



GreenScreen® for Safer Chemicals: Applications and New Developments

BizNGO Webinar Sept 11, 2013 at noon Eastern

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What is the GreenScreen[®]?

- A method for comparative Chemical Hazard Assessment (CHA) developed by Clean Production Action (CPA)
- Builds on the USEPA Design for Environment (DfE) approach and other national and international precedents (OECD, GHS)
- Freely and publicly accessible, transparent and peer reviewed



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



Key Concept to Formulating: Reduce Risk by Reducing Inherent Hazard

Risk = *f*(**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

Five of the 12 Principles of Green Chemistry are focused on Hazard Reduction



Origins of the GreenScreen™

State governments seek to identify safer, functional alternatives



USEPA DFE chemical alternatives assessment partnerships

Volume 1

Furniture Flame Retardancy Partnership: Environmental Profiles of Chemical Flame-Retardant Alternatives for Low-Density Polyurethane Foam







Builds on the USEPA Design for the Environment Approach: Hallmark of CHA



But how do I know which one is better?

	Table	e 4-1	s	cree	enin	g L	eve	l To	oxic	ology	and I	Exposu	e Sum	nar	y					
М ¹ Н =	= Moderate hazard concern	N = No Y = Yes P = Yes stimateo	for I val	ues		prot	fess			▲ Igmer	Persist		adation	prod ation	ucts e ships)	xpect				
1		tion ³	Ţ	ar		al							tion		Worke	ſ		enera pulatio		
Company	Chemical	% in Formulation ³	Cancer Hazard	Skin Sensitizer	Reproductive	Developmental	Neurological	Systemic	Genotoxicity	Acute	Chronic	Persistence	Bioaccumulation	Inhalation	Demal	Ingestion	Inhalation	Dermal	Ingestion	Aquatic
Albemarle	ANTIBLAZE 180 and ANTIBLAZE 195																			
	Tris(1,3-dichloro-2-propyl)Phosphate CAS # 13674-87-8	95%	м	L	М	м	L	м	М	м	М	м	L	N	Y	Y	N	Υ	Y	Υ
Albemarle	ANTIBLAZE 182 and ANTIBLAZE 205			Ì			ĺ		ĺ	1								1		
	Proprietary A Chloroalkyl phosphate (1)		М	L	М	М	L	М	М	М	М	М	L	Ν	Y	Y	N	Υ	Y	Υ
1	Proprietary B Aryl phosphate		L	L	M *	M *	М	M *	L	н	H	L	М	Ν	Y	Y	N	Y	N	Ν
1	Triphenyl Phosphate CAS # 115-86-6		L	L	L	L	L	М	L	н	Н	L	L	Y	Y	Y	Y	Y	Y	Υ
Albemarle	ANTIBLAZE V500		1		1	1	1	1	1	1			1				Ì			
	Proprietary C Chloroalkyl phosphate (2)		M	М	M^*	M^*	L	М	L	Μ	M	M	L	Ν	Y	Y	N	Y	Y	Υ
	Proprietary B Aryl phosphate		L	L	M *	M *	Μ	M *	L	н	H	L	M	Ν	Y	Y	Ν	Υ	Ν	Ν
	Triphenyl Phosphate CAS # 115-86-6		L	L	L	L	L	М	L	н	H	L	L	Y	Y	Y	Y	Υ	Y	Υ
Albemarle	SAYTEX RX-8500]										
	Proprietary D Reactive brominated flame retardant		L	М	L	L	М	М	L	М	М	L▲	L	N	Y	Y	Ν	Ν	Y	Υ
1	Proprietary B Aryl phosphate		L	L	M *	M*	Μ	M *	L	н	H	L	M	Ν	Y	Y	Ν	Υ	Ν	Ν
	Triphenyl Phosphate CAS # 115-86-6		L	L	L	L	L	М	L	н	H	L	L	Υ	Y	Y	Y	Υ	Υ	Υ

