Session H
Phthalate Esters and Safer Alternatives for Plasticizers

TUR Planner Continuing Education Conference
April 4, 2019
Devens, MA

TURI
TOXICS USE REDUCTION INSTITUTE
UMASS LOWELL

Overview

This session will provide an overview of

- plasticizers and applications,
- phthalate ester hazards, and
- safer alternatives.

- Liz Harriman, TURI
- Gary Nedelman, Mexichem
- Amelia Nestler, Northwest Green Chemistry

Goals of Session

Share results of TURA SAB phthalate ester review and EHS concerns

Understand the plasticizer function in plastics and resins

Learn about potential safer alternatives for plasticizers

Relevance to TUR Planning

- TURA individually listed phthalate esters

Abbrev.	Common Name	CAS No.
DMP	Dimethyl phthalate	131-11-3
DEP	Diethyl phthalate	84-66-2
DBP	Dibutyl phthalate	84-74-2
BBP	Butyl benzyl phthalate	85-68-7
DEHP	Di(2-ethylhexyl) phthalate	117-81-7
DnOP	Di-n-octyl phthalate	117-84-0

- CERCLA phthalate ester category currently on list, but not subject to reporting

TUR Planning on Alternative Toxics

- Other Ortho - Phthalate Esters

Abbrev.	Common Name	CAS No.
DIBP	Diisobutyl phthalate	84-69-5
DINP	Diisononyl phthalate	68515-48-0 28553-12-0
DPHP	Di(2-propylheptyl) phthalate	53306-54-0
DTDP		85-68-7
DIDP	Diisodecyl phthalate	26761-40-0 68515-49-1

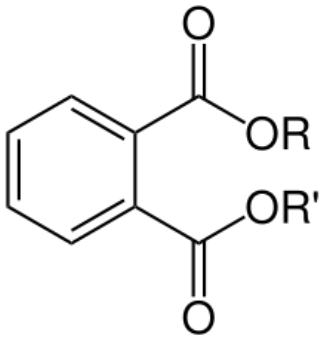
- Reportable chemicals below threshold

Phthalate Esters – SAB Review

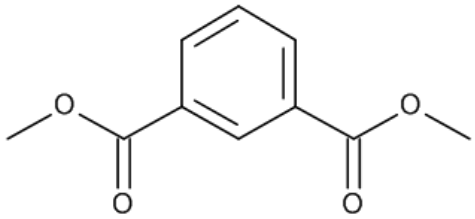
CERCLA listed and TURA listed, not reportable by DEP Policy

SAB review 2012-2015, focused on 10 selected ortho-PE's, also looked at meta-/iso- and para-/tere-

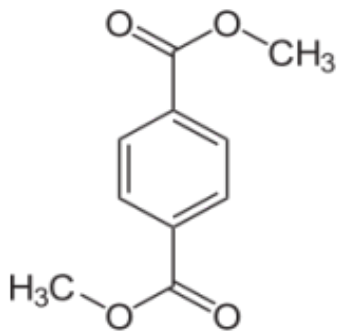
Phthalate Esters – Chemical Structure



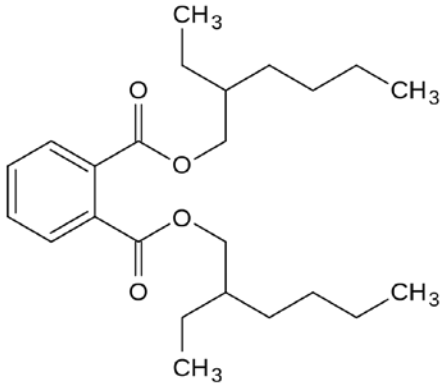
Ortho-phthalate ester



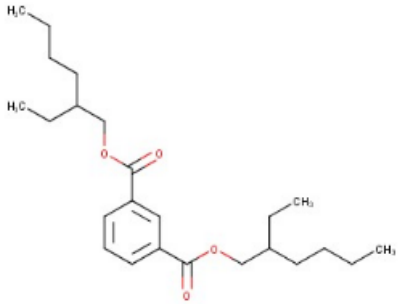
Isophthalate ester (meta-)



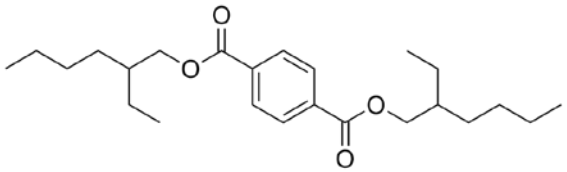
Terephthalate ester (para-)



e.g., DEHP: di-2-ethylhexyl phthalate



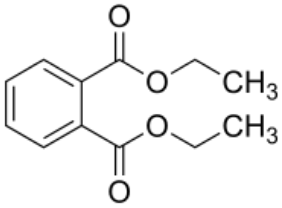
e.g., Di(ethylhexyl) isophthalate



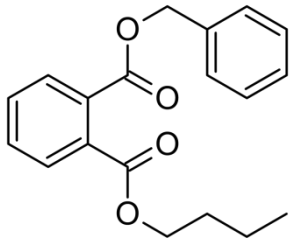
e.g., DEHT, DOTP; Di(ethylhexyl) terephthalate

