Alternatives Assessment

New Tools for Safer Chemicals

Ken Geiser
Lowell Center for Sustainable Production

November 30, 2011

What is Alternatives Assessment?

Alternatives Assessment is a process for identifying and comparing potential chemical and non-chemical alternatives that can be used as substitutes to replace chemicals or technologies of high concern.

Goals –

- Reduce risk by reducing hazard
- Encourage adoption of safer chemicals
- Avoid regrettable substitutions

Alternatives Assessment: Investing in Solutions rather than Problems

- Rather than focus on one bad option, we focus on choices and opportunities
- We move from problems to solutions

- We assure ourselves that the solutions we are advocating are preferable to the hazards we are replacing
- We encourage transparency and documentation

The Uses of Alternatives Assessment

- Industries can evaluate safer substitutes for chemicals of concern
- Governments can evaluate potential substitutes before restricting chemical uses

- Chemists and chemical engineers can select safer chemical processes and products in production processes

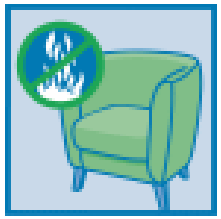
- Advocates can document safer alternatives to chemicals of public concern

US EPA, Design for Environment
Furniture Example

Human Health Hazard Concern

Ecotoxicity Hazard Concern

Environmental Concern



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	SAYTEX RZ-243																				
	Proprietary E Tetrabromophthalate diol diester		L	L	L*	L*	L	M*	L	L	H	L[?]	L	N	Y	Y	N	N	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
Ameribrom	FR513																				
	Tribromoneopentyl Alcohol CAS # 36483-57-5		M	L	M	M	M	M	M	M	M	L	L	Y	Y	Y	N	N	Y	Y	Reactive
Great Lakes	Firemaster 550																				
	Proprietary F Halogenated aryl ester		L	L	M	M	L	M	L	H	H	L[?]	L	N	Y	Y	N	Y	Y	Y	Additive
	Proprietary G Triaryl phosphate, isopropylated		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
	Proprietary H Halogenated aryl ester		L	L	M	M	L	M	L	H	H	L[?]	L	N	Y	Y	N	Y	Y	Y	Additive

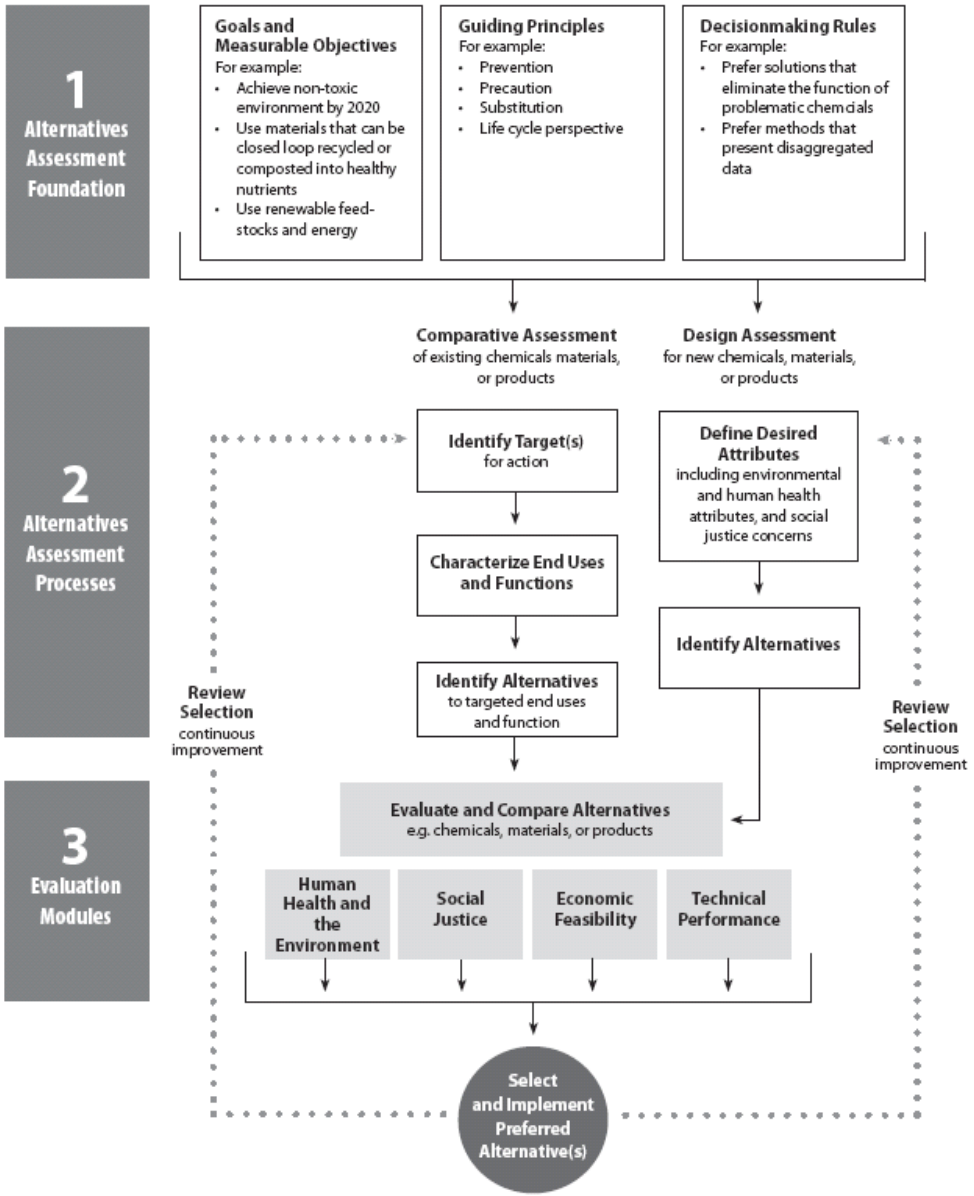
Lowell Center for Sustainable Production
UNIVERSITY OF MASSACHUSETTS

2004 Lowell Center convenes an International Workshop on Alternatives Assessment

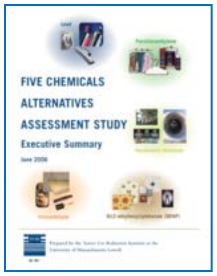
2006
Lowell Center publishes
An Alternative Assessment Framework

Three Parts

- The Foundation
- The Process
- The Modules



Massachusetts Toxics Use Reduction Institute's Five Chemical Alternatives Assessment



- 2005– Massachusetts Legislative sought a one year Alternatives Assessment on five chemicals of high concern
  - lead
  - perchloroethylene
  - formaldehyde
  - di (2-ethylhexyl) phthalate
  - hexavalent chromium

- The objective was to identify and assess alternatives in terms of cost, performance and health and environmental attributes

