Massachusetts Chemical Fact Sheet

n-Propyl Bromide
(nPB, 1-Bromopropane or 1-BP)

This fact sheet is part of a series of fact sheets developed by the Toxics Use Reduction Institute (TURI) to help Massachusetts companies and communities understand uses, health and environmental effects and the availability of safer alternatives to individual chemicals.

nPB is used as a solvent in vapor degreasing, metal cleaning and dry cleaning; as a solvent carrier in adhesives; and as a chemical intermediate. In December 2022, the US Environmental Protection Agency (EPA) found that nBP, "as a whole chemical, presents an unreasonable risk of injury to health under its conditions of use."[1] Based on that risk evaluation, EPA proposed final regulation of nPB which blocks consumer access, restricts industrial and commercial uses (with transition periods), and strengthens protections for workers.[2] EPA classifies nPB as a volatile organic compound (VOC) and a hazardous air pollutant (HAP).

Over the recent decades nPB has been used as an alternative for other solvents that have become more strictly regulated, such as methylene chloride, perchloroethylene (perc), and trichloroethylene (TCE). However, evidence has since come to light linking nPB to a range of human health hazards similar to those solvents it had replaced.

nPB has been reportable under the Toxics Use Reduction Act (TURA) since 2010 and was designated a Higher Hazard Substance under TURA in 2016**.** Under this designation, Massachusetts facilities in TURA-covered industrial sectors with ten or more employees are required to report, plan for reductions and pay fees if they use 1,000 pounds or more of nPB annually.

nPB Facts	
Synonyms	nPB; 1-Bromopropane; 1-BP, n-Propyl Bromide; Propyl bromide
Chemical Formula	C_3H_7Br
CAS Number	106-94-5
Vapor Pressure	110.8 mm Hg at 20˚C
Solubility	Soluble in cold water (2.5g/l@ 20˚C), diethyl ether, acetone, and ethanol
Flashpoint/ Flammability	Flashpoint: 22°C closed cup Highly flammable. Gives off irritation or toxic fumes (or gases) in a fire. Vapor/air mixtures are explosive. NO open flames, NO sparks and NO smoking. Do NOT expose to heat, friction or shock. Use water spray, powder, alcohol-resistant foam, carbon dioxide. In case of fire: keep drums, etc., cool by spraying with water. National Fire Protection Association (NFPA) fire rating of 2 (where level 4 is highest). "*Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating could release vapor in sufficient quantities to produce hazardous atmospheres with air.*"
Description	Colorless liquid at room temperature and pressure and has a pungent odor. It is found in products in liquid or spray form and is sometimes marketed as a "green" solvent.

Sources: Cameo Chemicals Database of Hazardous Materials, National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration; International Labour Organization (ILO), World Health Organization (WHO), International Chemical Safety Cards; PubChem.

Health and Environmental Impacts

The National Institute for Occupational Safety and Health (NIOSH) under the Occupational Safety and Health Administration (OSHA) has issued a Hazard Alert for nPB because of its hazardous characteristics.[3] Inhalation of vapor or mists and skin contact are the primary routes of exposure associated with uses of nPB.

Acute (Short-Term) Health Effects

The following effects have been reported among workers with high exposures to nPB:[4,5,6]

- Eye, nose, throat or lung irritation
- Headache, fatigue, dizziness, nausea or malaise

Chronic (Long-Term) Health Effects

Studies of both short- and long-term worker exposure to nPB indicate effects on the peripheral and central nervous systems, and hematological (blood) effects. Animal studies indicate similar nervous system effects, as well as effects on the liver, male and female reproductive systems, and on the developing fetus. nPB has also been shown to cause cancer in animal studies.

Neurotoxicity: Peripheral and central nervous system toxicity has been observed in workers exposed to nPB, and

in animals. In several studies, exposed workers exhibited the following symptoms persisting for months and, in some cases, years after exposure:[3,7,8]

- Joint pain or leg weakness and pain leading to difficulty with standing and walking (stumbling);
- Muscle twitching or numbness, tingling, and prickling in the hands or feet, loss of vibration sense;
- Anxiety, apathy, insomnia and memory and concentration difficulties.

