see next slide)



The Opportunity to Invest in Safer Chemicals GreenScreen™ for Safer Chemicals

A training opportunity brought to you by



Save the Date!

May 8, 2012 | Ann Arbor, MI

Hosted by NSF International

The GreenScreen™ for Safer Chemicals is a method developed by Clean Production Action. It is used by several organizations, including HP, to evaluate the hazards associated with specific chemicals and identify safer alternatives.

This day-long training will be of particular interest to business experts in supply chain management, materials selection, procurement, product and process design, environmental health and safety, sustainability, and regulatory affairs who need to select safer chemicals for their products.

For more information please contact Clean Production Action at greenscreen@cleanproduction.org

Visit: <http://www.cleanproduction.org/Greenscreen.php>

NSF is also hosting the 7th Annual Green Chemistry and Commerce Council (GC₃)
Innovators Roundtable

GC₃ 7th Annual Innovators Roundtable

May 9-11, 2012 | Ann Arbor, MI

Hosted by NSF International

Join the GC₃ business-to-business networking event for cross-sectional collaboration, and sharing of information and experiences about the challenges to and opportunities for safer chemicals and products.

For more information contact GC₃ at

Sarah_Shields@uml.edu