Steps in TURI's Five Chemical Alternatives Assessment

- **Step 1: Identify chemical uses**
- **Step 2: Prioritize chemical uses**
- **Step 3: Identify full range of alternatives**
- **Step 4: Screen alternatives**
- **Step 5: Prioritize alternatives for study**
- **Step 6: Conduct assessments**
  - technical (performance)
  - financial (costs)
  - environmental and health effects
- **Step 7: Display results**

Alternatives Assessment in REACH

2007 European Union's REACH Regulation came into force

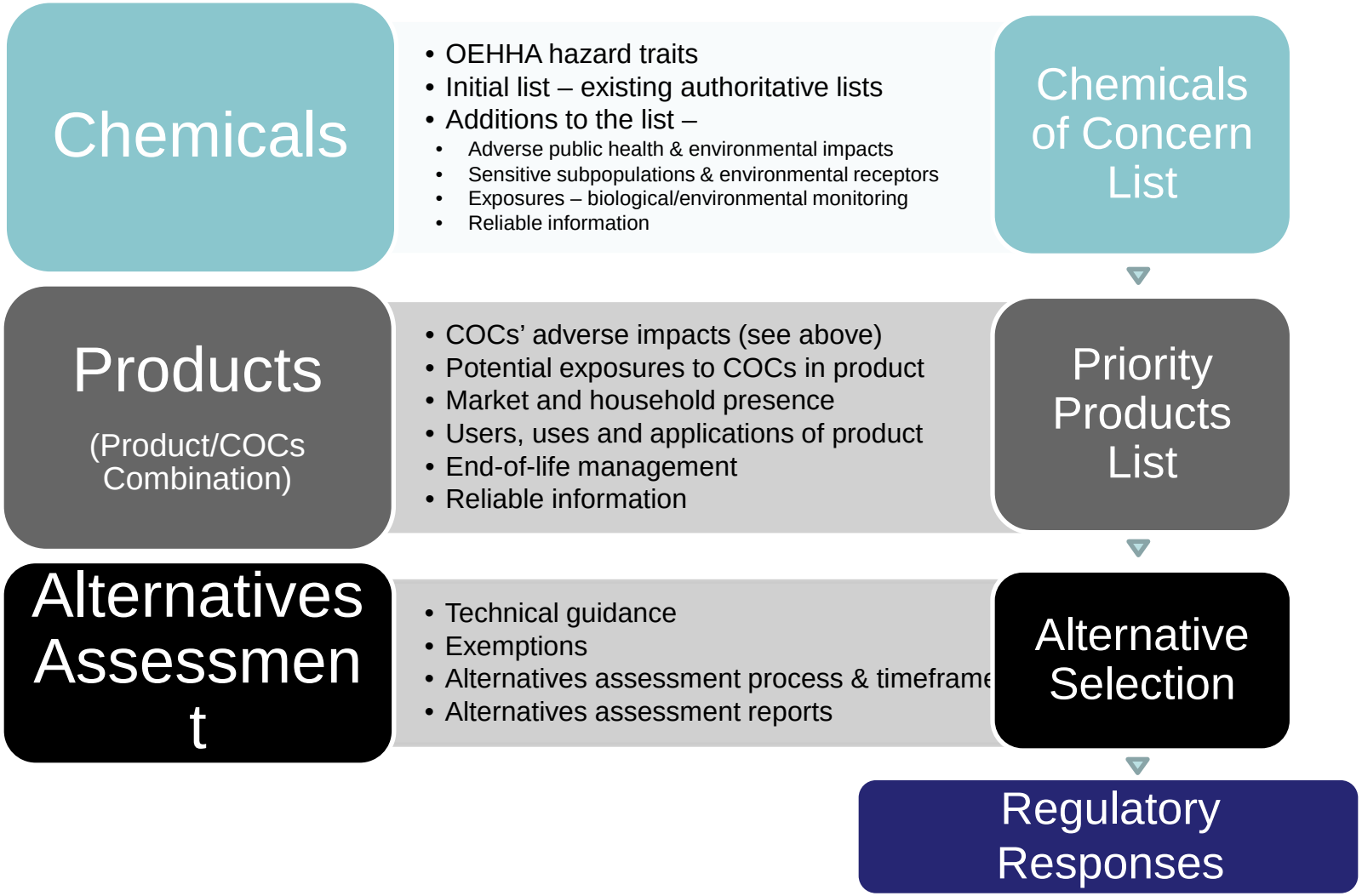
- Authorization requires that firms wishing to use Substances of Very High Concern (Annex XIII) that cannot be adequately controlled must assess suitable alternatives and, if suitable alternatives are available, may prepare a substitution plan.

- The European Chemicals Agency published Guidance on Alternatives Assessment for Restrictions (Annex XV) in 2007

Alternatives Assessment in the United Nations Stockholm Convention

2010 Stockholm Convention adopts an alternatives assessment process for screening chemicals to determine available alternatives before Annex listing

Alternatives Assessment in the California Safer Consumer Products Regulations, 2011