Developmental and reproductive effects: In 2003 the National Toxicology Program's (NTP) Center for the Evaluation of Risks to Human Reproduction (CERHR) concluded that nPB is a developmental and reproductive toxicant based on animal studies.[9] nPB was found to affect sterility in both females and males. nPB also caused delayed growth in the offspring of animals exposed during pregnancy. While no epidemiological study has examined the developmental and reproductive effects of nPB in humans, some case studies of female workers occupationally exposed to nPB reported altered menstrual periods.[9,10] These effects have not been observed in all studies. The European Union characterizes nPB with the risk phrase H360FD (May damage fertility. May damage the unborn child.)[11]

Liver toxicity: Animal studies suggest that exposure may harm the liver.[12]

Immunosuppression: Animal studies suggest that exposure may suppress the immune system.[13]

Hematological effects: Studies of workers indicate that exposures can result in lowered red blood cell count.[3]

Cancer: Evidence from a 2-year inhalation cancer study conducted by NTP resulted in classification of nPB as "reasonably anticipated to be a human carcinogen." The International Agency for Research on Cancer (IARC) of the World Health Organization classified nPB as a "possible human carcinogen."[14,15] Because nPB is a newer solvent, and cancer takes a long time to develop, studies of cancer associated with nPB exposure among workers or the public have not been conducted.

Worker Exposure Limits

No federal or Massachusetts agency has established safe exposure limits for workers using nPB, although in 2016 NIOSH issued a draft report proposing a Recommended Exposure Limit (REL) of 0.3ppm.[16] In 2014, the American Conference of Governmental Industrial Hygienists (ACGIH) lowered its Threshold Limit Value (TLV) for nPB from 10 ppm to 0.1 ppm as a time weighted average (TWA).[17] This change was based on evidence of nervous system damage in workers exposed to low levels of nPB as well as the potential of nPB to cause cancer.[18] Employers and workers should err on the side of caution by keeping exposures to nPB as low as possible.

Environmental Fate

EPA recommends that nPB be disposed of similarly to other halogenated solvents in order to avoid damage to aquatic life. The LC_{50} (lethal concentration at which 50% of test animals die) is 67 mg/L (slightly toxic) for fathead minnows. According to EPA, nPB has a low tendency to concentrate in living organisms, is moderately mobile in soil, tends to volatilize and breaks down easily in water. [19]

Uses

nPB is effective at dissolving fats/oils, waxes and resins. As a degreasing agent, nPB is used in operations such as metal finishing and metal working; precision cleaning; auto parts cleaning; dry cleaning; and removing solder flux residue in electronic parts manufacturing. nPB is also used as a chemical processing intermediate in the synthesis of pharmaceuticals, insecticides, quaternary ammonium compounds, flavors and fragrances, and as a solvent for extracting tar from asphalt.

Products Containing nPB

Employers or employees may only know nPB products by their trade names. The following list shows some common trade names for nPB-containing products. **This list is not comprehensive, and product formulations may change at any time.** If there is a question as to whether a specific product contains nPB, check the Safety Data Sheet (SDS). Additional nPB-containing products are no longer on the market but may still be present in the workplace.

Degreasing, lubrication, extraction & cleaning agents	
Abzol (Albemarle)	Metalnox M6960 (Kyzen)
Alpha VaporEDGE 1000 (Cookson Electronics)	Misty Safety Solvent 2000 (Amrep)
Contact Cleaner (Blaster)	NPB Heavy Duty Cleaner Degreaser (MG Chemicals)
DrySolv (Envirotech)	Pensolv PB2000 (West Pentone)
Ensolv A, CW, EX, GCS & Ionic (Envirotech)	Solvon (Poly Systems)
Entron and Entron-Aero (Reliance)	Techtride NPB (Parts Cleaning Technologies)
GenTech (Reliance)	Triagen (Ecolink)
Hypersolve (Ecolink)	VDS-3000 (SuperKleen/Albatross)
Instant Super Degreaser II, NoFlash, Electra-X (LPS)	X-CEL, X-CEL IC (Western Chemical International)
Lenium ES, GS, XS, RV (Petroferm)	
Adhesives	
Whisper Spray (Henkel)	Endurabond Normac 900R-NPB (Blair Rubber Co)
K-Grip 501 Spray Adhesive (Maple Leaf Sales II)	Soft Seam Adhesive (Spectrum Adhesives, formerly Mid-South Adhesives)

