Use of DecaBDE Flame Retardants in Plastic Shipping Pallets: Assessing Safer Alternatives

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Solutions for a Sustainable Future

Safer Alternative

Maine law:

"A substitute process, product, material, chemical, strategy or any combination of these"

Issue: Use of DecaBDE in Plastic Pallets

- Pallets used to ship/store wide range of commodities

- Plastic pallets pose higher fire risk than wood
- DecaBDE fire retardant added to plastic to reduce flammability

Questions for the Assessment

- **Substitute chemical or material:**
  - Safer alternative flame retardants (non-brominated or -chlorinated)?
- **Substitute process/strategy:**
  - Alternative measures for reducing fire risks
- **Substitute product:**
  - Non-plastic pallets

Areas to Explore

- Market
  - Service providers
  - End users
- Regulatory drivers & other safety concerns (fire, sanitation, ergonomics, etc.)
- Management landscape: warehouses & palletized storage
- Reasons for use of deca in plastic pallets & availability of potential alternatives
- Hazards posed by potential alternative flame retardants

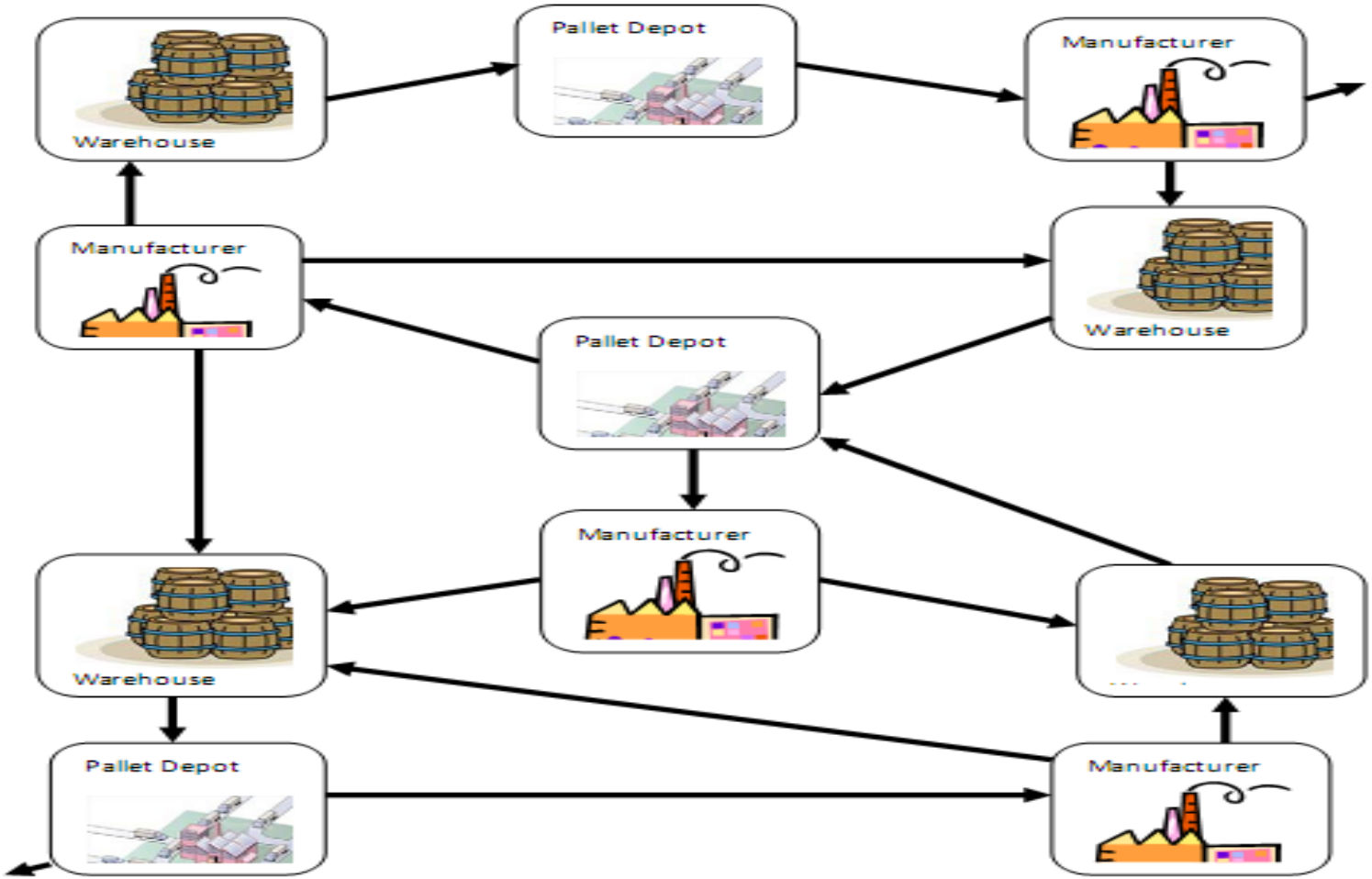
Finding Information Sources

- Market analyses
- Pallet service firms
- Pallet manufacturers
- Compounders
- Flame retardant experts
- Chemical screens/ toxicological assessments
- Regulatory bodies (national, state, local)
  - NFPA
  - EPA (DfE)
  - Fire marshals
- Insurers
- Consumer goods manufacturers & shippers
- Warehouses

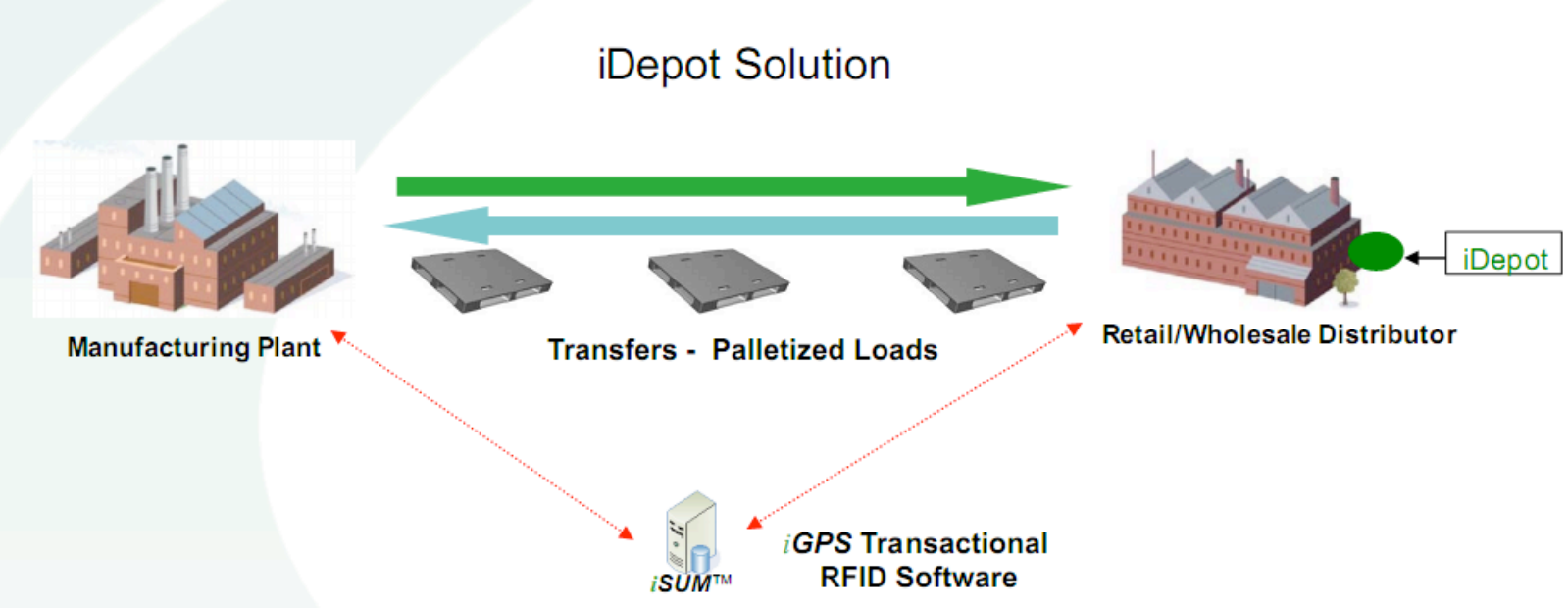
Market for Pallets: Type & Use

- Over3 billion shipping pallets in use nationally
  - Wood dominant material
  - About 900 million plastic
  - "Grocery pallet" (40x48 inches) largest - 30% of market
- "Open pool" leased pallets (c. 85 million, 10 million plastic) - iGPS, CHEP, PECO
- Closed loop/internal use
- Single use