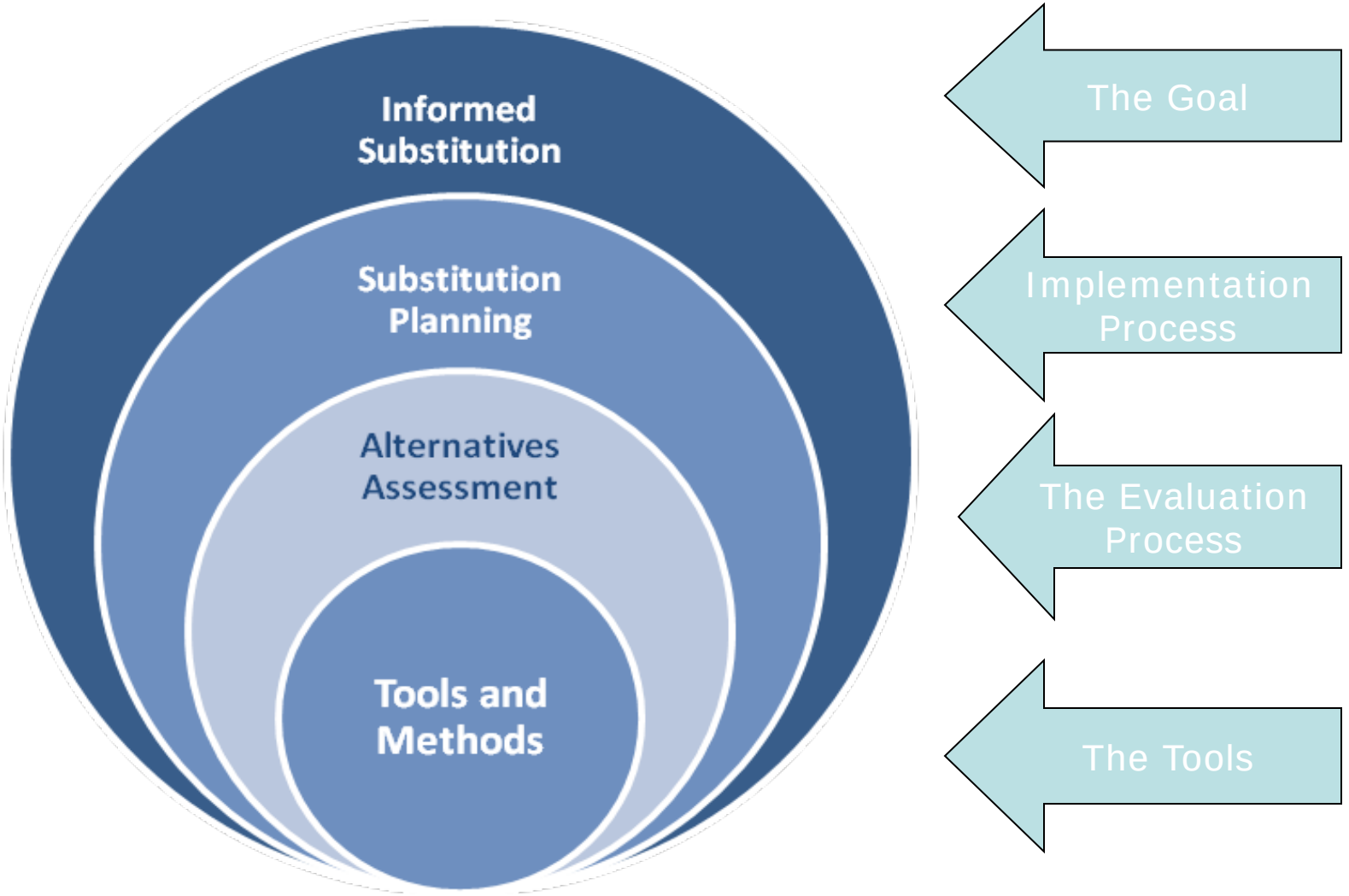


Alternatives Assessment: The Process

Alternatives Assessment is a step-defined process which may require several iterations

- Focus on function of chemical of concern
- Focus on substitution, process or product redesign
- Considers the “necessariness” of a chemical of concern

Conceptualizing Alternatives Assessment



Tools for Alternatives Assessment (Modules)

- Comparative Chemical Hazard Assessments
- Life Cycle Assessments *(Life Cycle Thinking)*
- Cost and Financial Assessments
- Technical Performance Assessments

- Social Impact Assessments
- Risk Assessments

Biz/NGO Alternatives Assessment Protocol

An iterative process to identify a small set of the least hazardous alternatives to chemicals of concern

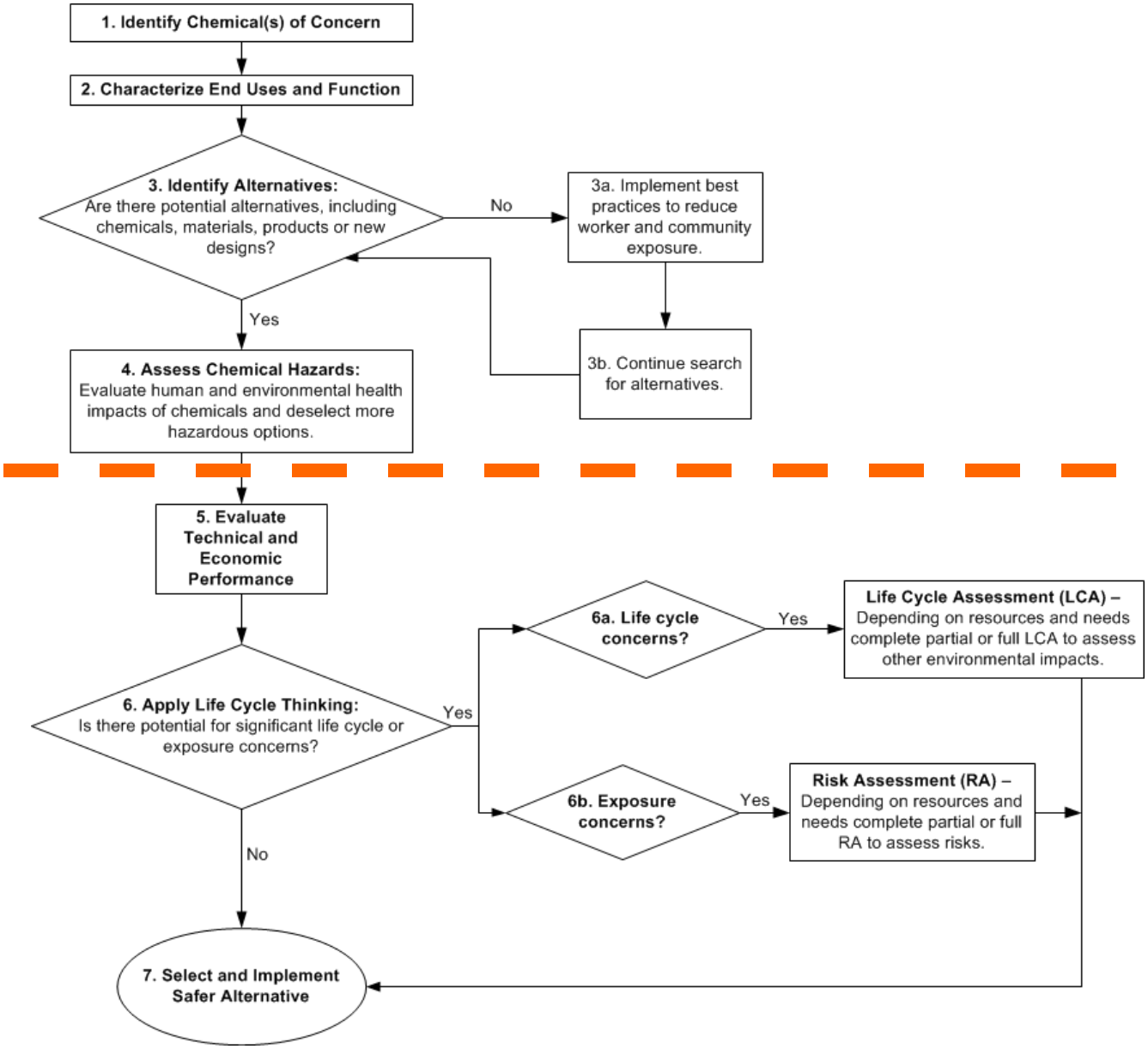
Developed with industry from an industry perspective

- based on a comparative chemical hazard assessment (CCHA)
- may include a life cycle assessment or risk assessment
- avoids trading off chemical hazard for other life cycle benefits