Some facilities using nPB as a drop-in substitute for other solvents have experienced problems with equipment corrosion. nPB must be stabilized to prevent the buildup of acid breakdown products and to inhibit reaction with

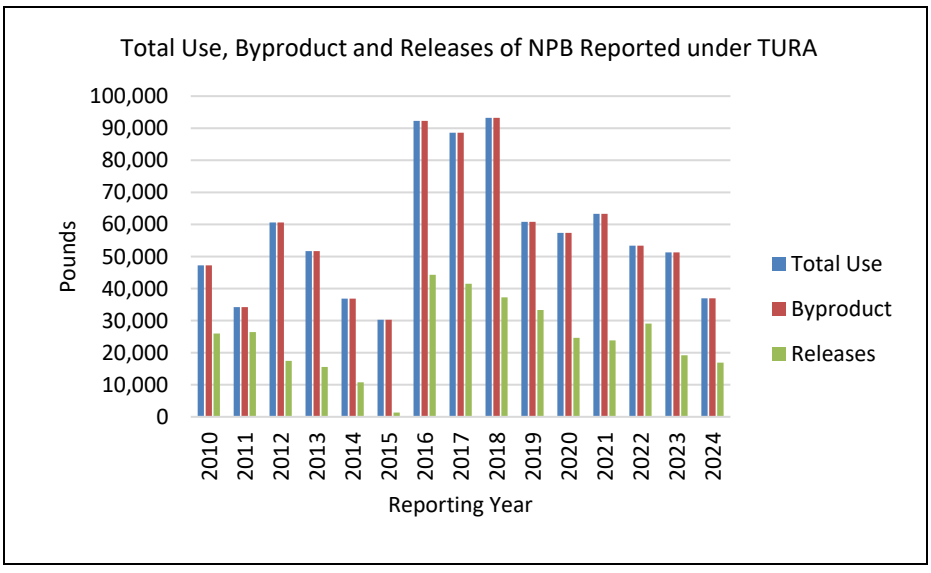
metals. If not properly stabilized, nPB breaks down into hydrobromic acid, which can corrode equipment and potentially emit very toxic hydrogen bromide gas. Chemicals used as stabilizers include hazardous 1,3-dioxolane and 1,2- butylene oxide.[9]

In 2010, the first year that reporting was required for large quantity (>10,000 lb/year) users of nPB under TURA, three Massachusetts facilities (two industrial cleaning applications and one adhesive formulation) reported 47,209 pounds used. When nPB was designated a Higher Hazard Substance in 2016 (thus lowering the reporting threshold to 1,000 lb/year), reported use increased to 92,300 pounds with 21 facilities reporting. This use, along with byproduct (production-related waste) and releases of NPB to the environment, is shown for TURA filers in the charts below.

Currently, the fabricated metal products sector uses the majority of nPB reported under TURA.

