



Toxics Use Reduction Institute

EH&S Considerations for Drop-In Alternatives to TCE

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EH&S Considerations for Drop-In Alternatives to TCE

- Overview of Standard Hazard Criteria
- Do TCE, Perc, & nPB have anything in common?
- EPA Information
- Studies on nPB
- Comprehensive Solutions from an EH&S perspective



Criteria Overview

- Science Advisory Board
 - Environment – Physical Characteristics
 - PBT
 - Vapor Pressure
 - Flashpoint
 - NIOSH-REL; OSHA-PEL; TLV-TWA
 - Health – Inherent Hazards
 - IARC
 - Mutagenicity/Carcinogenicity/Neurotoxicity
 - Reproductive/Developmental Toxicity
 - LC50/LD50

Identified Drop-In Solvents

- Identified 20 alternative drop-in solvent degreasers
- Six Classes of Chemicals
 - Hydrochlorofluorocarbon
 - Hydrofluorocarbon
 - Hydrofluoroethers
 - n-Bromopropane
 - Volatile Methylsiloxanes
 - Dichloroethylene

Class	Base Chemical
1	Chlorinated hydrocarbon*
2	HCFC
3	HFC
4	HFE
5	nPB
6	Volatile Methylsiloxanes
7	Dichloroethylene

*Replaced Solvents



TCE – PCE – nPB?




ACUTE EFFECTS (SHORT TERM)

TCE - HHS	PCE – Pending HHS	nPB - ?
Inhaled, acts as CNS depressive & exposure can cause dizziness, unconsciousness, visual disturbances, nausea & vomiting.	Single exposures can cause CNS effects such as dizziness, headache, sleepiness, confusion, nausea, difficulty speaking and walking.	High inhalation can cause respiratory tract irritation, CNS depression and anesthetic effects.
GI absorption is rapid if ingested and can produce CNS depression . Aspiration onto lungs can cause chemical pneumonia .	High- level exposure may cause vomiting, unconsciousness & death.	Ingestion of a large amount can cause abdominal pain, nausea and vomiting.
Very high levels can cause irregular heartbeat which can be fatal .	Not considered a significant skin irritant but prolonged exposure with undiluted liquid may cause skin irritation.	Can cause eye and skin irritation and redness.
Exposure can result in skin irritation and corneal injury.	An eye irritant causing pain, redness and general inflammation.	




TCE – PCE - nPB?

CHRONIC EFFECTS (LONG TERM)

TCE - HHS	PCE – Pending HHS	nPB - ?
<p>Repeated contact can cause irritation, blistering, roughening and cracking of exposed skin.</p>	<p>Long-term exposure may cause liver and kidney damage.</p>	<p>Prolonged exposure may cause lung, liver and kidney damage.</p>
<p>Repeated exposure can cause memory loss, headache, depression and weakness in the arms and legs.</p>	<p>Prolonged and repeated exposure may cause dermatitis.</p>	<p>Extended skin exposure may lead to pain, cracking and dermatitis.</p>
<p>Drinking or ingesting large amounts may cause liver and kidney damage, impaired immune function.</p>	<p>Increased health risks for people with pre-existing skin disorders and impaired renal or liver function.</p>	
<p>Breathing for long periods of time may cause impaired heart function, unconsciousness & death.</p>		

TCE – PCE - nPB?

CANCER HAZARDS

TCE - HHS	PCE – Pending HHS	nPB - ?
It may cause mutations & possible impaired fetal development.	US Dept of Health & Human Services says reasonably anticipated to be a carcinogen.	No available information.
There is evidence that TCE causes lung kidney & liver cancer in animals.	Animal testing has linked high exposure to liver and kidney cancer as well as also leukemia.	
It may cause lung and liver cancer.	NIOSH recommends handling it as a possible carcinogen.	
Trichloroethylene is probably carcinogenic to humans (IARC - Group 2A).	Tetrachloroethylene is probably carcinogenic to humans (IARC - Group 2A).	HAS NOT BEEN EVALUATED BY IARC TO DATE.

Information for Some Solvents

from EPA study

Solvent	Exposure limit (source)	VOC?	Listed HW?	HAP?
Perchloro-ethylene	25 ppm (ACGIH) 100 ppm (OSHA)	No	Yes	Yes
n-Propyl Bromide	10 ppm (ACGIH) 5-100 ppm (mfr)	Yes	No	No
Decamethyl-cyclopenta-siloxane (D5)	10 ppm (mfr)	Yes	No	No
Trichloro-ethylene	50 ppm (ACGIH) 100 ppm (OSHA)	Yes	Yes	Yes