USEPA DfE cannot offer scoring-GreenScreen provides decision logic





How to do a GreenScreen™ Assessment

1. Assess and classify hazards

- 2. Apply the Benchmarks
- 3. Make informed decisions





18 Hazard Endpoints

Human Health Group I	Human Health Group II and 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	Skin Sensitization	Persistence	
Toxicity	Respiratory Sensitization	reisisteriee	
Endocrine Activity	Skin Irritation	Bioaccumulation	
	Eye Irritation		



GreenScreen[™] Criteria Example 1 - Carcinogenicity (C)

Information type	Information Source	High (H)	Moderate (M)	Low (L)
Data	GHS Category	1A (Known) or 1B (Presumed) for any route of exposure	2 (Suspected) for any route of exposure or limited or marginal evidence of carcinogenicity in animals	Adequate data available, and negative studies, no structural alerts, and GHS not classified.
	EPA-C (1986)	Group A, B1 or B2	Group C	Group E
A sample of	EPA-C (1996, 1999, 2005)	Known or Likely		Not Likely
A Lists	IARC	Group 1 or 2A	Group 2B	Group 4
	California Prop 65	Known to the state to cause cancer		



Where Do the Hazard Endpoints and Criteria Come From?

Source of GreenScreen Hazard Endpoints:

- GHS/CLP Globally Harmonized System of Classification and Labeling of Chemicals (United Nations)
- OECD Screening Information Data Sets (SIDS) and test methods
- USEPA Design for the Environment Program (DfE) Alternatives Assessment Criteria for Hazard Evaluation
- USEPA New Chemicals Program and test methods
- Others; eg. Candian DSL





Assess & Classify Hazards



- Literature review
- Test Data
- Analogs/Surrogates
- Q/SAR Models
- Hazard Lists



Assess & Classify Hazards: Final Product --Documented Findings & Conclusions

Mutagenicity/Genotoxicity (M) Score (H, M or L): M

Vinyl acetate was assigned a score of Moderate for mutagenicity based on classification as a GHS Category 2 germ cell mutagen, due to positive *in vitro*, and weakly positive *in vivo* assays.

- In vitro Several Ames bacterial reverse mutation assays (GLP-compliance not reported; only one study was identified as following OECD 471 Guidelines) were identified utilizing Salmonella typhimurium tester strains TA 97, TA98, TA100, TA102, TA1530, TA1535 and TA1537 with and without metabolic activation (concentrations not reported). Vinyl acetate was determined to be negative for mutagenicity under all tested conditions (ESIS 2000).
- In vitro Several cytogenetic assays (GLP-compliance and method not reported) were identified utilizing human lymphocytes and Chinese Hamster Ovary (CHO) cells with and without metabolic activation (concentrations not reported). Vinyl acetate (purity not reported) tested positive for clastogenicity in human lymphocytes and CHO cells under tested conditions (ESIS 2000).
- In vitro A mouse lymphoma assay was conducted (GLP-compliance and method not reported) utilizing L5178Y cells without metabolic activation (concentration not reported). Vinyl acetate (purity not reported) was found to be positive for mutagenicity under the tested conditions (ESIS 2000).
- In vitro A micronucleus assay (GLP-compliance not reported; high content cytotoxicity method developed by Litton Laboratories) was conducted utilizing human TK6 cells without metabolic activation at concentrations of 0, 0.001, 0.005, 0.01, 0.05, 0.25, 0.5, 1.0 and 2.0 mM of vinyl acetate (purity not reported). Increased incidences of micronucleated events occurred at concentrations of 0, 5 to 2.0 mM of vinyl acetate in a dose-dependent manner.