Phthalate Esters - Uses

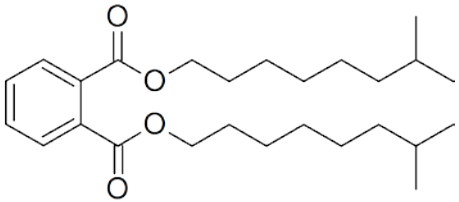
- Plasticizers in plastics
- solvents and emollients in personal care products and cosmetics



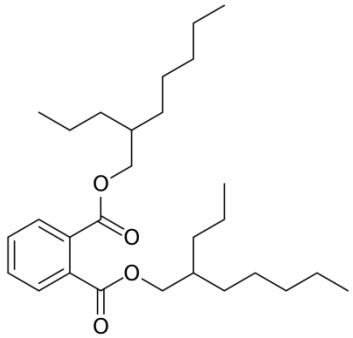
DEP – diethyl phthalate



BBP



DINP



DPHP

- Commercial products are mixtures, with various chain lengths and configurations

SAB selected 10 ortho PE's for in-depth review

10 Phthalate Esters Selected for In-Depth Review		Carbon chain length
DAP	Diallyl phthalate	C3
DMEP	Bis(2-methoxyethyl) phthalate	C3
DIDP	Diisodecyl phthalate	C8-C10
DnOP	Di-n-octyl phthalate	C8
DINP	Diisononyl phthalate	C8-C9
Din911P	1,2-Benzenedicarboxylic acid, 1-nonyl 2-undecyl ester, branched and linear	C8-C11
DPHP	Di-2-propyl heptyl phthalate	C7, C10
DUP	Diundecyl phthalate	C10-C11
DIUP	Diundecyl phthalate, branched and linear	C9-C11
DTDP	Ditridecyl phthalate	C10-C13

Review summary

- Effects of Highest Concern
  - Reproductive and developmental toxicity
  - Liver effects
  - Thyroid effects
  - Endocrine effects
- Cumulative effects
- Low dose effects

Summary Findings: Ortho PEs

C1-C3 (includes individually TURA listed DMP and DEP, and non-listed DPP, DMEP, and DAP, among others):

C1-C3 chain length substances have significant health effects, but not always the same effects as other PEs. These substances often are used as film-forming solvents; most of the known commercial plasticizer products are not in this range.

~ C4-C7

- Includes individually TURA listed DBP, BBP, DEHP (C8 total: C6 backbone w/ C2 branch), and non-listed DIBP, DinHP, DnPP, DnHP, DCHP, DiHepP, among others:
- Are the most well studied substances;
  - there is a significant body of animal evidence of adverse reproductive and developmental health effects, as well as some human evidence from epidemiological studies. (CPSC, 2010g)

Endocrine Pathways (C4-C7)

- General consensus from animal studies that some C4 and longer ortho-PEs are anti-androgens, interrupting the testosterone synthesis pathway.
- “Male reproductive syndrome” from fetal exposure during critical window
- Concern regarding the impact on hormone pathways.

Liver Effects (C4-C7)

- Liver is a primary target organ for most ortho-PEs, showing effects in chronic and subchronic animal studies.
- There are concerns that some of the liver effects involving peroxisome proliferation seen in animal studies are relevant to humans.