Data considered by EPA

TABLE 3.—ECOSYSTEM AND OTHER ENVIRONMENTAL PROPERTIES OF NPB AND OTHER SOLVENTS

Property	Description of environmental property	Value for nPB	Value for trans-1,2-dichloro-ethylene	Value for trichloroethylene	Value for methyl chloroform
K_{oc} , organic-carbon partition coefficient.	Degree to which a substance tends to stick to soil or move in soil. Lower values (< 300)* indicate great soil mobility; values of 300 to 500 indicate moderate mobility in soil.	330 (Source: ICF, 2004a).	32 to 49 (Source: ATSDR, 1996).	106 to 460 (Source: ATSDR, 1997).	152 (Source: U.S. EPA, 1994a).
Break down in water.	Mechanism and speed with which a compound breaks down in the environment. (Hydrolysis half-life values > 25 weeks* are of concern.)	Hydrolysis is significant. Hydrolysis half-life of 26 days (Source: ICF, 2004a).	Photolytic decomposition, dechlorination and biodegradation are significant; hydrolysis not significant (Source: ATSDR, 1996).	Volatilization and biodegradation most significant, with hydrolysis relatively insignificant. Hydrolysis half-life of 10.7 to 30 months (Source: ATSDR, 1997).	Volatilization most significant; biodegradation and hydrolysis also occur (Source: ATSDR, 2004).
Volatilization half-life from surface waters.	Tendency to volatilize and pass from water into the air.	3.4 hours-4.4 days (Source: ICF, 2004a).	3 to 6.2 hours (Source: ATSDR, 1996).	3.4 hours to 18 days (Source: ATSDR, 1997).	Hours to weeks (Source: U.S. EPA, 1994a).
LC ₅₀ (96 hours) for fathead minnows.	Concentration at which 50% of animals die from toxicity after exposure for 4 days.	67 mg/L (Source: Geiger, 1988).	108 mg/L (Source: U.S. EPA, 1980).	40.7 to 66.8 mg/L (Source: NPS, 1997).	52.8 to 105 mg/L (Source: U.S. EPA, 1994a).
log K_{ow}	Logarithm of the octanol/water partition coefficient, a measure of tendency to accumulate in fat. Log K_{ow} values >3* indicate high tendency to accumulate.	2.10 (Source: ICF, 2004a).	-0.48 (Source: LaGrega <i>et al.</i> , 2001, p. 1119).	2.38 (Source: LaGrega <i>et al.</i> , 2001, p. 1127).	2.50 (Source: LaGrega <i>et al.</i> , 2001, p. 1127).
Bioconcentration factor.	High factors (>1000)* indicate strong tendency for fish to absorb the chemical from water into body tissues.	23 (Source: HSDB, 2004).	5 to 23 (Source: ATSDR, 1996).	10 to 100 (Source: ATSDR, 1997).	<9 (Source: U.S. EPA, 1994a).

*Criteria from EDSTAC, 1998.

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Significant New Alternatives Policy (SNAP)

End Use	Substitute	Decision	Further Information
Metals cleaning, electronics cleaning, and precision cleaning	N-propyl bromide (nPB) as a substitute for CFC-113 and methyl chloroform	Acceptable...	EPA Recommends the use of PPE, including chemical goggles, flexible laminate protective gloves and chemical-resistant clothing. EPA expects that all users of nPB would comply with any final Permissible Exposure Limit that the OSHA issues in the future under 42 U.S.C. 7610(a).

How is EPA proposing that nPB may be used?

For this end use,	EPA is proposing that use of nPB is:
Coatings (only for facilities that as of proposal date provided data demonstrating ability to maintain acceptable exposure levels)	Acceptable Subject to a Use Condition
Aerosol solvent	Unacceptable*
Adhesive carrier solvent	Unacceptable*

* Data from a number of facilities and from modeling indicate likely exposures in excess of potentially protective levels, and therefore, unacceptable health risks for users of nPB-based adhesives and aerosols.

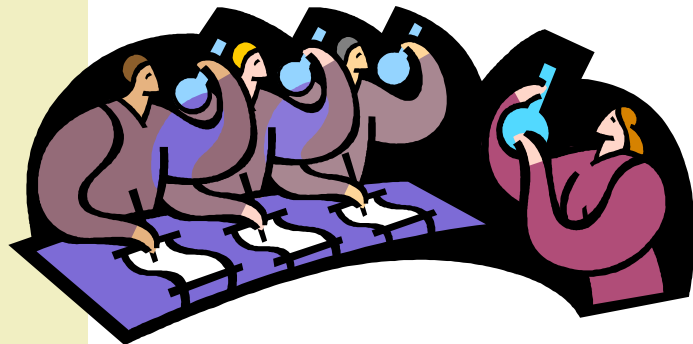
nPB is not currently regulated as a hazardous air pollutant and is not listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA). nPB is not required to be reported as part of the Toxic Release Inventory under Title III of the Superfund Amendments and Reauthorization Act. Despite this, large amounts of nPB might be harmful if disposed of in water. We recommend that users dispose of nPB as they would dispose of any spent halogenated solvent (F001 waste under RCRA). Users should not dump nPB into water, and should dispose of it by incineration.

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Volatile Methyl Siloxanes

Dow – OS 10, OS 20, OS 30

ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Can affect you when breathed in or ingested.	Over exposure to skin can cause de-fatting and drying of skin leading to dermatitis.	Insufficient information available.
Can cause eye and skin irritation and redness.	Repeated ingestion can cause internal injuries.	
High levels of exposure can cause dizziness, disorientation & shortness of breath.		



Insufficient information does not imply safety!

Further research is critical for proposed alternatives.

nPB as an option

- NIOSH Epidemiological study
 - Who?
 - When?
 - Why?
 - What?
 - How?
 - Next steps
- ANA Study
- EPA study
 - LD50 data
 - Observed Effects on Animals & Humans



- Input Substitution
- Production Unit Modernization
- Product Reformulation
- Production Unit Re-design or Modification
- Improved Operations & Maintenance
- Integral Recycling

- Resources available for EH&S data
 - Toxicology
 - PBT Profiler
 - TURA Program
 - Bibliographies of Current Studies
- Disposal Issues
- Continual Process Improvement
- Regulation
- Count the Cost