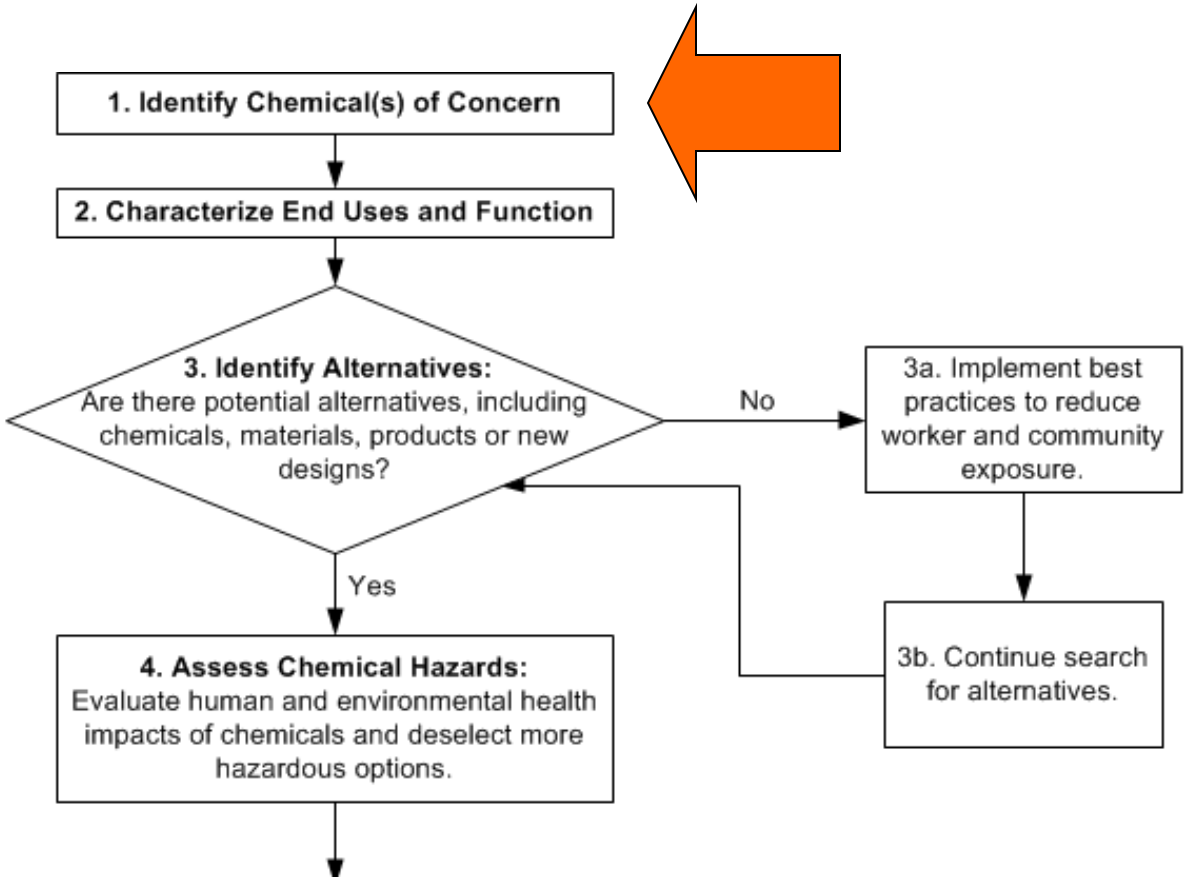
Employs a CCHA to identify a preferred alternative and follows with cost and performance assessments

If the preferred alternative proves impractical or cost prohibitive, then moves to the next (lower) preferred alternative

Seven Step Biz/NGO Alternatives Assessment

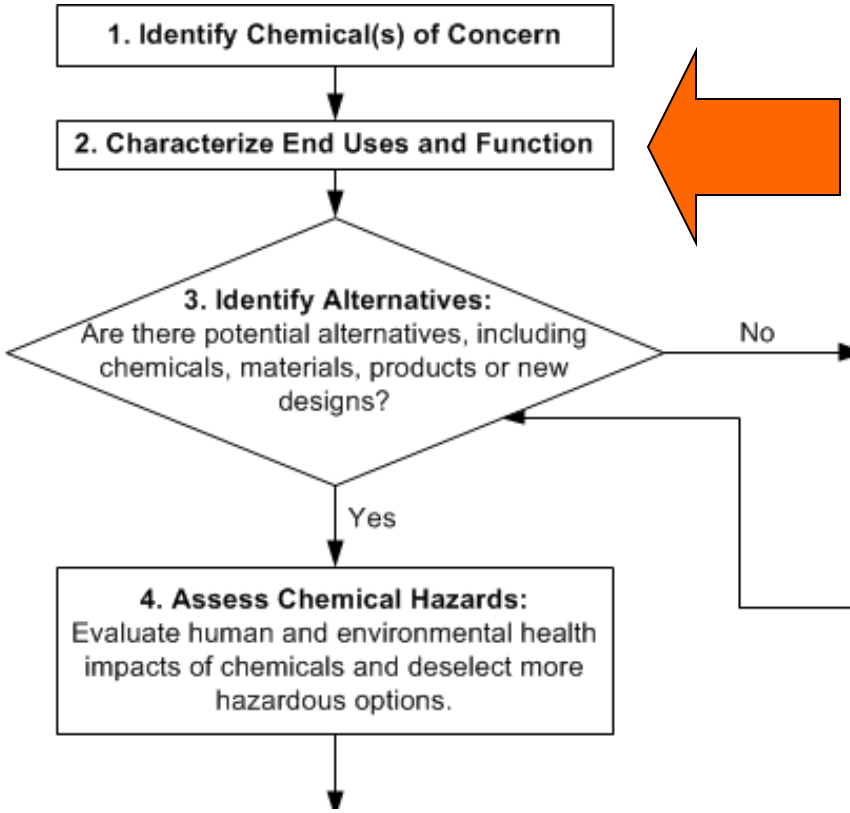


Step 1. Identify Chemicals of Concern



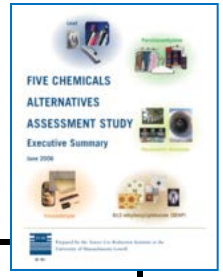
- Search government, NGO, corporate (RSLs) lists
- Sufficiently characterize the chemical of concern
  - physical
  - chemical
  - hazard traits
- Identify relevant sources of information

