Alternatives Assessment
New Tools for Safer Chemicals

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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

<table>
<thead>
<tr>
<th>Company</th>
<th>Chemical</th>
<th>% in Formulation</th>
<th>Cancer Hazard</th>
<th>Skin Sensitizer</th>
<th>Reproductive</th>
<th>Developmental</th>
<th>Neurological</th>
<th>Systemic</th>
<th>Genotoxicity</th>
<th>Acute</th>
<th>Chronic</th>
<th>Persistence</th>
<th>Bioaccumulation</th>
<th>Potential Routes of Exposure</th>
<th>Reactive or Additive?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albemarie</td>
<td>SAYTEX RZ-243</td>
<td></td>
<td>L L L* L* L M* L L H L</td>
<td>N Y Y N N N Y Y</td>
<td>Additive</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proprietary E Tetramethylphthalate diol diester</td>
<td></td>
<td>L L M* M* M* L L H H L</td>
<td>N Y Y N N N N N</td>
<td>Additive</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proprietary B Aryl phosphate</td>
<td></td>
<td>L L M M M* L L H H L</td>
<td>N Y Y N N N N N</td>
<td>Additive</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Triphenyl Phosphate CAS # 115-86-6</td>
<td></td>
<td>L L L L L L M L H H</td>
<td>Y Y Y Y Y Y Y</td>
<td>Additive</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Ameribrom</td>
<td>FR513</td>
<td></td>
<td>M L M M M M M M M L L</td>
<td>Y Y Y N N N Y Y</td>
<td>Reactive</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Tribromoneopentyl Alcohol CAS # 36483-57-5</td>
<td></td>
<td>M L M M M M M M M M M</td>
<td>Y Y Y N N N Y Y</td>
<td>Reactive</td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Great Lakes</td>
<td>Firemaster 550</td>
<td></td>
<td>L L M M M L M L H H L</td>
<td>N Y Y N N N Y Y Y</td>
<td>Additive</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Proprietary F Halogenated aryl ester</td>
<td></td>
<td>L L M M L M M M L H H</td>
<td>L N Y Y N N Y Y Y</td>
<td>Additive</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Proprietary G Triaryl phosphate, isopropylated</td>
<td></td>
<td>L L M* M* M* M* L H H L</td>
<td>N Y Y N N N N N</td>
<td>Additive</td>
<td></td>
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<tr>
<td></td>
<td>Triphenyl Phosphate CAS # 115-86-6</td>
<td></td>
<td>L L L L L L M L H H</td>
<td>Y Y Y Y Y Y Y</td>
<td>Additive</td>
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</tr>
<tr>
<td></td>
<td>Proprietary H Halogenated aryl ester</td>
<td></td>
<td>L L M M L M L H H L</td>
<td>N Y Y N N N Y Y Y</td>
<td>Additive</td>
<td></td>
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</tbody>
</table>
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
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.

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

Chemicals
- OEHHA hazard traits
- Initial list – existing authoritative lists
- Additions to the list –
  - Adverse public health & environmental impacts
  - Sensitive subpopulations & environmental receptors
  - Exposures – biological/environmental monitoring
  - Reliable information

Products (Product/COCs Combination)
- COCs’ adverse impacts (see above)
- Potential exposures to COCs in product
- Market and household presence
- Users, uses and applications of product
- End-of-life management
- Reliable information

Alternatives Assessment
- Technical guidance
- Exemptions
- Alternatives assessment process & timeframe
- Alternatives assessment reports

Chemicals of Concern List
- Priority Products List

Alternative Selection

Regulatory Responses

Department of Toxic Substances Control
November 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

- **Informed Substitution**
- **Substitution Planning**
- **Alternatives Assessment**
- **Tools and Methods**

- **The Goal**
- **Implementation Process**
- **The Evaluation Process**
- **The Tools**
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

1. Identify Chemical(s) of Concern
   
2. Characterize End Uses and Function
   
3. Identify Alternatives:
   - Are there potential alternatives, including chemicals, materials, products or new designs?
   - No
   - Yes
   
4. Assess Chemical Hazards:
   - Evaluate human and environmental health impacts of chemicals and deselect more hazardous options
   
5. Evaluate Technical and Economic Performance
   
6. Apply Life Cycle Thinking:
   - Is there potential for significant life cycle or exposure concerns?
   - Yes
   - No
   
7. Select and Implement Safer Alternative

3a. Implement best practices to reduce worker and community exposure.

3b. Continue search for alternatives.

6a. Life cycle concerns?
   - Yes
   - Life Cycle Assessment (LCA) – Depending on resources and needs complete partial or full LCA to assess other environmental impacts.
   - No

6b. Exposure concerns?
   - Yes
   - Risk Assessment (RA) – Depending on resources and needs complete partial or full RA to assess risks.
Step 1. Identify Chemicals of Concern

1. Identify Chemical(s) of Concern
2. Characterize End Uses and Function

3. Identify Alternatives:
   Are there potential alternatives, including chemicals, materials, products or new designs?
   - Yes
   - No

   3a. Implement best practices to reduce worker and community exposure.
   3b. Continue search for alternatives.

