Alternatives Assessment Overview

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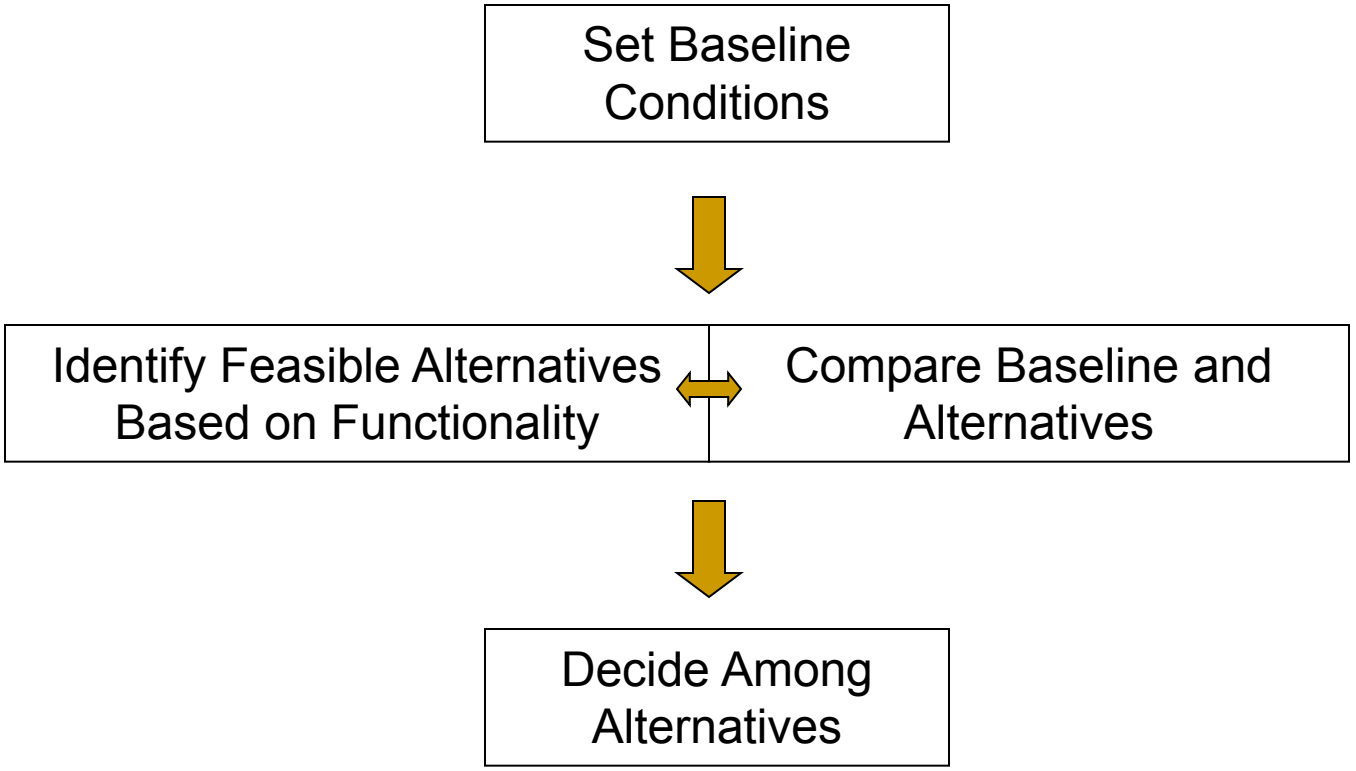
Purpose

- DuPont has developed and tested an approach to making informed decisions about chemical selection.
- Society is driving companies like DuPont to make decisions based on more than just regulatory requirements.
- To that end, our Framework attempts to address the interests of a variety of stakeholders.
- As an important stakeholder, we'd like to share our Framework with you and get your feedback.