nPB Use Reported Under TURA: 2016 and 2024

Industry Sector	Facility Name	Location	2016 Use	2024 Use
Adhesives and Sealants	ITW (Holcim)	Danvers	13,227	-
	Amrize Building Envelope LLC	Rockland	-	4,866
Porcelain Electrical Supplies	Morgan Advanced Ceramics	New Bedford	3,306	-
Wire and Cable	American Superconductor Corp	Ayer	4,128	1,376
Fabricated Metal Products	Stafford Manufacturing Corp	Wilmington	6,868	6,612
	Delta Electronics Mfg Corp	Beverly	2,258	-
	Valentine Tool & Stamping Co	Norton	2,204	1,433
	B&J Manufacturing Corp	Taunton	2,797	-
	Central Metal Finishing Inc	North Andover	6,960	6,735
	Tech Etch Inc	Plymouth	4,600	-
	Absolute Metal Finishing	Norwood	1,554	2,242
	Litron Inc	Agawam	1,183	-
	Duncan Galvanizing	Everett	8,331	-
	Tech Etch Inc	Plymouth	3,585	4,699
	Microgroup	Medway	-	1,564
	Senior Metal Bellows	Sharon	-	1,219
Machine Tool Accessories	LS Starrett Co	Athol	7,150	-
Electron Tubes	Communications & Power Industries LLC	Beverly	1,292	-
Electronic Equipment	International Rectifier Hirel Products	Leominster	8,777	-
	Microsemi Lawrence	Lawrence	4,324	-
	Aerovox Corp	New Bedford	5,498	-
	Sinclair Mfg Co	Norton	1,653	-
	Ultra Electronics Herley	Woburn	1,600	-
	Ametek Hcc Aegis	New Bedford	1,005	-
Industrial Machinery	Synventive Molding Solutions	Peabody	-	5,004
Transportation Equipment	Lockheed Martin Corp	Andover	-	1,199
		Totals	**92,300**	**36,949**



In 2007, EPA's Significant New Alternatives Policy (SNAP) program, which evaluates and regulates substitutes for ozone depleting chemicals, determined that nPB was an acceptable substitute for chlorofluorocarbon-113 and for methyl chloroform when used as a solvent in industrial cleaning equipment for metals, electronics, and precision cleaning. At that time EPA also considered nPB unacceptable as an aerosol solvent or as an adhesive carrier.[19]

At that time, health concerns and increased regulation of TCE (for degreasing and metal cleaning) and perc (for garment cleaning) resulted in increased use of nPB in these

sectors as a relatively inexpensive and less regulated "drop-in substitute" for these two chlorinated solvents. However, scientific evidence now indicates that **nPB is not a safer substitute for TCE or perc, or for other solvents such as methylene chloride**.

Workers may unknowingly be exposed to hazardous levels as nPB has been marketed as a "green" product. One study of multiple dry-cleaning establishments found that nPB levels in the breathing zone of dry-cleaning operators were routinely high—over twice to 10 times the exposure limit of 5 ppm (TWA) set by the California Occupational Safety and Health Standards Board.[20]

Alternatives

A number of alternatives to nPB for its primary uses in degreasing, cleaning, and adhesive applications are readily available.

Degreasing

Non-halogenated alternatives to nPB for use in degreasing and precision cleaning operations include aqueous or semi-aqueous cleaning processes and non-halogenated organic solvents. For vapor degreasing, key physical properties that dictate which alternative is appropriate include low latent heat, low boiling point, high flashpoint, low surface tension and high solvency powers.

The TURI Laboratory can help identify appropriate process- and application-specific alternatives. Some facilities may be able to redesign their processes to eliminate the need for degreasing altogether. Effective aqueous and semi-aqueous processes may include the use of soaking or ultrasonic equipment.

Aqueous Cleaners

Aqueous cleaners have been used for decades to meet industry surface cleaning needs. Aqueous cleaners can typically be categorized as acidic, alkaline, neutral, caustic, enzymatic-microbial, or powdered detergents. Many aqueous products on the market are suitable replacements for halogenated solvents, like nPB, in specific applications.

Although aqueous cleaning is generally among the safest alternatives, the process uses water and a smaller quantity of additives such as mineral acids, builders, corrosion inhibitors, detergents, chelating and sequestering agents, emulsifiers, and surfactants to improve cleaning. The potential hazards of products in this broad category vary depending on the concentration as well as the surfactants and additives used. Aqueous cleaners are nonflammable but may contain additives with some level of VOCs. Especially as concentrates, these cleaners may have environmental hazards and risks to aquatic life that must be considered.