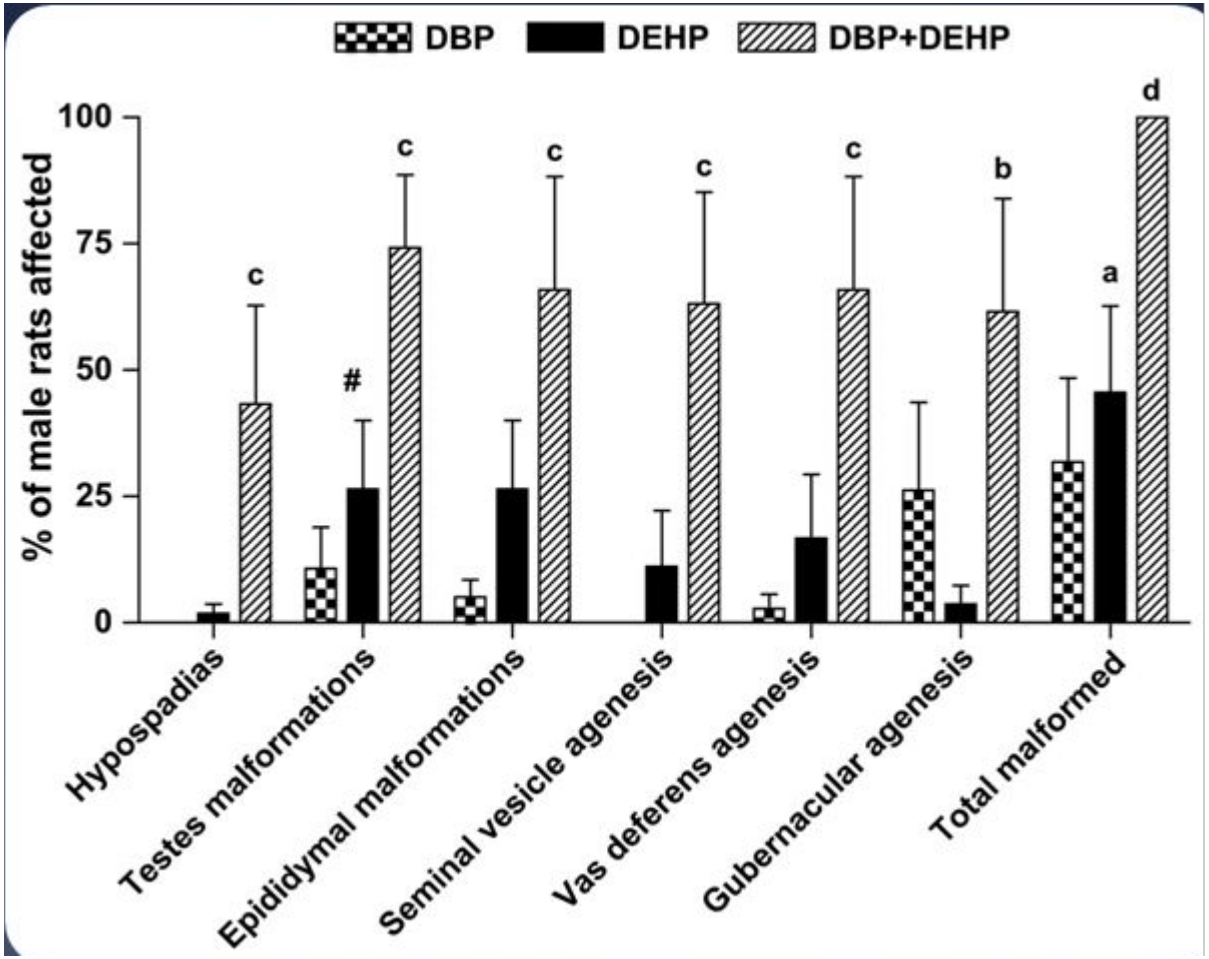
Thyroid (C4-C7)

- While not systematically evaluated by the SAB, thyroid effects were noted in a few of the reproductive studies reviewed, indicating an area of concern

> C7

- Includes individually TURA listed DnOP, and non-listed DINP, DIOP, DIDP, DNP, Din911P, DIUP, DUP, DPHP, DTDP, among others):
- After C7, there is a general tendency as the carbon backbone chain length increases, for the adverse effects to diminish and for there to be fewer scientific studies.

Cumulative effects: lessons from phthalates



Howdeshell et al. 2007

Phthalate Esters by carbon side chain backbone length: Regulatory and Policy Activity (as of 1APR2019)

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
DMP	DEP		DBP	DnPP; DPP	DEHP		DINP		DTDP			
TURA	TURA CoRAP (concluded no further risk mgmt based on consumer exposure) WA CHCC ME CHC -P		TURA CA Prop 65 CPSC SVHC Auth EPA CAP EPA TSCA EU Restrict RoHS ME CHC*-P WA CHCC	SVHC EPA CAP SNUR CPSC WA CHCC	TURA SVHC Auth CA Prop 65 CPSC EPA CAP EPA TSCA EU Restrict RoHS WA CHCC ME CHC - P		CA Prop 65 CPSC EPA CAP EU Restrict WA CHCC		CoRAP			
		DIBP		DIPP	TBPH		DnOP	DIUP				
		SVHC Auth EPA CAP EPA TSCA CPSC RoHS WA CHCC		SVHC	EPA TSCA CoRAP WA CHCC		TURA EPA CAP EU Restrict WA CHCC	CoRAP				
		DMEP	BBP (ring)	PIPP		DIOP	DIDP					
		SVHC WA CHCC	TURA SVHC Auth CA Prop 65 CPSC EPA CAP EPA TSCA EU Restrict RoHS ME CHC*-P WA CHCC	SVHC			CA Prop 65 EPA CAP EU Restrict WA CHCC					
		DAP	DCHP (ring)	DnHP; DHP		Benzyl C7-C9			DUP, DnUP			
		CoRAP	EPA TSCA SVHC CPSC ME CHC WA CHCC	SVHC CA Prop 65 CPSC WA CHCC		CoRAP			CoRAP			
			DHNUP 7-11 branched and linear 68515-42-4									
			SVHC									
					C6-8, C7 rich; DiHepP			C9-C11				
					SVHC			CoRAP				
						DPHP			DPHP			
						CoRAP			CoRAP			
							Din911P					
					610P; Di C6-10PE							
KEY					SVHC							