Step 2. Characterize End Uses and Functions



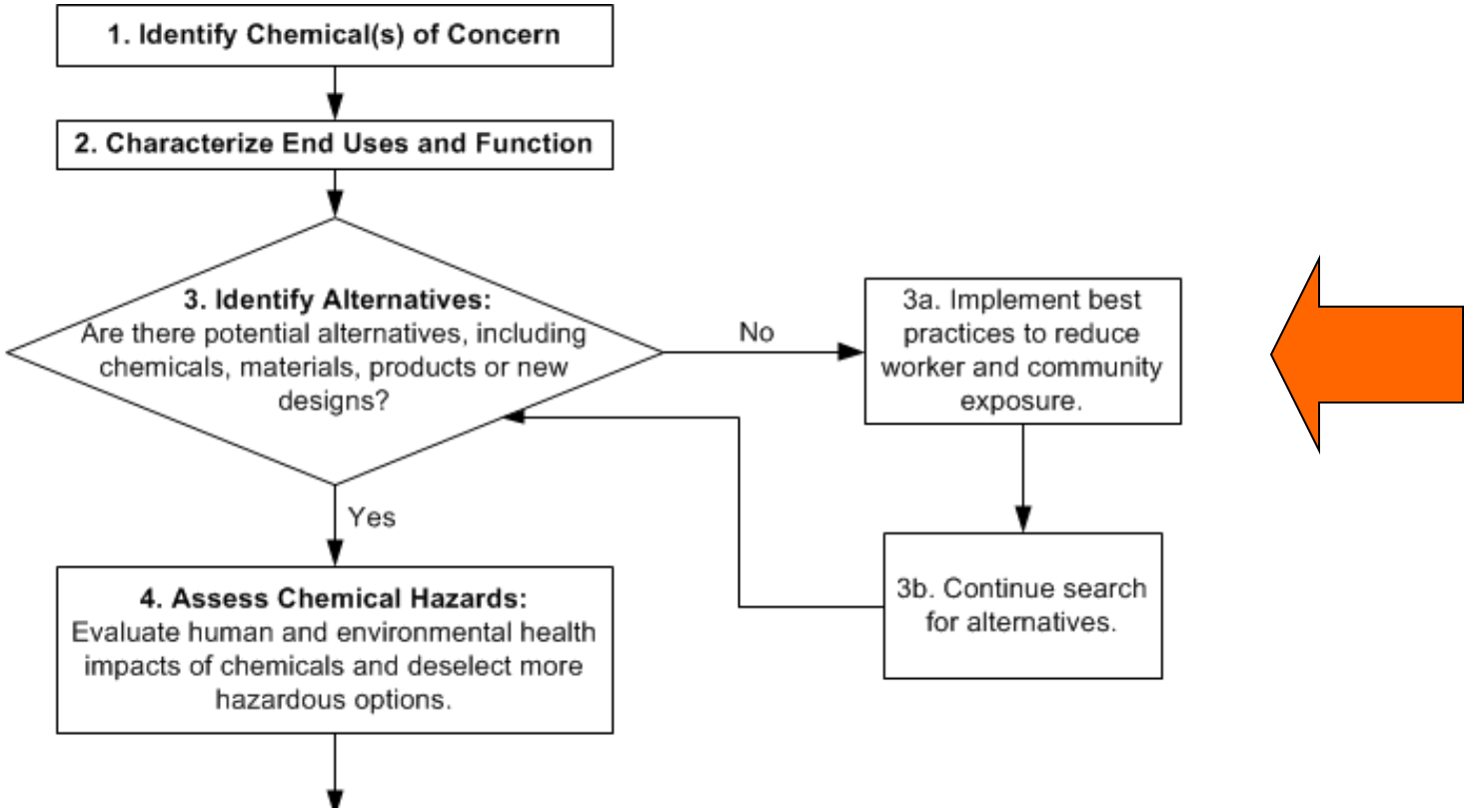
- Identify primary uses
- Characterize uses by
  - function
  - necessity
  - use potential
  - availability of alternatives
- Prioritize uses

Example: Considerations for prioritizing Formaldehyde Use Categories



Use/Application	Important Considerations
Decorative laminants (plastics, computer monitors)	Not likely to have high emissions, Alternatives Available
Floor finish (commercial acid cured, varnish)	High emissions, high worker exposure, consumer exposure
Insulation (phenolic foam and fiberglass)	Consumer and worker exposure, Alternatives Available
Glass fiber roofing mats	Alternatives Available
Paper products (wallpaper, wet strength additives)	Relatively low emissions, consumer exposure
Paint	Consumer, worker exposure
Ceiling Tiles	Consumer, worker exposure