Populate Hazard Summary Table with Hazard Classification Levels

	Green Screen Hazard Ratings																		
	Group I Human Group II and II* Human Ecotox Fate											Phy	sical						
Carcinogenicity	Mutagenicity	Reproductive Toxicity	Developmental Toxicity	Endocrine Activity	Acute Toxicity	: - - - -	systemic loxicity		Neurotoxicity	Skin Sensitization*	Respiratory Sensitization*	Skin Irritation	Eye Irritation	Acute Aquatic Toxicity	Chronic Aquatic Toxicity	Persistence	Bioaccumulation	Reactivity	Flammability
						single	repeated	single	repeated	*	*								
L	L	L	М	М	L	L	L	vH	н	L	L	L	L	н	н	vL	L	М	L

Level of Concern:

- vH = very High
- H = High
- M = Moderate

- L = Low
- vL = very Low
- DG = Data Gap



Populate Hazard Summary Table ... and with Levels of Confidence

	Green Screen Hazard Ratings																		
Group I Human Group II and II* Human Ecotox Fate										te	Physical								
Carcinogenicity	Mutagenicity	Reproductive Toxicity	Developmental Toxicity	Endocrine Activity	Acute Toxicity	Systemic Toxicity Neurotoxicity Neurotoxicity Skin Sensitization* Skin Sensitization* Skin Irritation Skin Irritation Skin Irritation Skin Irritation Chronic Aquatic Toxicity Chronic Aquatic Toxicity Persistence								Bioaccumulation	Reactivity	Flammability			
						single repeated single repeat					*								
L	L	L	М	М	L	L L VH H L L L L H H VL L M L													

Level of Concern:

- vH = very High
- H = High
- M = Moderate

- L = Low
- vL = very Low
- DG = Data Gap

Level of Confidence:

- Bold = High confidence
- Italics = Low confidence



Optional Hazard Summary Table: Make Exposure Route Transparent

Example of a GreenScreen[™] that incorporates route of exposure in ٠ benchmark score: potassium permanganate ($KMnO_4$)

		F 1	gure	e 1:	G	reen	Scree	n Ha	zard	Ratings	s Ior F	otass	lum	Pern	nang	anat	e			
	G	Frou	οIΗ	umai	n			G	roup II	and II* H	uman				Eco	otox	tox Fate		Physical	
Route of Exposure	С	м	R	D	E	AT		ST		Ν	SnS*	SnR*	IrS	IrE	AA	CA	Р	в	Rx	F
							single	repeated*	single	repeated*										
Inhalation	L		м	м		DG	DG	м	DG	н										
Oral	L	L	м	H	м	м	vH	М	DG	н	L	DG	vH	vH	vH	н	L	vL	н	L
Dermal	L		L	М		L	н	М	DG	DG										

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated values and lower confidence. Hazard levels in BOLD font reflect values based on test data (See Guidance). Please see Appendix A for a glossary of hazard acronyms.

Thank you to Dr. Margaret Whittaker for use of this slide



Fumed Nano Silica (DRAFT only)



The scope of this GreenScreen is intentionally restricted to use of fumed silica as a flow agent in foods and powders.

Rating³: Nano fumed silica was assigned a Benchmark Score of 4 based on low bioavailability, and general lack of toxicity in animal studies and with human experience.

					Gree	nScr	een™	Haza	ard R	ating	s: Na	no fu	med s	silica					
Group I Human				Group II and II* Human									Eco	otox	Fate Phys al			•	
						S	Т	1	N										
с	Μ	R	D	E	AT	Sing le	Rep eate d*	Sing le	Rep eate d*	Sn S*	Sn R*	IrS	IrE	A A	C A	Р	в	R X	F
Lo		Lo	Lo		Lo	Lo	Lo	Lo	Lo										
L _d	L	L _d	L_{d}	L	L _d	L _d	L_{d}	L _d	L _d	L	L	L	L	L	L	vH	L	L	L
Li		Li	L		Li	L	L	L	L										

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated values and lower confidence. Hazard levels in **BOLD** font reflect values based on test data (See Guidance).