Semi-Aqueous and Non-Halogenated Solvents

When aqueous cleaning is not feasible or practicable, use of solvents may be needed to achieve degreasing performance requirements. Semi-aqueous degreasing often combines solvent-based contaminant removal and rinsing with water. Many solvent-based products are available with significantly improved environmental health and safety profiles compared to halogenated solvents like nPB. Potentially safer solvents include biobased cleaners, terpenes, esters, alcohols, acetone, ketones, acetates, petroleum distillates, and semi-aqueous solvents.

There is overlap within the categories and some aqueous cleaners may contain organic solvents. It is imperative to know that these solvents are not always safer as exposure can result in acute health effects (ranging from irritation of the eyes, skin and respiratory system, dizziness, nausea, and confusion); and chronic effects (including liver and kidney problems). Solvents also typically evaporate quickly, creating air quality concerns in the workplace. Most non-halogenated organic solvents are flammable or combustible liquids, may be classified as VOCs and may pose environmental hazards and risks to aquatic life.

Drop-In Halogenated Solvents

Avoid "drop-in" solvents such as trans-1,2-Dichloroethylene/ hydrofluoroether (transDCE/HFE) blends as they are not preferrable from an environmental health and safety standpoint.[21] In general, hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) also pose significant hazards, such as ozone depletion (HCFCs) and global warming (HFCs). Likewise, methylene chloride and TCE are not less hazardous alternatives.

Vacuum Degreasing

Vacuum degreasers provide parts cleaning inside a sealed chamber, minimizing emissions and increasing overall efficiency. Users can select from multiple cycle programs and process options to match the needs of their parts or products. Vacuum degreasing can use a wide variety of cleaners, including safer solvents or aqueous cleaners, which can be almost fully recovered and reused.

One safer solvent blend used in vacuum degreasing units is "modified alcohols." A variety of products currently on the market contain modified alcohol, many of which contain glycol ethers mixed with alcohols. These glycol/alcohol blends are highly compatible with water-based formulations.

Alcohol cleaners can have a high evaporation rate, are combustible and may be classified as VOCs. They also may be harmful if swallowed and may cause breathing difficulties if inhaled. Both alcohol and modified alcohol

cleaners have been shown to cause mild skin and eye irritation.

Garment Cleaning

The least toxic alternatives to nPB in dry cleaning are carbon dioxide (CO_2) and professional wet cleaning. CO_2 systems use CO_2 in liquid or supercritical fluid but require specialized equipment. In addition, the highly pressurized gas poses potential safety risks. Professional wet cleaning uses water-based methods with specialized detergents and tensioning equipment, offering a safer and cost-effective alternative despite potential skin and eye irritation.[22] TURI has experience assisting Massachusetts garment cleaning facilities to convert to professional wet cleaning. Results show good cleaning quality, fewer health hazards, and natural resource savings.

Hydrocarbon-based solvents and the volatile methyl siloxane (D5) solvent are also used. Hydrocarbon-based solvents require process changes, present fire hazards and lack comprehensive toxicity testing. D5 raises concerns about persistence, bioaccumulation, and potential carcinogenicity with studies showing increased incidence of uterine cancer in rats.[23]

Adhesives

Alternatives to nPB used as the solvent carrier in adhesive products include both non-solvent and solvent substitutes. Water-based adhesives are less toxic alternatives and are suitable for some, but not all, applications. Some aqueous-based carriers use latex or latex-synthetic blends. However, there are worker sensitization concerns associated with latex and some aqueous-based carriers may contain ammonia, which can irritate the eyes, respiratory tract, and skin. Additional process changes may be required if aqueous-based alternatives are used. Hot melt adhesives also appear to be less toxic and work for some applications.

Some solvent adhesive formulations use acetone, and while generally low in toxicity, it has a very low flashpoint, so systems must be in place to minimize the chance of fire or explosion. Other solvent-based formulations may contain mineral spirits, petroleum solvents, petroleum distillates, and naphthas that present additional human health and/or environmental concerns.

Halogenated solvent-based formulations using methylene chloride, TCE, or trans DCE are undesirable alternatives to nPB-based products given their significant human health and environmental health impacts.