Pallet Market: Open Pool Pallet Leasing



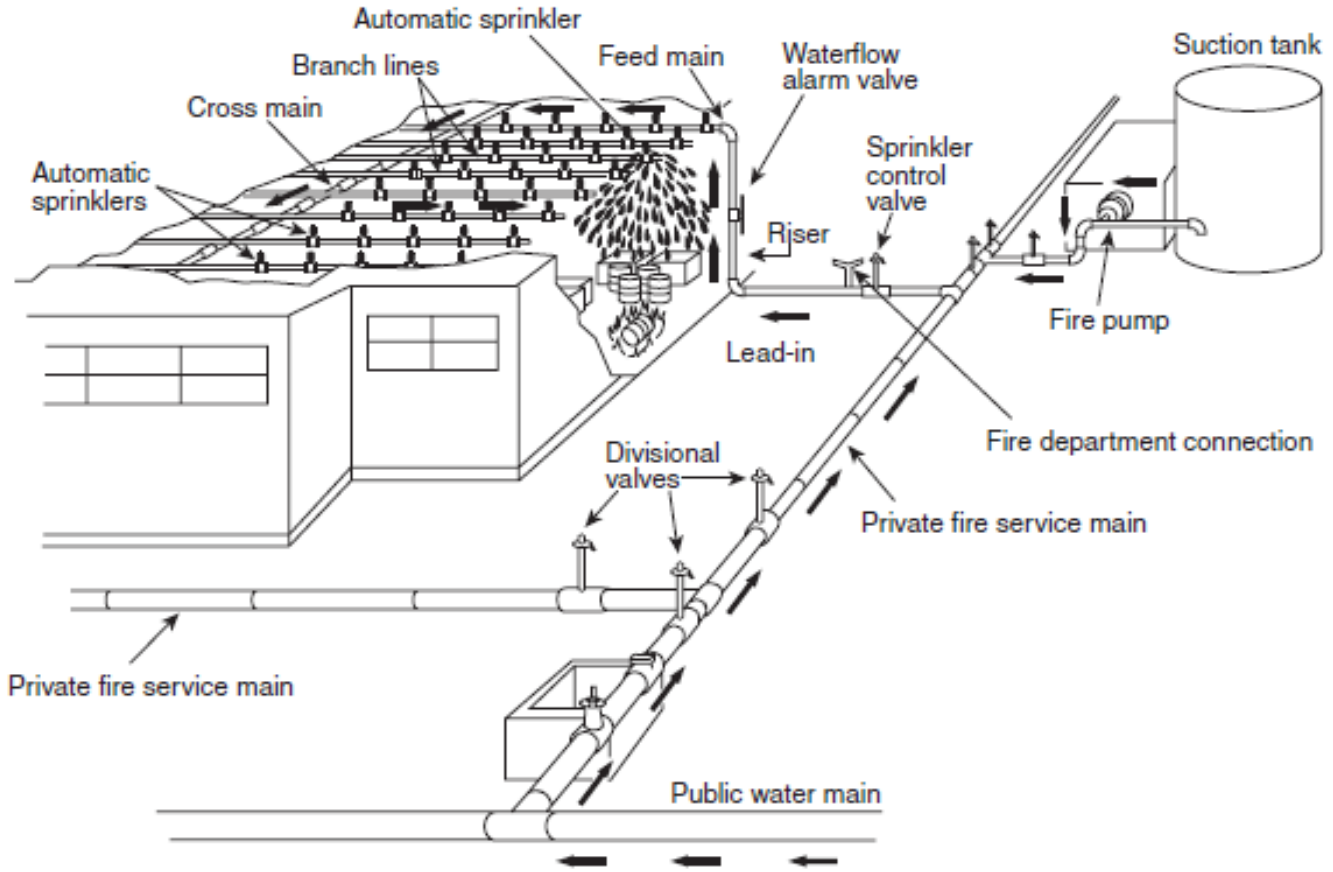
Market: IGPS Open Pool Pallets with RFID



Fire Safety Regulations

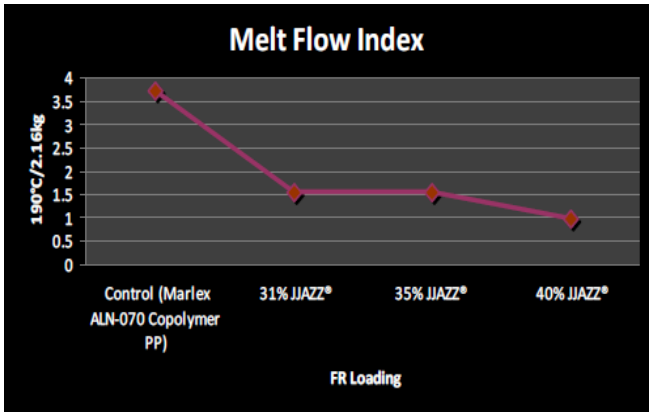
- **National Fire Protection Association - NFPA 13**
  - **Sets fire safety (sprinkler & management) standards adopted by states, localities for fire protection for warehouses**
  - **Standards based on levels of protection required for wood fires**
    - Stricter storage standards for plastic pallets
      - Greater heat released by polyolefin plastic fires
      - Unless tests demonstrate plastics burn with equal or less heath than wood.

