Life Cycle Thinking for Sustainable Technologies

P2 though Nanotechnology Conference
Washington DC

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Green Blue Institute (GreenBlue)
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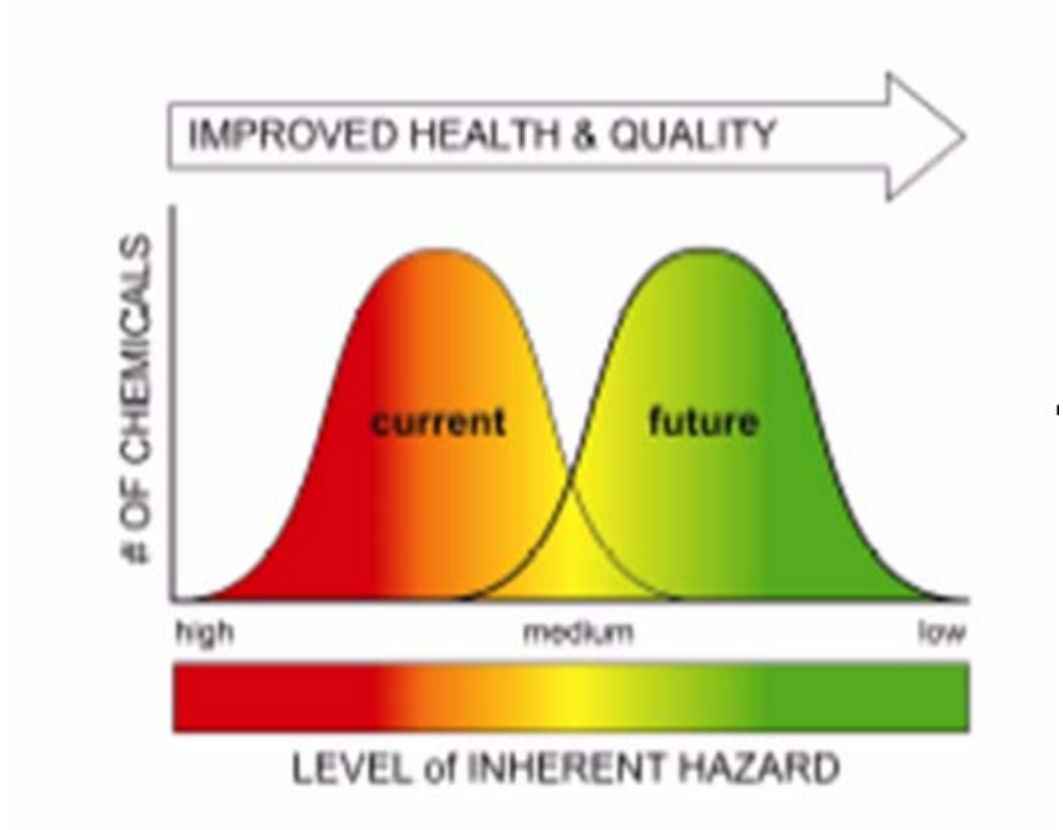
A Goal of Green Chemistry



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What is a Sustainable Product?

‘Cradle to Cradle’ Design

- **Meets market requirements**
- **Positive social effects (for individuals and communities)**
- **Safe for human and ecological health**
- **Sourced from renewable or repeatedly recycled materials**
- **Sourced from renewable energy**
- **Designed for safe, productive return to nature or industry**
- **Recovered and recycled at highest quality after use**