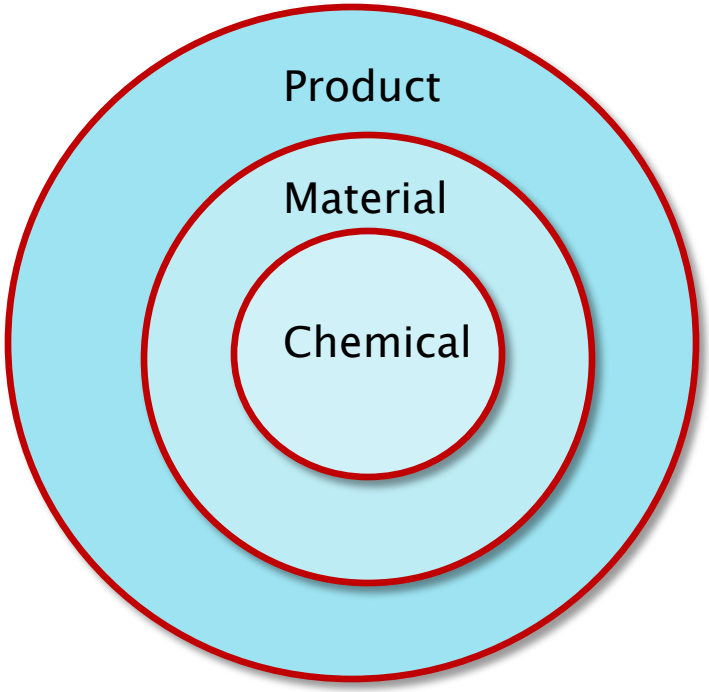
Step 3. Identify Alternatives



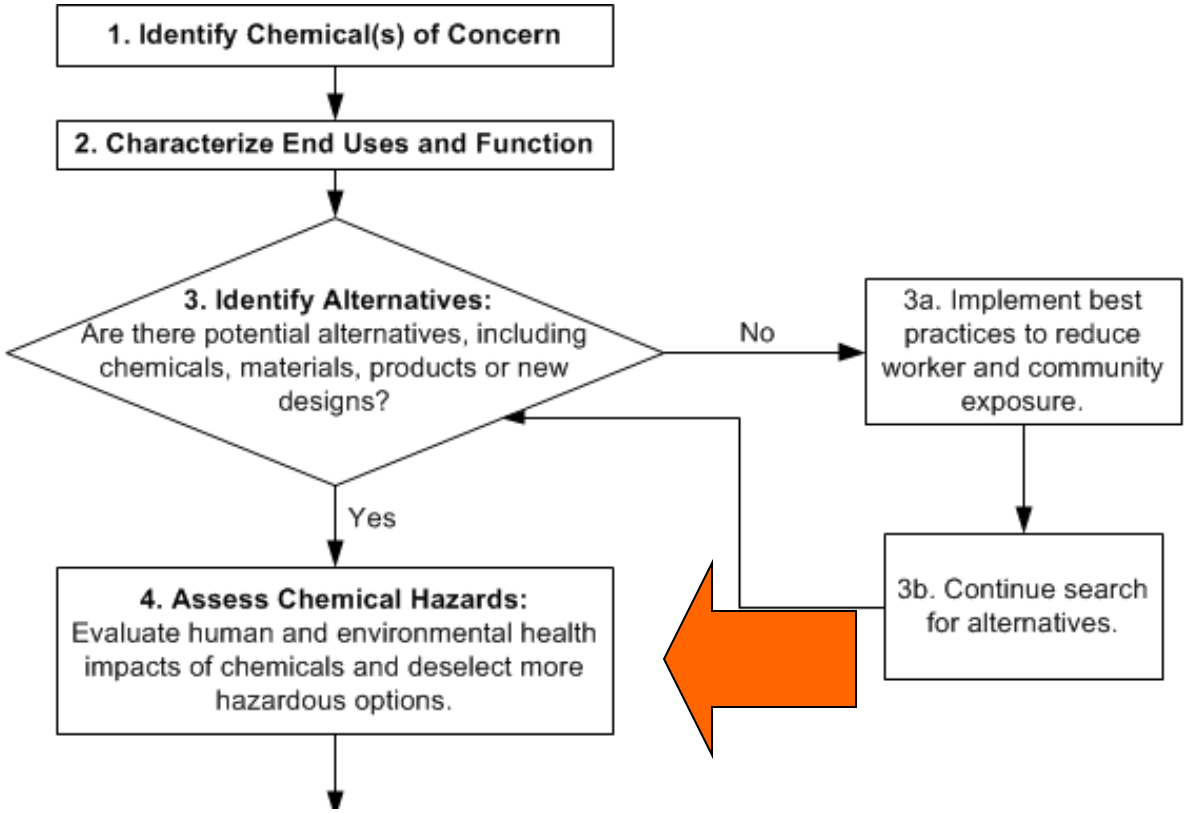
- Sources of information may include distributors, trade shows, trade journals, scientific literature, government reports.
- If there are no alternatives, implement best practices and continue searching

Identify Chemical and Non-Chemical Alternatives for Specific Uses

1. Chemical
2. Material
3. Product Re-design
4. Process Change
5. Eliminate the Use / Function
6. Systems Change



Step 4. Assess Chemical Hazards



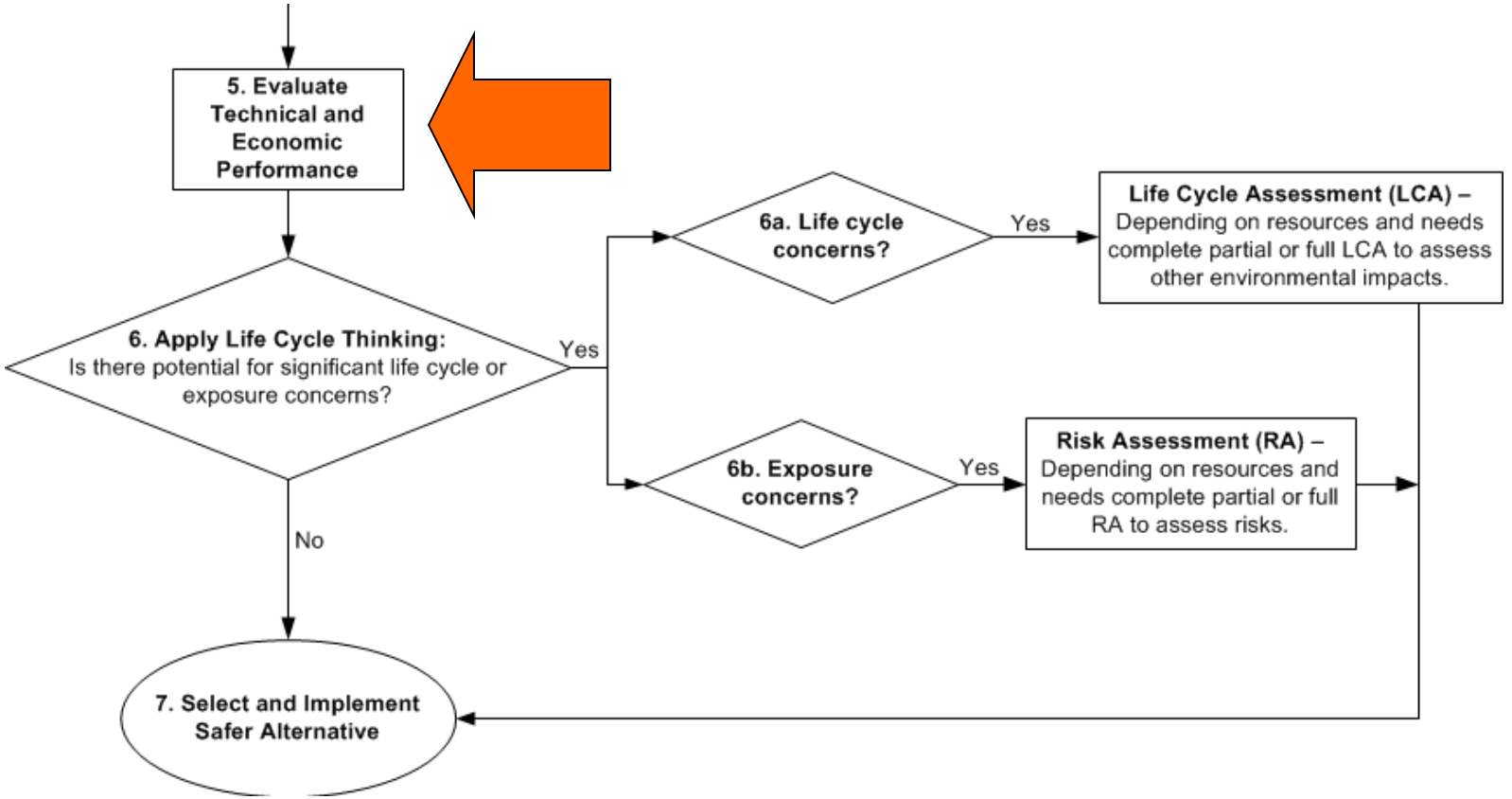
- Conduct a comparative chemical hazard assessment
- Deselect the more hazardous options

Comparative Chemicals Hazard Assessment Methods

Tool for comparing chemical alternatives on the basis of chemical hazards

- Environment Canada's Chemical Substance Assessment
- TURI's Pollution Prevention Options Analysis System (P2OASys)
- EPA's DFE Chemical Alternatives Assessment Framework
- Clean Production Action's Green Screen
- Washington DOE's QCATs