4. Assess Chemical Hazards:
   Evaluate human and environmental health impacts of chemicals and deselect more hazardous options.

- 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

1. Identify Chemical(s) of Concern

2. Characterize End Uses and Function

3. Identify Alternatives:
   Are there potential alternatives, including chemicals, materials, products or new designs?
   - No
     - 3a. Implement best practices to reduce worker and community exposure.
   - Yes
     - 3b. Continue search for alternatives.

4. Assess Chemical Hazards:
   Evaluate human and environmental health impacts of chemicals and deselect more hazardous options.
## Example: Considerations for prioritizing Formaldehyde Use Categories

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

6. Apply Life Cycle Thinking:
   Is there potential for significant life cycle or exposure concerns?

6a. Life cycle concerns?
   - Yes: Life Cycle Assessment (LCA) – Depending on resources and needs, complete partial or full LCA to assess other environmental impacts.
   - No: 6b. Exposure concerns?

6b. Exposure concerns?
   - Yes: Risk Assessment (RA) – Depending on resources and needs, complete partial or full RA to assess risks.
   - No: Select and Implement Safer Alternative
# Technical Assessment

**Example:** perc in dry cleaning

<table>
<thead>
<tr>
<th>Assessment Criteria</th>
<th>Perc</th>
<th>Carbon Dioxide</th>
<th>Glycol Ethers</th>
<th>High Flash Hydrocarbon</th>
<th>N Propyl Bromide</th>
<th>Siloxanes</th>
<th>SolvonK4</th>
<th>Wet Cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle time (min)</td>
<td>45</td>
<td>35 – 45</td>
<td>&gt; 45</td>
<td>65-75</td>
<td>45</td>
<td>50 - 60</td>
<td>60 – 65</td>
<td>20-40</td>
</tr>
<tr>
<td>Load capacity (lbs)</td>
<td>50</td>
<td>60</td>
<td>43</td>
<td>35-90</td>
<td>50</td>
<td>55</td>
<td>40-90</td>
<td>20-75</td>
</tr>
<tr>
<td>Cleaning capability</td>
<td>Aggressive</td>
<td>Gentle</td>
<td>Less effective</td>
<td>Effective</td>
<td>Aggressive</td>
<td>Less effective</td>
<td>Effective</td>
<td>Effective</td>
</tr>
<tr>
<td>Difficulty with fabrics and garments</td>
<td>Leather, suedes, beads, delicates</td>
<td>Triacetates, specially dyed acetates</td>
<td>None identified</td>
<td>Vinyl appliqués</td>
<td>Leather, suedes, beads, delicates</td>
<td>None identified</td>
<td>Appliqués or decorations glued to fabric</td>
<td>Leather, suede and fur</td>
</tr>
<tr>
<td>Time required for pre-spotting</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low to Medium</td>
</tr>
<tr>
<td>Equipment compatibility</td>
<td>Perc equipment</td>
<td>CO₂ equipment</td>
<td>Retrofit Gen IV or higher Hydrocarbon</td>
<td>Hydrocarbon</td>
<td>Retrofit Perc or Hydrocarbon Gen IV or higher</td>
<td>Retrofit Perc, Hydrocarbon Gen IV or higher</td>
<td>Retrofit Hydrocarbon or New SolvonK4 system</td>
<td>Wet Cleaning equipment</td>
</tr>
<tr>
<td>Special equipment</td>
<td>None</td>
<td>High pressure equipment</td>
<td>Vapor recovery</td>
<td>Fire safety equipment, including grounds and bonding to minimize static electricity build up</td>
<td>New seals, gaskets, and doors may be required</td>
<td>Combustible – must meet fire safety codes</td>
<td>Combustible – must meet fire safety codes</td>
<td>Additional finishing equipment and training required</td>
</tr>
<tr>
<td>Waste management concerns</td>
<td>Handle spent solvent and solids as hazardous waste</td>
<td>Waste soils and lint do not require special handling</td>
<td>Difficult to distill water prior to waste mgmt</td>
<td>Considered as waste oil in MA, to be disposed of as hazardous waste, empty containers may contain residual and may be dangerous</td>
<td>If used as a drop in replacement, residual perc may be present for up to 6 months</td>
<td>Separation needed before disposal. Treat as hazardous waste</td>
<td>Waste solvent disposed of as industrial waste.</td>
<td>Requires discharge to industrial wastewater treatment facility</td>
</tr>
</tbody>
</table>
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

5. Evaluate Technical and Economic Performance

6. Apply Life Cycle Thinking:
   Is there potential for significant life cycle or exposure concerns?

6a. Life cycle concerns?
   - Yes: Life Cycle Assessment (LCA) – Depending on resources and needs complete partial or full LCA to assess other environmental impacts.
   - No: 6b. Exposure concerns?
   - Yes: Risk Assessment (RA) – Depending on resources and needs complete partial or full RA to assess risks.

7. Select and Implement Safer Alternative

• 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.