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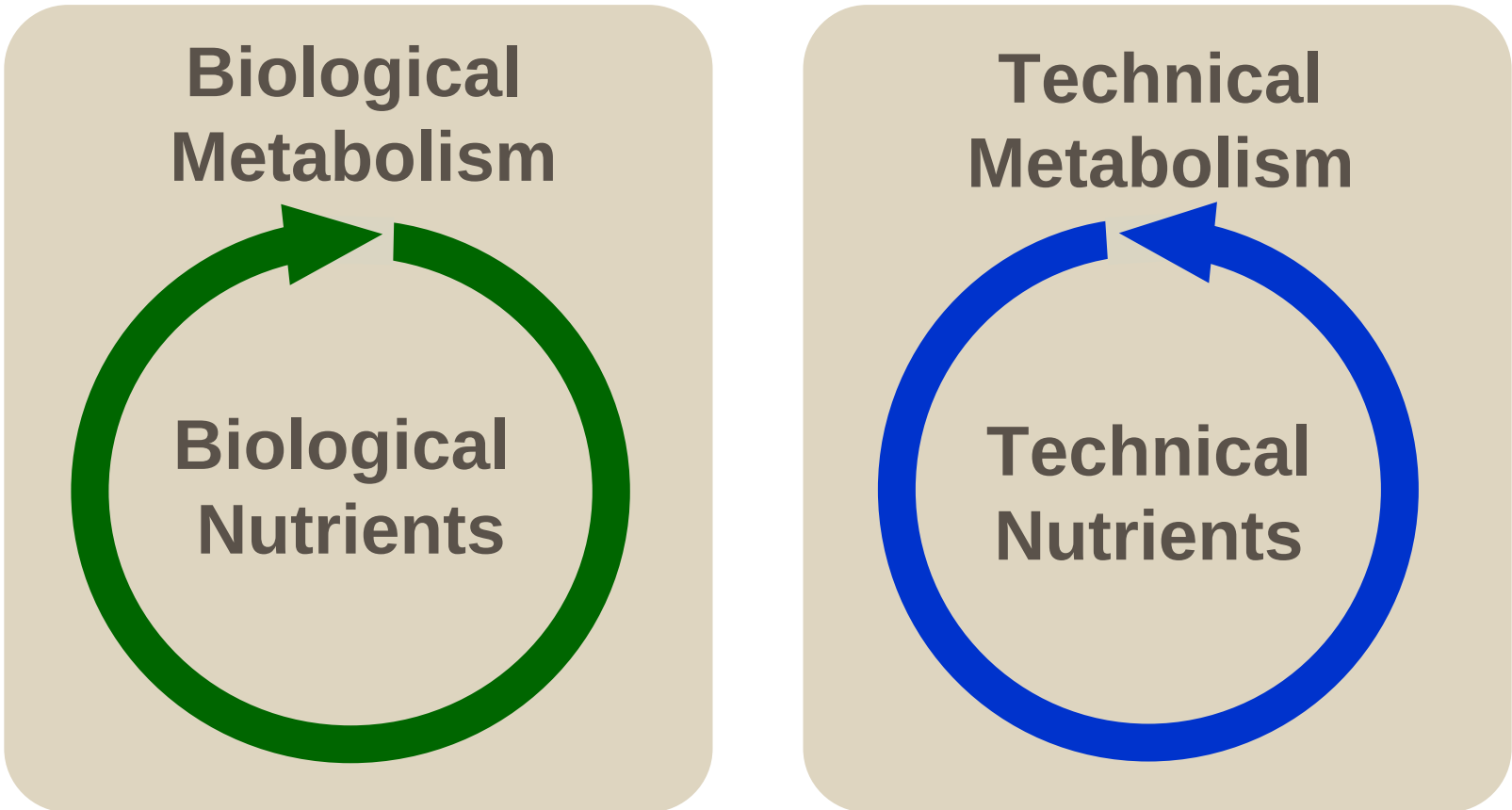
Design for Metabolisms



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NGO Views

Choosing Environmentally Preferable Food Service Ware

Reusable and Sustainable Biobased Products

Health Care Without Harm

Table 1- Baseline Sustainability Criteria for "Preferred" Biobased Products

Criteria	Rationale
1. 100 percent biobased carbon content: no fossil fuel-based materials used in product including coatings	Most biobased food service ware marketed today do not contain fossil fuel based content, though some paper and fiber products are coated with plastic. It is possible to produce food service ware with 100 percent biobased carbon content including coatings.
2. No highly hazardous additives, including both additives mixed into the product and surface treatments: ▪ No persistent, bioaccumulative, toxics (PBTs) ▪ No carcinogens ▪ No reproductive/developmental toxicants ▪ No organohalogen-based chemicals (bromine, chlorine, fluorine or iodine)[1] ▪ No endocrine disruptors *See Resources section for reference chemical lists.	Many chemicals are approved for use as additives in food service ware to achieve certain properties such as heat, water and grease resistance. Some of these chemicals are considered highly hazardous-they have the potential to be released into the environment via manufacture, use and disposal and scientific data tests show that they persist in the environment, bioaccumulate in animals or humans and/or are toxic to animals or humans.
3. No engineered nanomaterials[ii] added	The behavior and characteristics of nanoparticles in materials and living organisms is often unique and unpredictable. To date nanomaterials have not been subject to thorough testing for risks to human health and the environment. Until nanomaterials are subject to comprehensive hazard and exposure assessments that include evaluations of their behavior in the environment, how people and wildlife may be exposed, persistence, bioaccumulation and toxicity, we recommend against their use in biobased materials.