Alternatives Assessment Definition

- From EPA's website
  - Alternatives Assessments "evaluate the environmental and health impacts of potential alternatives to problematic chemicals."
  - The outcome ".. provides industry with the information they need to choose safer chemicals, as well as avoid unintended consequences of switching to a poorly understood substitute."
  - Life cycle approach (raw material through end-of-life) is encouraged/expected

Proposed Alternatives Assessment Framework



Alternatives Assessment Framework

I. Set Baseline Conditions
- Identify target chemical
- Identify the driver for conducting the assessment
- Identify the end goal (e.g., lower residual, substitution, reduction of specific exposure)
- Establish the Product Trail

II. Identify Feasible Alternatives
- Identify attributes/functionality that an alternative MUST have
- Engage other regions/existing supplier for alternatives info
- Conduct brainstorming session with business/R&D experts to consider:
    - Drop-in chemical replacements
    - Process change with chemical replacement
    - Product redesign to reduce concentration of COC
    - Product redesign to reduce exposure potential during manufacture, use or disposal
    - Product redesign to improve reuse/recycling
- Explore commercial availability/feasibility of alternatives
- Identify potential, functional alternatives (iterative process)

Framework (cont'd)

III. Compare Baseline and Alternatives

-Compare the following criteria
- -Performance
- -Manufacturability
- -Human Health Profile
- -Environmental Profile
- -Safety
- -Economic Feasibility
- -Market Impact /Green Labeling Opportunities
- -Screening Life Cycle Assessment (energy/water/emissions)
- -Exposure Potential throughout Product Trail
- -Social Considerations/Stakeholder Buy-In

-Use guidance tools/best practices to populate template

IV. Decide

-Refine business factors for decision-making
-Decide whether to stay with baseline or pursue an alternative
-Document rationale, as needed
-If alternative is selected, make a plan with a clear timeline

Template

Target Chemical:	Driver:			
End Goal:				
Function of Target Chemical:				
	BASELINE	ALTERNATIVES		
Criteria				
Chemical Name				
Structure				
CAS No.				
Performance				
Manufacturability				
Human Health Profile (e.g., CMR, endocrine activity)				
Environmental Profile (PB and aquatic toxicity)				
Safety				
Economic Feasibility				
Market Impact/Green Labeling Opportunities				
Screening Life Cycle Assessment (energy, resource use, water use)				
Exposure Potential throughout product trail				
Social Considerations/Stakeholder Buy-In (NGO, deselection and biomonitoring lists)				

Additional Guidance for the Template

Driver
Describe the voluntary or involuntary business rationale for conducting this Alternatives Assessment.

Baseline
Identify the compound or compounds that are targeted for the Assessment. You may wish to include a CAS Number and a graphic showing the structure of the compound.

Alternatives
Arriving at viable alternatives is often a long-term process that involves discussions with internal and external experts. Some businesses have elected to conduct brainstorming sessions and include members of R&D, marketing and even downstream customers. If downstream customers are included, stakeholder involvement can occur in early stages of the assessment.

Performance
Performance criteria and testing are strictly the purview the business conducting the assessment. It is important to establish a clear and finite set of functional performance criteria that will "make or break" the selection of an alternative. To describe differences in performance between the baseline and various alternatives, some businesses may wish to develop an index such as this:

-2 = Much worse than control
-1 = Worse than control
0=Same as control
+1 = Better than control

Additional Guidance for the Template

Manufacturability

Companies like DuPont believe that materials not currently commercially available can still be viable as long as the new material can be manufactured in the near future (i.e., "manufacturability). It is important to recognize that new materials can as viable as existing materials, and allowing new materials can drive innovation. To describe differences in manufacturability between the baseline and various alternatives, some businesses may wish to develop an index such as this:

-2 = Much worse than control
-1 = Worse than control
0=Same as control
+1 = Better than control

Human Health Profile

There is no single list of human health criteria to compare alternatives against, as it would be unreasonably long. Rather, it is recommended that the toxicologists be engaged to lead this portion of the assessment to eliminate any candidates with obvious potential health issues and to