Regulatory Context

Massachusetts

Effective January 2016, nPB was designated as a Higher Hazard Substance under TURA. Under this designation, Massachusetts facilities with 10 or more full-time employee equivalents that manufacture, process or otherwise use 1,000 pounds or more of nPB annually are required to report on their use and to conduct toxics use reduction planning. For more information about facility responsibilities under the TURA program, see: http://www.mass.gov/dep/toxics/toxicsus.htm.

nPB is subject to other regulatory considerations, shown in the following table.

Additional Regulatory Considerations	
Occupational Exposure Limits	• ACGIH TLV/TWA:[a] (2014): 0.1 ppm [17] • OSHA PEL:[b] *no PEL established* • NIOSH REL:[c] *0.3ppm (proposed 2016)* [16] • CA OSH PEL (2009):[d] 5 ppm [3] • Existing chemical exposure limits (ECEL)[2]: 0.05ppm
OSHA	• OSHA's Hazard Communication Standard applies to nPB. Employers are required to provide health and safety information and training to workers using nPB.[3]
EPA	• Effective January 2016, nPB has been added to the list of chemicals reportable under the Toxics Release Inventory.[24] • The Agency has not reviewed nPB to determine whether nPB should be regulated as a hazardous waste or as a toxic substance in drinking water. • EPA added nPB to the list of hazardous air pollutants in 2021.[25] • EPA's SNAP states that nPB use as an aerosol solvent or as an adhesive carrier solvent would be unacceptable.[19] • EPA's proposed TSCA rule (2024) identifies restrictions for industrial, commercial, and consumer uses of nPB.[2]
European Union	• The EU classifies nPB as H360FD (May damage fertility. May damage the unborn child.), H315, H319 (Causes skin irritation. Causes serious eye irritation.), H335, H336 (short term exposure may cause respiratory irritation, dizziness or drowsiness), H373 (prolonged exposure may cause damage to organs), H225 (highly flammable liquid and vapor). [11] • nPB is listed as a Substance of Very High Concern under REACH.[26]
California	California Proposition 65 lists nPB as a developmental/reproductive toxicant (male and female) and as a carcinogen. [27,28]

[a] ACGIH's Threshold Limit Value/Time Weighted Average for inhalation exposures lasting 8 hours/day, 5 days/week.
[b] OSHA's Permissible Exposure Limit (typically for an 8-hour time weighted average).
[c] NIOSH's Recommended Exposure Limit.
[d] CA OSH Standards Board PEL (8-hour time weighted average). *This exposure limit was based on reproductive and developmental toxicity data and industry's technological feasibility assessments.*

[1] Environmental Protection Agency, Final Revised Unreasonable Risk Determination for 1-Bromopropane, December 2022, https://www.epa.gov/system/files/documents/2022-12/1-BP_Final%20Revised%20RD_12-12-22.pdf

[2] Environmental Protection Agency. "1-Bromopropane (1-BP); Regulation Under the Toxic Substances Control Act (TSCA)." 89 Fed. Reg. 65066, Aug. 8, 2024, https://www.govinfo.gov/content/pkg/FR-2024-08-08/pdf/2024-17204.pdf

[3] Occupational Safety and Health Administration, National Institute for Occupational Safety and Health. Hazard Alert: 1-Bromopropane. July 2013.

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[9] National Toxicology Program, Center for the Evaluation of Risks to Human Reproduction. Monograph on the Potential Human Reproductive and Development Effects of 1- Bromopropane. October 2003, NIH Publication. 04-4479. https://ntp.niehs.nih.gov/sites/default/files/ntp/ohat/bromopropanes/1-bromopropane/1bp_monograph.pdf

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[13] Morgan DL, et al. Multisite carcinogenicity and respiratory toxicity of inhaled 1-bromopropane in rats and mice, Toxicol Pathol. 2011 39(6):938-48.

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[26] Official Journal of the European Union, Commission Regulation (EU0 2017/999, June 13, 2017, Accessed 1/30/2026 at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R0999

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