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Principles and Keys to Success

- Trust is critical to success. In order to engender trust, the nanotech industry will need to provide and demonstrate:
  - **Data**
    - Make the investment ($)
    - Focus on providing hazard and exposure information – not risk assessment
    - Apply life cycle thinking
  - **Transparency**
    - Labeling?
  - **Self regulation and/or third party verification, e.g.,**
    - Code of ethics – standardized, enforceable and ambitious
    - DfE Partnership
  - **Commitment to continual improvement**

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Challenge: Comparative Hazard and Exposure Assessment Across the Life Cycle

Manufacture

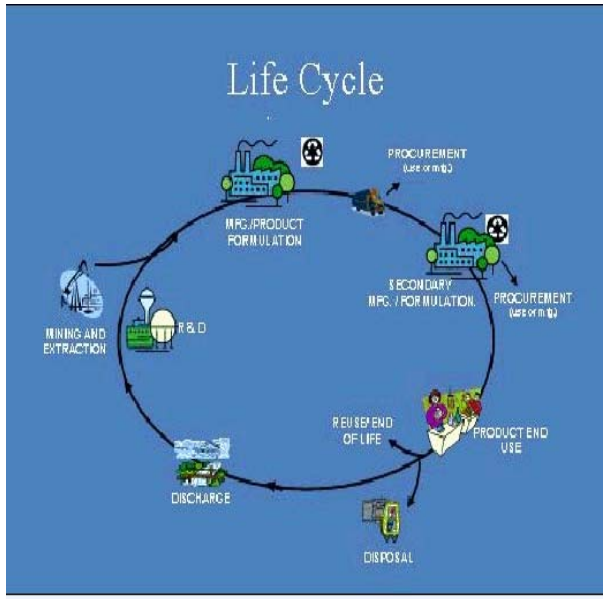
- Hazards associated with chemical via direct exposure during manufacture

Use

- Hazards associated with use of product with chemical reacted or added in

End of product

- Hazards associated with chemical at end of life/new life (i.e. discharge to environmental media (air, water, land), combustion, landfill, compost, litter or recycle)



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Models to Support Success – Non Regulatory

- The **US EPA Design for the Environment (DfE)** Projects and Related Initiatives
    - Formulator Program
    - CleanGredients™
    - Flame Retardancy Partnerships
        - Furniture Flame Retardancy Partnership
        - Flame Retardants in Printed Circuit Boards
- Codes of Ethics/Practice

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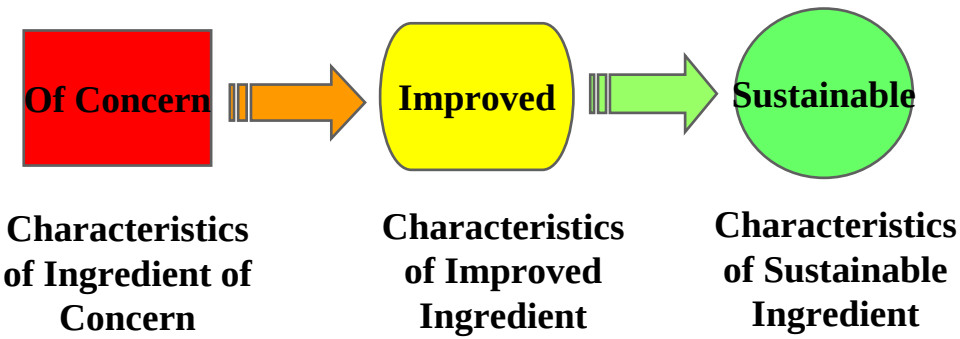
The DfE Formulator Program –
Market Recognition

When you see the DfE logo on a product, what does it mean?

It means that the DfE technical workgroup has screened each ingredient in the product for potential human health and environmental effects and that—based on currently available information, predictive models, and expert judgment—the product contains only those ingredients that pose the least concern among chemicals in their class.



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Green(er) Chemistry in the Supply Chain –
www.cleangredients.org

A database of Industrial & Institutional (I&I) cleaning product ingredients and their characteristics* to:

- **help formulators identify ingredients that may be useful for green product formulation**
- **provide opportunity for raw material suppliers to showcase their ingredients with especially positive environmental and/or human health and safety attributes**

*** By *characteristics* we mean functional properties such as critical micelle concentration, physical properties such as biodegradability, and associated human and environmental health toxicological information.**

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Information to Support Decision Making –