1. *look first at any toxicity characteristics inherent in the baseline chemical that have been targeted as a concern and then*
2. *examine any remaining toxicological endpoints of interest that would allow a determination of whether one candidate has an overall improved toxicological profile versus the baseline or another candidate. Consider endpoints in the box[1] if they are relevant.*
3. *focus on toxicology aspects that are most relevant to the product and its application. For example, if a non-volatile material is used in an isolated system, inhalation exposure may not be very relevant.*

Potential Endpoints
Acute
Cancer
Developmental
Endocrine Disruption
Genotoxicity/Mutagenicity
Immune System
Irritation/Corrosion – skin, eyes
Neurological
Reproductive
Sensitizer – respiratory, skin
Systemic Toxicity/organ Effects

1. Rossi, M., Heine, L. , 2007. Green Screen for Safer Chemicals: Evaluating Flame Retardants for TV Enclosures, Clean Production Action, Version 1.0

Additional Guidance for the Template

Environmental Profile

Similar to the Human Health Profile, the criteria used to compare environmental profiles should center on any environmental impacts that may be of concern for the baseline material. Persistence, tendency to bioaccumulate and aquatic toxicity are often important to consider in the absence of any other impact of concern. Various resources can assist in this assessment, including the EPA's PBT Profiler and Corporate fate and transport consultants.

Safety

Safety metrics are again tailored to the characteristics of the materials under consideration and the conditions of their handling and use. Potential to explode and flammability are examples of fundamental safety characteristics that could be considered. Process Safety and Fire Protection consultants can be helpful in assessing safety risks.

Economic Feasibility

Economic feasibility can be measured a number of ways. In many cases, raw material costs are a sufficient indicator of differences between options. In other cases, a more holistic approach (e.g., value-in-use assessment) would more appropriately demonstrate economic differences among alternatives. The appropriate choice is made by the business conducting the assessment. Engineering Evaluations consultants can be helpful in providing assistance.

Additional Guidance for the Template

Market Impact/Green Labeling Opportunities

Changes to a product formulation could present hurdles or opportunities in the marketplace. An important part of assessing the impact of a substitute material is to understand how the market (downstream customers and ultimate consumers) may react to the reformulation. If the substitution could be perceived as beneficial, the business may wish to consider labeling/advertising changes. If Green Labeling opportunities are explored, note that there are resources who can help interpret external green labeling standards.

Screening Life Cycle Assessment (energy, resource consumption, carbon footprint, ghg)

Screening Level Life Cycle Assessments are typically performed to evaluate the carbon footprint of a process (from cradle to grave) including energy use, natural resource consumption, and generation of emissions. The scope of any subsequent LCA work will depend on how much the Screening Level LCA influences the alternative selection. Sustainability Analysis resources are available to assist in these assessments.

Exposure Potential Throughout Product Trail

Toxicity characteristics alone do not dictate the risk of a particular chemical. Potential exposure during manufacture, use and disposal must also be considered to get a full picture of potential risk. Using the product trail, consider exposure to workers, to downstream industrial customers, to consumers (if the chemical is used in consumer products) and to the general public who could be exposure to emissions during manufacture or disposal of the material. This analysis may be qualitative or quantitative in nature, concentrating on potential differences in exposure among the alternatives throughout the product trail.

Additional Guidance for the Template

Social Considerations/Stakeholder Acceptance

Stakeholder acceptance is an important factor that can make or break a product's success in the market place. While approaches should be used to accurately assess viability and potential risk, it is important to "take the pulse" of the public regarding the use of certain materials. The PRO3 tool (http://pro3.es.dupont.com/) is a good screening tool to start this process. Understanding stakeholder viewpoints can also be achieved by directly engaging the downstream customers/consumers who will be impacted by product redesign or reformulation. This strategy has proved successful for some DuPont businesses that have used it.