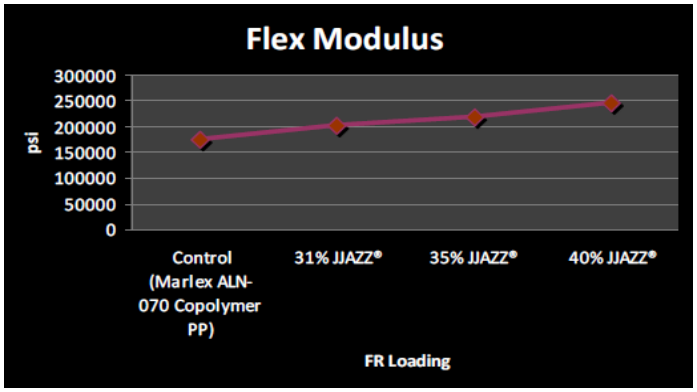
Can Better Warehouse Protection/Management Systems Provide Safer Alternative?

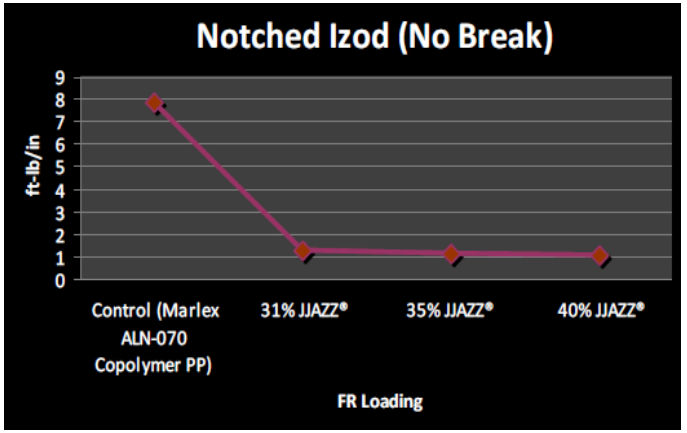


Effects of Flame Retardants on Plastic & Pallet

- Key properties of plastic compounds
  - Specific gravity
  - Modulus
  - Impact resistance
  - Melt flow index







Alternative Safer Flame Retardants

- **Addition of flame retardants to pallets affects performance characteristics of plastic**