How to do a GreenScreen™ Assessment

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3. Make informed decisions





Step 2: Apply the Benchmarks to the Hazard **Classifications**

ABBREVIATIONS

- P Persistence B Bioaccumulation
- T Human Toxicity and Ecotoxicity



Low P* + Low B + Low T (Ecotoxicity, Group I, II and II* Human) + Low Physical Hazards (Flammability and Reactivity) + Low (additional ecotoxicity endpoints when available)

Prefer—Safer Chemical

BENCHMARK 3

This

passes

all of the

criteria.

- Moderate P or Moderate B
- Moderate Ecotoxicity
- c. Moderate T (Group II or II* Human)
- d. Moderate Flammability or Moderate Reactivity

Use but Still Opportunity for Improvement

BENCHMARK 2

- a. Moderate P + Moderate B + Moderate T (Ecotoxicity or Group I, II, or II* Human)
- b. High P + High B
- c. High P + Moderate T (Ecotoxicity or Group I, II, or II* Human)
- d. High B + Moderate T (Ecotoxicity or Group I, II, or II* Human)
- e. Moderate T (Group I Human)
- f. Very High T (Ecotoxicity or Group II Human) or High T (Group II* Human)
- q. High Flammability or High Reactivity

Use but Search for Safer Substitutes

BENCHMARK 1

- PBT = High P + High B + (very High T (Ecotoxicity or Group II Human) or High T (Group I or II* Human)]
- b. vPvB = very High P + very High B
- c. vPT = very High P + [very High T (Ecotoxicity or Group II Human) or High T (Group I or II* Human)]
- d. vBT = very High B + [very High T (Ecotoxicity or Group II Human) or High T (Group I or II* Human)]
- e. High T (Group I Human)

Avoid—Chemical of High Concern



If this chemical and its breakdown products pass all of these criteria. then move on to Benchmark 2.

If this chemical and its breakdown products pass all of these criteria, then move on to Benchmark 4.



Benchmark U = Undetermined due to insufficient data

Aligned with -**Regulatory Drivers**







GreenScreen[®] Inspector™ at www.toxservices.com





How to do a GreenScreen Assessment

1. Assess and classify hazards

2. Apply the Benchmarks







Value of Benchmark Score

Results can be presented as a simple 1-4

score that supports taking action:

- BM1 avoid/phase out
- BM2 manage to use safely
- BM3 getting there
- BM4 inherently low hazard





Value of Benchmark Score

- Scores can be used without <u>toxicology</u> <u>training</u>
- Drives wider adoption of preferred materials
 - Preferred materials/positive list
 - -Guide new product development
 - Drives innovation of new materials









- 1. Support State Alternatives Assessment Regulations
 - Interstate Chemicals Clearinghouse
 - IC2 AA Guidance
 - Website/database of GS assessments
 - ME Safer Chemicals in Children's products; WA; CA DTSC....
- 2. **Materials Procurement -
 - Identify chemicals of concern **and** safer alternatives
 - E.g. Hewlett Packard approved materials list; mandatory for HP suppliers providing potential replacements



Applications for GreenScreen/CHA



3. Product Development

- New formulations
 - E.g., Green Chemistry and Commerce Council consortium to evaluate alternative plasticizers for wire and cable applications
- New chemicals
 - EU PINFA pilot to identify inherently lower hazard non-halogenated flame retardants

4. Corporate Policies

- Manage chemical inventories
 - E.g. Staples corporate policy,
 - HP corporate policy
 - Nike corporate sustainability report



Applications for GreenScreen/CHA



- 5. **Standards, Scorecards and Ecolabels
 - USGBC LEED v4
 - Health Product Declaration
 - MOU with C2C Product Innovation Institute
 - BizNGO Guide to Safer Chemicals

HP is the world's leading practitioner of the GreenScreenTM 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 hazardbased assessment framework developed by the NGO Clean Production Action."