Furniture Flame Retardancy Partnership Table 4-1

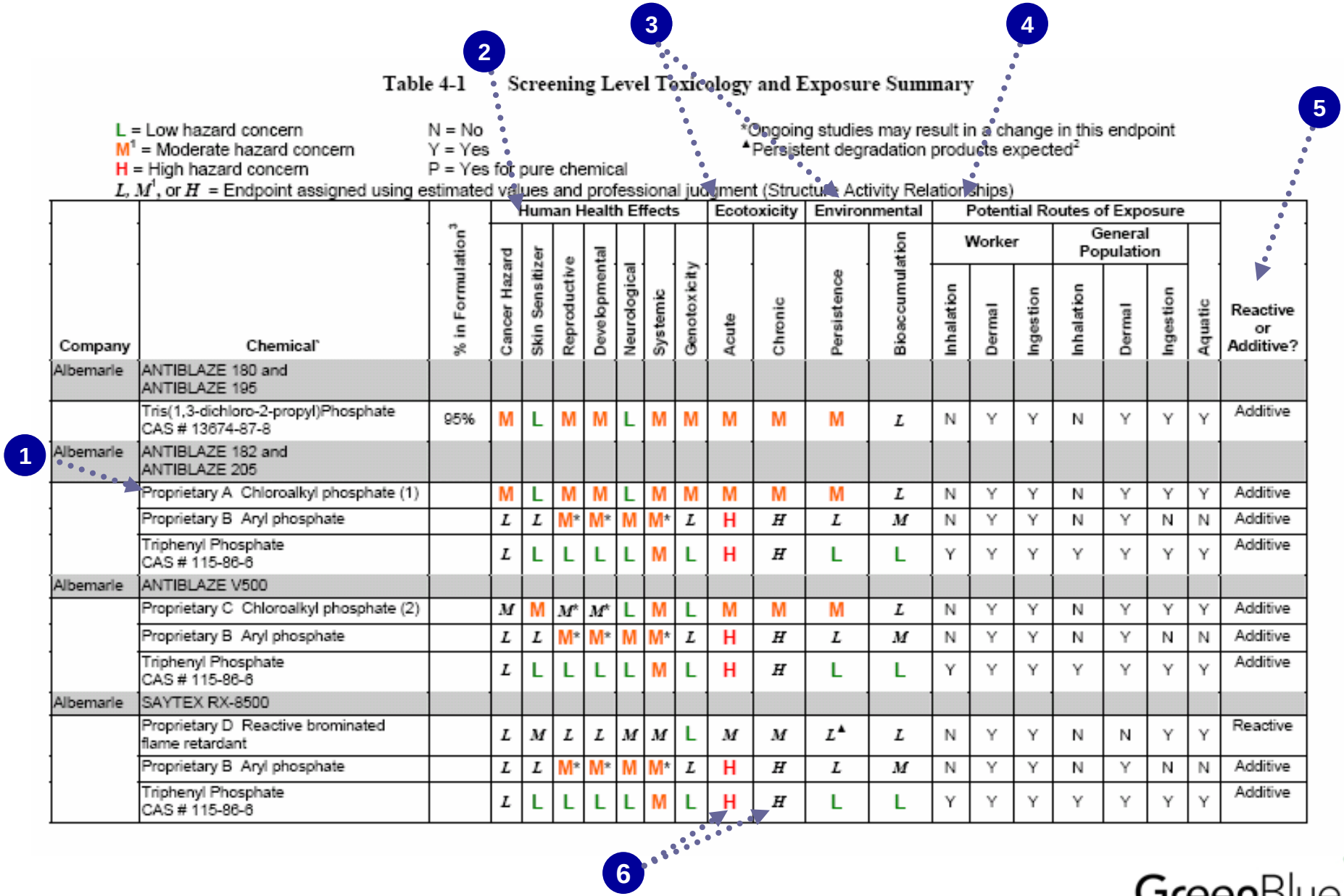

Table 4-1 Screening Level Toxicology and Exposure Summary

L = Low hazard concern
M[1] = Moderate hazard concern
H = High hazard concern
L, M[1], or H = Endpoint assigned using estimated values and professional judgment (Structure Activity Relationships)

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

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

Company	Chemical*	% in Formulation[3]	Human Health Effects							Ecotoxicity		Environmental		Potential Routes of Exposure							Reactive or Additive?
														Worker			General Population				
			Cancer Hazard	Skin Sensitizer	Reproductive	Developmental	Neurological	Systemic	Genotoxicity	Acute	Chronic	Persistence	Bioaccumulation	Inhalation	Dermal	Ingestion	Inhalation	Dermal	Ingestion	Aquatic	
Albemarle	ANTIBLAZE 180 and ANTIBLAZE 195																				
	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	Additive
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	Additive
	Proprietary B Aryl phosphate		L	L	M*	M*	M	M*	L	H	H	L	M	N	Y	Y	N	Y	N	N	Additive
	Triphenyl Phosphate CAS # 115-86-6		L	L	L	L	L	M	L	H	H	L	L	Y	Y	Y	Y	Y	Y	Y	Additive
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	Additive
	Proprietary B Aryl phosphate		L	L	M*	M*	M	M*	L	H	H	L	M	N	Y	Y	N	Y	N	N	Additive
	Triphenyl Phosphate CAS # 115-86-6		L	L	L	L	L	M	L	H	H	L	L	Y	Y	Y	Y	Y	Y	Y	Additive
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	Reactive
	Proprietary B Aryl phosphate		L	L	M*	M*	M	M*	L	H	H	L	M	N	Y	Y	N	Y	N	N	Additive
	Triphenyl Phosphate CAS # 115-86-6		L	L	L	L	L	M	L	H	H	L	L	Y	Y	Y	Y	Y	Y	Y	Additive

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END

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