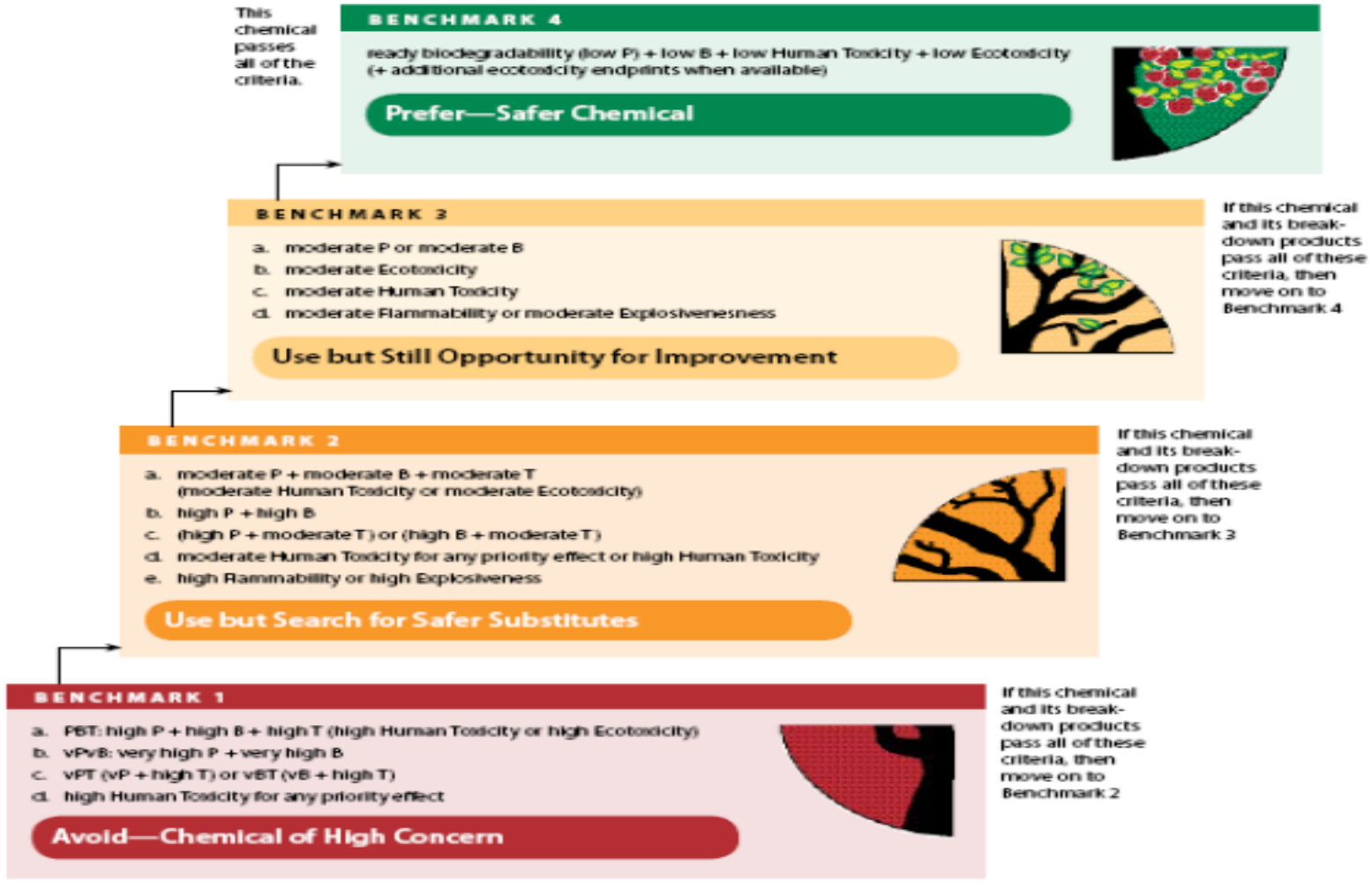
- **Finding the balance**
  - Strength
  - Stiffness
  - Durability
  - Design
  - Weight
  - Cost

- **Major alternative classes of flame retardants**
  - Phosphates
  - Metallics

Non-Halogenated Flame Retardants Selected for 'Safer Alternatives' Review

Flame Retardant	CAS#	Reason for Selection
Melamine polyphosphate	218768-84-4	Recommended by PINFA[132].
Ethylenediamine phosphate	14852-17-6	Demonstrated FR properties for polypropylene
Ammonium polyphosphate	68333-79-9	Excellent general purpose FR but recommended for use with synergists
Red phosphorus	7723-14-0	Demonstrated application in thermoplastics
Magnesium hydroxide	1309-42-8	Demonstrated FR properties in thermoplastics and is currently being used in a polypropylene pallet
Aluminum trihydroxide	21645-51-2	Demonstrated FR properties in PE but not in PP
Zinc Borate	138265-88-0	Useful as a supplemental FR with ATH and Magnesium Hydroxide
Magnesium stearate	557-04-0	Magnesium hydroxide particles treated with stearate acid to facilitate a better dispersion of magnesium hydroxide in a polymer matrix