HP's Global Citizens Report





Choosing Better Materials

- Replacing materials is expensive
 - Want to select alternatives that won't be restricted in the future
- Replacements should have lower environmental impact
 - Want to avoid unintended consequences
 - Want to identify preferable materials (not just minimally acceptable)







HP Uses GreenScreen to Choose Alternatives to Substances of Concern

- Select alternatives that won't be restricted in the future
 - E.g., Low toxicity
- Articulate materials goals to suppliers
 - Not simply saying what HP doesn't want
 - Defining what HP does want in its products

Common Name	CAS #	Full Name	Benchmark
Preferred			
Design	none	Design material out, dematerialize	4
Substance 0	######-##	Chemical name	4
Use but still opportunity for improve	ment		
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





PVC-Free Power Cord Green Screen Program

- Screening mandatory, in addition to all standard and regulatory requirements
- Full disclosure under CDA
- Over 30 materials screened
 - Several approved
- 100% of PVC-free power cords have been screened





Ongoing

- Bringing more material types into program
- Promoting the use of the GreenScreen within the electronics industry and with formulators as a common tool
- Helping to incorporate GreenScreen ratings into ecolabels
- Helping with infrastructure to enable screening and sharing of results







US Green Building Council LEED v4 Materials & Resources -- MRc4 Credit

MRc4: Building Product Disclosure and Optimization – material ingredients (July 2012) – may earn credit for either or both

- Option 1. Material Ingredient Reporting (disclosure)
 - Health Product Declaration (which uses GreenScreen List Translator)
 - Manufacturer disclosure with GreenScreen assessments of chemicals not disclosed
- Option 2. Material Ingredient Optimization
 - Products that have fully inventoried chemical ingredients to 100 ppm that have no Benchmark 1 hazards
 - Use GreenScreen List Translator (100% of cost)
 - Use full GreenScreen method (150% of cost)





GreenScreen Program Developments

1. GS v1.2 FINAL Guidance – 9/11/2013

Go to: http://www.cleanproduction.org/Greenscreen.v1-2.php

- 2. Licensed GS Profilers
- 3. GS Certified Practitioners
- 4. Verification Program
- 5. Automation of the GS List Translator
- 6. GreenScreen for nanomaterials



Licensed GreenScreen Profilers Perform GS Assessments as a Service to Clients

Demonstrate expertise, knowledge, competency and capacity

Margaret H. Whittaker, Ph.D., M.P.H., E.R.T., D.A.B.T., UK/EU

ToxServices LLC

www.toxservices.com

Teresa L. McGrath, Supervising Toxicologist NSF International <u>www.nsf.org</u>

NSF Sustainability

Patricia Beattie, PhD, DABT SciVera LLC <u>www.scivera.com/services.php</u>







Certified Practitioner (CP) Training Program

- Individuals in organizations become certified to perform GS assessments for their organization

 Eligible to submit GS assessments for verification
- Requirements include:
 - One day workshop (i.e. IN Training in Sept 2013)
 - Advanced GS Topics (available via webinars)
 - Practicum: perform 2 GS assessments with coaching by a GS Trainer
- Pilot underway, program to launch Q1 2014

GS Verification Program

Self assess chemicals for your organization using the GS as a Certified Practitioner (CP)

- OR -

Verify NON VERIFIED GS Assessment via GS Verification Program

Generate NON VERIFIED GS assessment; May NOT use GS trademarks to make public product claims

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PROFIL

CHEMICA

VERIFICATION

COMMUNICATION

May use GS trademarks to claim verified product scores via license agreement Generate NON VERIFIED GS assessment; May NOT use GS trademarks to make public product claims

Engage licensed GS

Profiler to assess

chemicals using the GS



Automation of the GS List Translator: Software Partners

Healthy Building Network via Pharos (NGO)

The Wercs via GreenWERCS (for profit)