Step 5. Evaluate Technical and Economic Performance

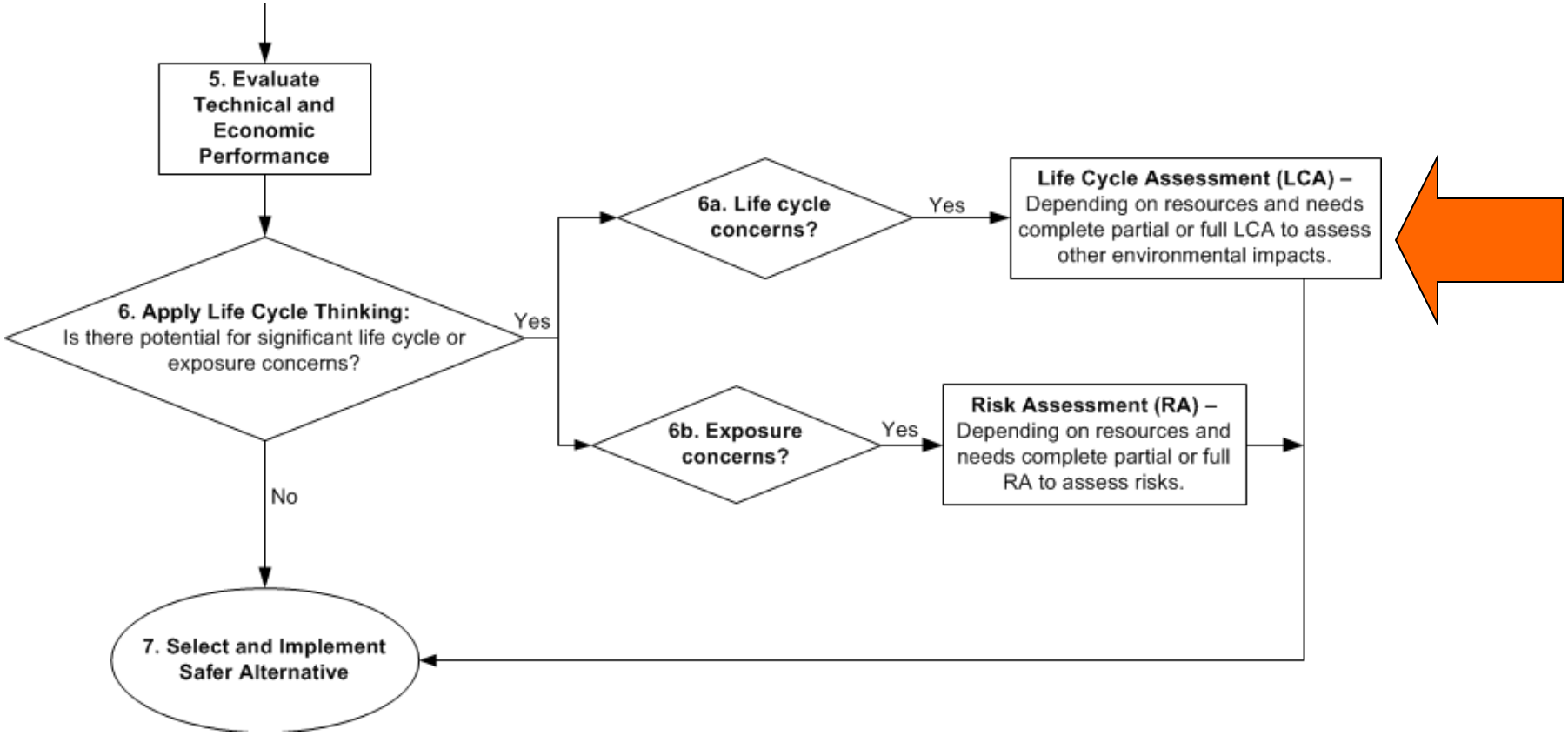


- Conduct performance assessment
  - use standard technical assessment tools
- Conduct comparative cost assessment
  - use direct price comparison and full cost and total cost assessments

Technical Assessment
Example: perc in dry cleaning

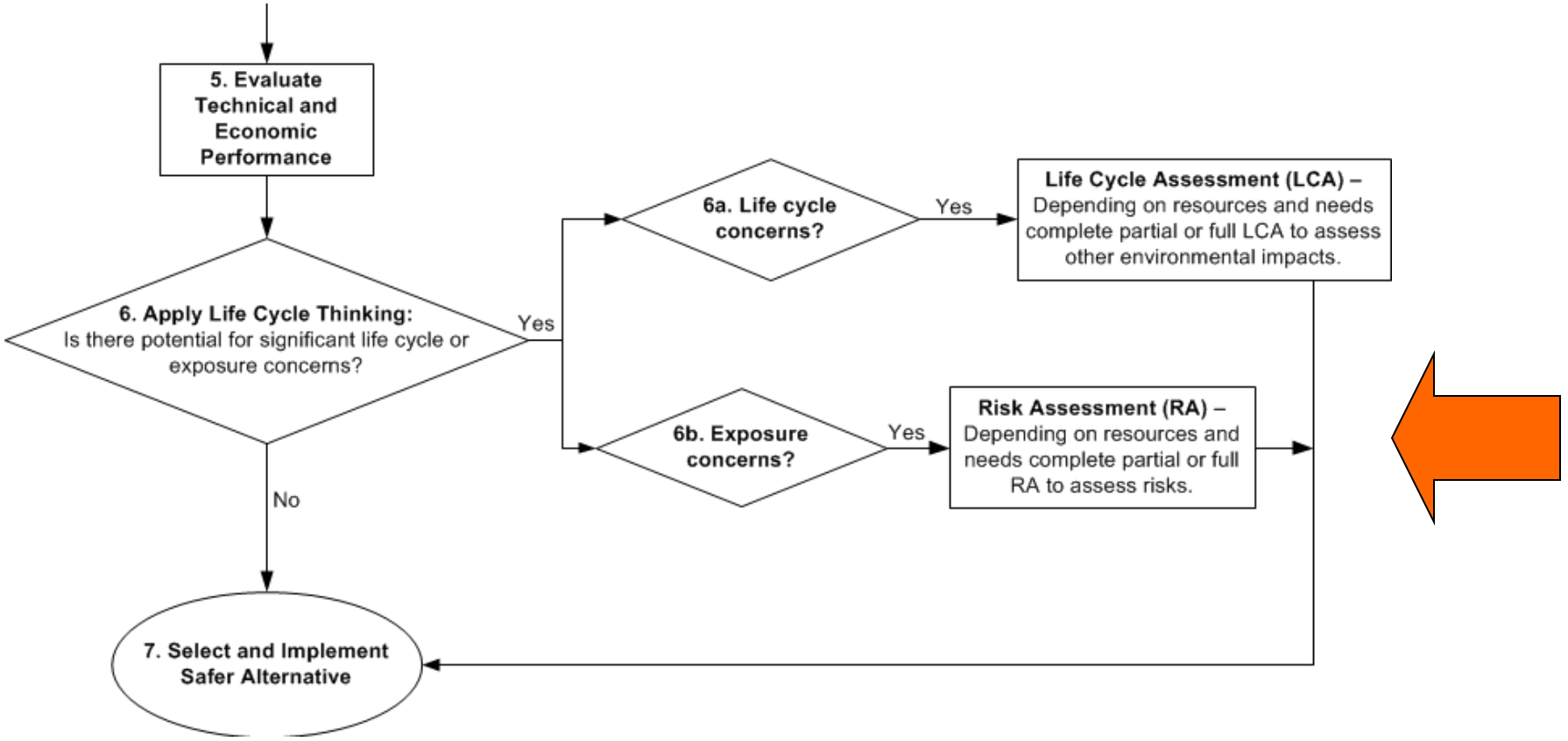
Assessment Criteria	Perc	Carbon Dioxide	Glycol Ethers	High Flash Hydrocarbon	N Propyl Bromide	Siloxanes	SolvonK4	Wet Cle
Cycle time (min)	45	35 – 45	> 45	65-75	45	50 - 60	60 – 65	20-40
Load capacity (lbs)	50	60	43	35-90	50	55	40-90	20-75
Cleaning capability	Aggressive	Gentle	Less effective	Effective	Aggressive	Less effective	Effective	Effective
Difficulty with fabrics and garments	Leather, suedes, beads, delicates	Triacetates, specially dyed acetates	None identified	Vinyl appliqués	Leather, suedes, beads, delicates	None identified	Appliqués or decorations glued to fabric	Leather, suede and fur
Time required for pre-spotting	Medium	High	Low	Medium	Low	High	Low	Low to Medium
Equipment compatibility	Perc equipment	CO_2 equipment	Retrofit Gen IV or higher Hydrocarbon	Hydrocarbon	Retrofit Perc or Hydrocarbon Gen IV or higher	Retrofit Perc, Hydrocarbon Gen IV or higher	Retrofit Hydrocarbon or New SolvonK4 system	Wet Cleaning equipment
Special equipment	None	High pressure equipment	Vapor recovery	Fire safety equipment, including grounds and bonding to minimize static electricity build up	New seals, gaskets, and doors may be required	Combustible – must meet fire safety codes	Combustible – must meet fire safety codes	Additional finishing equipment and training required
Waste management concerns	Handle spent solvent and solids as hazardous waste	Waste soils and lint do not require special handling	Difficult to distill water prior to waste mgmt	Considered as waste oil in MA, to be disposed of as hazardous waste , empty containers may contain residual and may be dangerous	If used as a drop in replacement, residual perc may be present for up to 6 months	Separation needed before disposal. Treat as hazardous waste	Waste solvent disposed of as industrial waste.	Requires discharge to industrial wastewater treatment facility