Green Screen



Green Screen Results

Screening Level Toxicology Hazard Summary

Chemical	CAS #	Human Health Effects									Aquatic Toxicity		Fate		Physical		GS Benchmark Score (Chemical)
		Carcinogenicity	Mutagenicity	Reproductive/ Developmental	Endocrine Disruption	Neurotoxicity	Acute Toxicity	Skin/Eye Corrosion/Irritation	Dermal/Respiratory Sensitization	Systemic Toxicity/ Repeated Dose	Acute Aquatic	Chronic Aquatic	Persistence	Bioaccumulation	Explosivity	Flammability	
Decabromodiphenyl Ether	1163-19-5	M	L	M	M	M	L	M	L	M	H	H	vH	M	nd	L	1
Aluminum Trihydroxide	21645-51-2	L	*L*	L	nd	M	L	M	L	M	L	*M*	vH	L	L	L	2
Ammonium Polyphosphate	68333-79-9	L	L	*L*	nd	nd	L	L	L	*L*	L	*L*	L	L	L	L	4
Ethylenediamine Phosphate	14852-17-6	L	*M*	*M*	nd	nd	*M*	*H*	*H*	*M*	L	H	M	L	L	L	2
Magnesium Hydroxide	1309-42-8	L	L	L	nd	*L*	L	M	*L*	M	L	L	vH	L	L	L	2
Magnesium Stearate	557-04-0	L	L	L	nd	nd	L	M	L	M	*L*	*M*	H	L	M	H	2
Melamine Polyphosphate	218768-84-4	*M*	*M*	L	nd	nd	L	L	*L*	*H*	*L*	*L*	*M*	L	L	L	2
Red Phosphorus	7723-14-0	L	L	L	nd	H	H	H	L	H	L	M	M	L	H	H	1
Zinc Borate	1332-07-6	L	L	*M*	*M*	nd	L	M	L	M	H	nd	nd	L	L	L	2

nd=not determined/unknown
L=Low Hazard M=Moderate Hazard H=High Hazard vH=very High Hazard-Endpoints in colored text (**L, M, and H**) were assigned based on experimental data.
Endpoints in black italics (*L, M,* and *H*) were assigned using estimated values and professional judgment (Structure Activity Relationships)

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Plastic pallets with Non-BFR Flame Retardants

- Currently produced or available plastic pallets with non-BFR flame retardants
  - Passed one or both of two major pallet flame retardant tests (UL 2335/FM 4996)
  - Use flame retardant systems scoring 2 or above on Green Screen
- Currently only two pallets with flame retardants meet both criteria
  - Rehrig Pacific (magnesium hydroxide)
  - CHEP (phosphate-based)

DEP Tests for 'Functionally Equivalent'

- *Pallet meets the Grocery Industry (GMA) Pallet Performance Specifications (from 1992 recommendations on the Grocery Industry Pallet System) or is capable of being manufactured to meet those standards.*
- *Pallet currently used by grocery industry or other consumer market sectors to ship the same types of goods shipped on pallets containing decaBDE (e.g., pallets made from wood or metal)*

Grocery Manufacturers Association (GMA) Standards

- ***Fire protection***
  - "Meet or exceed current pallet resistance to fire."
- ***Size and structure***
  - 48x40 inches; no more than 6 inches in height; minimum 85% coverage on the (non-skid) top surface of the pallet; 60% coverage on the bottom surface; '4-way entry' (openings that allow forklifts and other equipment to lift the pallet from any direction); and meet other technical criteria to facilitate consistency with pallet management equipment
- ***Weight***
  - Less than 50 pounds
- ***Sanitation***
  - Material that does not contaminate the product it carries
- ***Durability***
  - Capable of 'multiple cycles'
- ***Strength***
  - Capable of holding 2800-pound loads both in racks (which provide support only for the edges of the pallets) and, on a flat surface, in stacks five loads high (each fully loaded with 2800 pounds).

GMA Functional Equivalence Test

Pallet	Weight (lb)	Bottom Surface Coverage	Top Surface Coverage	Rack Load	Fire Resistance	Edge Chamfer
iGPS	48.5	57%	97%	≥2,800	UL 2335 & FM 4996	Y
CHEP all wood	65	unknown	unknown	≥2,800	N/A	N
CHEP plastic	62	unknown	unknown	≥2,800	UL 2335 & FM 4996	Y
CHEP composite block	65	55%	unknown	≥2,800	FM 4996	N
PECO all wood	unknown	unknown	unknown	≥2,800	N/A	N
Rehrig Pacific plastic	49.5	unknown	unknown	2,000	UL 2335	Y

Functional Equivalence Test for Use in Shipping Same Types of Consumer Goods

- Some alternative pallets fail test
  - Metal pallets rarely used in consumer market
  - Plastic pallets without flame retardants can't serve similar function in open-pool pallet market
- Wood pallets are used for similar products
  - In determining equivalence, need to consider whether special subcategories rely most heavily on plastic pallets
  - No available data demonstrating such a pattern, but most comprehensive industry survey data from 2007

Approach to Determining 'Safer Alternatives"

- Broadened perspective on 'safer alternatives'
  - Safer chemical flame retardant alternatives
  - Systematic review of process and management alternatives that could meet safety &/or functional requirements while eliminating/ modifying need for flame retardant chemicals
- Provided alternative ways of viewing 'functionally equivalent'
- Expands horizon of issues considered in search for safer alternatives
- Widens basis for policy decisions

For additional information or questions

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