CAS RN: 115-07-1	← → ← ← ← ← ← ← ← ← ← ← ← ← ← ← ← ←	Q• Google lock and impacts Pandora Rad New Musi
Detailed Direct Hazard Listings	All Verce Authoring Management Distribution System Window Help Jokuwa Werce GreenScreep List Translator Tool	The Grees
FLAMMABLE EC - CLP/GHS Hazard Statements (EU H-Statements) H220 Extremely flammable gas GreenScreen Benchmark Unspecified - occupational haz	d only - HPD	Sample Hazardous Mixture
CANCER. Intri Agency for Rsrch on Cancer - Cancer Monographs (IARC) Group 3: Agent is not classifiable as to its carcinogenicity to humans - GreenScreen Ben Unspecified		III View Last Published Assess an Ecotox. Fate Physical
EXEMPT Cerman FEA - Substances Hazardous to Waters (VwVwS) Non-Hazardous to Water (Water Hazard Class 0 NWG)	Chemical Sample Hazardoos Mixture (1000164)	city-Repeat Exp anter Thicky (AV) Voate Thicky (CV) Voate Thicky (CV) Voate (T)
Life Cycle Research	% Fermu % Fermu bar handless Munigen M	Neurotox Acute Aq Chronic / Pensister Bioaccur Reactivity
Research Status: No life cycle research started	Add/Edit Chemical Chemical Chemical Formulation Duioto Ethylene dichloride (107-06-2) Supporting Documentation 2 LT-1 H M H H H H	
The Pharos team has not yet researched the life cycle of this substance and has no information about chemi-		VH
that may be associated with its life cycle.	Duiste Ethylene glycol dimethyl ether (110-71-4) Supporting Documentation 2 LT-1 H H H M M	L or M or H or vH
	Dates Harachlorobenzene (118-74-1) Supporting Documentation 1 LT-1 H H MorH H MorH H MorH H	Mor H or vH VH H or vH VH
Description: Major uses: In polymerized form as polypropylene for plastics and carpet fibers. Chemical intermed	Delate transaction Decementation	
		H or vH
manufacture of acetone, isopropylbenzene, isopropanol, isopropyl halides, propylene oxide, acrylonitrile, cum		VH IIIIIIII
from petroleum oils during the refining of gasoline. Catalytic or thermal cracking of hydrocarbons always yield		VH
Can be obtained by catalytic dehydrogenation of propane.	Delete 1-Butanesufforic acid, 1,1,2,3,3,4,4-enonafluoro-, potassium salt (29420- 49-5-3) Supporting Documentation	
[O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. 13th Edition, White		
NJ: Merck and Co., Inc., 2001., p. 1404-1405]	Delete Butanoic acid, heptafluoro- (375-22-4) Supporting Documentation 1 LT-U	
the metric and responses in the second	Delete 1-Hexanesulforic acid, 1,1,2,2,3,3,4,5,5,6,6,6-tridecafluoro-, potassium sait 1 (3871-96-6) Supporting Documentation	
VOC designation: VVOC (Boiling point: -48 degrees Celsius) 😡	- Refresh 🖡 Hotes	😑 Back 🔳 Preview Assessment 🗹 Assessment 0



What GreenScreen List Translator Is

- Automated hazard list search tool that translates authoritative lists into GreenScreen criteria
- Identifies known "bad actor" chemicals using lists

 GreenScreen Benchmark
 1 chemicals





What the GreenScreen List Translator Isn't

- It does NOT include an assessment of data
- It does NOT represent a comprehensive review
- It does NOT review transformation products
- It does NOT identify safer chemicals – need to perform full GreenScreen assessment





The GreenScreen[™] Tools



- Full GreenScreen
 - Systematic evaluation of chemical based on 18 hazard endpoints
 - Identifies inherently safer chemicals
 - Requires technical expertise
 - Best to use licensed profiler

GreenScreen List Translator

- Readily identifies Benchmark 1 chemicals
- Based on authoritative lists
- Doesn't require toxicology expertise



"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



Contact Info

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