Step 6a. Apply Life Cycle Thinking



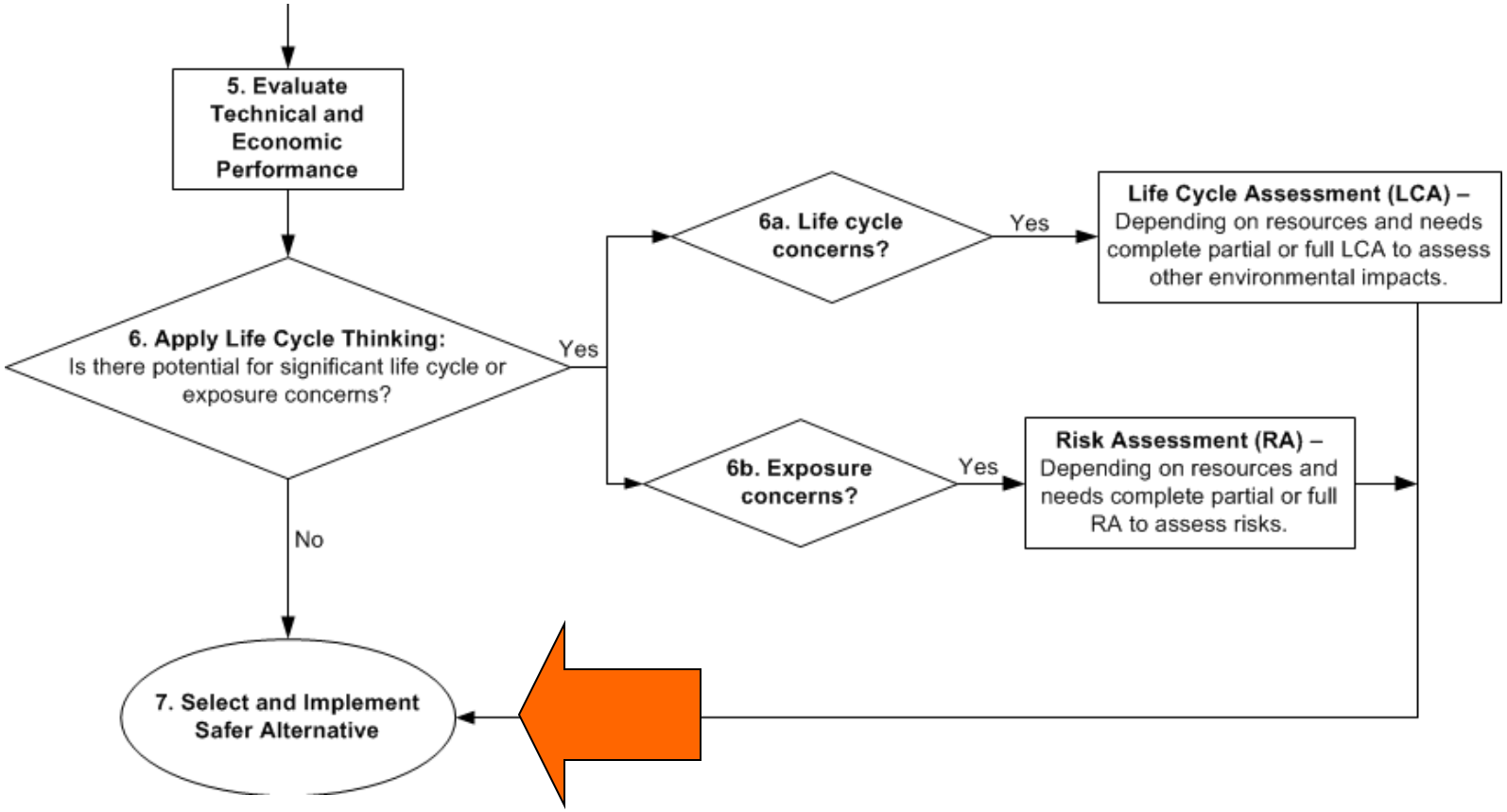
- LCAs identify the energy, wastes and environmental impacts cradle to grave (often life cycle thinking is sufficient)

Step 6b. Consider Exposure and Risk



- Exposure assessment and, perhaps, RAs may also be valuable

Step 7. Select Safer Alternative



- Compare with original chemical of concern
- Make decision
- Commence substitution

Alternatives Assessment

- A decision support process yet under development
- A process valuable to those seeking conversion to a safer, more sustainable economy

For more information see:

www.bizngo.org
www.turi.org
www.sustainableproduction.org
www.epa.gov/dfe
www.ic2saferalternatives.org

Thank you.