Salient Points About Framework

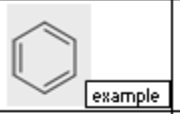
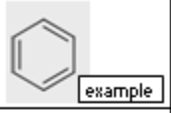
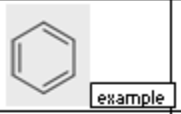
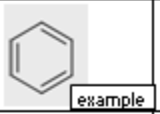
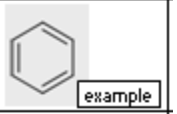
- Historically conversations about safe chemicals have been largely limited to only PBT characteristics. We believe good decision-making involves a broader spectrum of criteria.
- The Framework includes four basic steps that are not new, but lend themselves to an organized methodology.
- The various comparison criteria cover multi-stakeholder interests.
- The Framework includes a template for organizing the information plus guidance for obtaining the necessary information.
- Specific decision-making criteria are not included because a "one-size-fits all" approach is unworkable given the diversity of businesses, products and processes.

Case study

Target Chemical: Solvent Z	**Driver:** Reproductive Toxicant under REACH
End Goal: Replace Solvent Z with non-CMR, low toxicity risk, more sustainable sustainable chemistry	
Function of Target Chemical: Solubilize/Coalesce binder polymers PolyAmideImide and PolyEtherSulfone	

-2 = Much worse than control	
-1 = Worse than control	
0=Same as control	
+1 = Better than control	

	Very significant disadvantage
	Significant disadvantage
	Potential disadvantage
	No known advantage/disadvantage vs. control
	Slight advantage
	Important advantage

	Baseline	Alternatives →				
Chemical	Solvent Z	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Structure						
CAS #						
Performance*	0	0	0	0	Not fully tested	Not fully tested
Manufacturability*	0	-1 (viscosity)	0	0	0	-2 (corrosive & odor)
Human Health Profile (eg CMR, endocrine activity)	Reproductive Toxicant under REACH	Not a CMR Mild Hypnotic	Not a CMR	Not a CMR	Corrosive to skin/eye	Acute oral toxicity; CMR status unknown
Safety	Some potential for flammability and reactivity	Lower potential for flammability and reactivity	Lower potential for flammability and reactivity	Lower potential for flammability and reactivity	Some potential for flammability and reactivity	Lower potential for flammability and reactivity
Environmental Profile (PB and aquatic toxicity)	Not considered persistent or bioaccumulative (PBT profiler)	Not considered persistent or bioaccumulative (PBT profiler)	Not considered persistent or bioaccumulative (PBT profiler)	Not considered persistent or bioaccumulative (PBT profiler)		Nitrogen Emission
Economic Feasibility (Cost/lb)	$1.64/lb	$2.05/lb	$1.90/lb	$12-17/lb	$8/lb volume not readily avail	$2.40/lb (volume avail unk)
Market Impact/Green Labeling Opportunities	Market would welcome replacement	TBD	TBD	Biobased route exists	TBD	Biobased route exists
Life Cycle Assessment (energy, resource use, water use)	N/D	N/D	N/D	N/D	N/D	N/D
Exposure Potential throughout trail	Controlled exposure to workers below TLV; no consumer exposure because not present in final product	Controlled exposure to workers below TLV; no consumer exposure because not present in final product	Controlled exposure to workers below TLV; no consumer exposure because not present in final product	Controlled exposure to workers below TLV; no consumer exposure because not present in final product	Controlled exposure to workers below TLV; no consumer exposure because not present in final product	Controlled exposure to workers below TLV; no consumer exposure because not present in final product
Social Considerations/Stakeholder Buy-in (NGO, deselection and biomonitoring lists)	EU & US HPV	EU & US HPV	EU & US HPV			No regulatory or public concerns

Questions for Feedback

- Can this approach lead to sound decision-making consistent with your goals?
- Are there any critical gaps in our thinking?
- How might we improve upon this framework?