

# **Summarizing the Regulatory and Health Issues Surrounding the Use of n-Propyl Bromide in Foam Fabricating Adhesives**

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## **Abstract**

N-propyl bromide (NPB) has been gaining popularity as a replacement solvent used in spray adhesives that are utilized in the foam fabricating industry. It has been heralded as a replacement for ozone depleting substances since the late 1990's. This paper will briefly summarize the latest information regarding its regulatory status and issues surrounding its toxicity when used in spray adhesive formulations. Upaco Adhesives, a division of Worthen Industries, has never offered NPB based foam fabricating adhesives due to the regulatory and health issues that surrounded its use.

## **Introduction**

Adhesive solvents are materials that solvate the adhesive resins (solids) and act as a carrier for these adhesive solids. The solvent actually carries the solids to the materials to be bonded. Once the adhesive is applied to the surfaces to be bonded, the solvent evaporates, therefore leaving the solids behind to produce a lasting bond.

Solvents not only provide a carrier medium to liquefy the adhesive, but they are also instrumental in providing adhesion to materials. This is achieved by lowering the surface tension of the adhesive or by solvating any contaminants that are on the surface of the substrate, such as oils or mold release compounds. This action allows the adhesive to wet into the surface of the material to be bonded, which is fundamental in creating the bond. Solvents also influence the wet tack and open time of adhesives. It is very important that a solvent evaporate quickly so as to provide the quick strength, "wet tack" that is needed for the fast handling of bonded foam parts. On the other hand, the solvent cannot evaporate too quickly or the adhesive will dry and be tack free before a larger part can be assembled. It is critical that the adhesive have a long working window of opportunity for the spray operator to assemble a variety of parts. An adhesive with the proper working window allows a sprayer to fabricate large as well as small parts. They can just as easily assemble high tension parts or simple parts that have little "spring open" force.

## **Regulatory Status of NPB**

The Montreal Protocol of Substances that Deplete the Ozone Layer of 1990 banned the production of methyl chloroform also known as 1,1,1 trichloroethane by January 1, 1996. <sup>(1)</sup> Methyl chloroform was a very effective solvent for use in foam fabricating spray adhesives. It was non-flammable and non-toxic. Eliminating methyl chloroform created an immediate need to find alternatives. One alternative was methylene chloride, also known as dichloromethane. This solvent was also non-flammable, however, it was considered to be a suspected carcinogen and The Occupational Safety and Health Administration (OSHA) set a Time Weighted Average (TWA) exposure limit of 25 parts per million (ppm). Installing air handling equipment capable of maintaining an airborne TWA concentration of 25 ppm or below was very difficult and became impractical. Waterbased and hot melt adhesives were utilized in many spray applications, however, many foam fabricators were not satisfied with their performance for various reasons. There was a need to find a solvent that would be non-flammable, non-toxic, fast drying, inexpensive, and be a good solvent for the adhesive resins used to formulate spray adhesives.

In the late 1990's, n-propyl bromide was introduced in adhesive formulations as such a material. N-propyl bromide also known as normal propyl bromide, NPB, 1-bromopropane, and 1-BP was non-flammable, fast drying and worked well in formulations used in the foam fabricating industry. These adhesives quickly gained popularity and were successful in replacing methylene chloride as well as waterbase and hot melt formulations. NPB is not considered a hazardous air pollutant (HAP) by the EPA nor is it a hazardous waste under the Resource Conservation and Recovery Act (RCRA). <sup>(2)</sup> NPB is a volatile organic compound (VOC), therefore its use is controlled under state and local regulations implementing Federal clean air requirements at 40 CFR Part 51. <sup>(2)</sup> NPB was submitted to the Environmental Protection Agency's Significant New Alternatives Policy Program (SNAP) in hopes that it would be approved for use as a replacement for the ozone depletor methyl chloroform.

The SNAP program was developed by the EPA after it was given the authority by the Clean Air Act in Section 612 to develop a program for evaluating alternatives to ozone-depleting substances. Under this program any materials that are to be used as replacements for known ozone depletors are either accepted or are deemed unacceptable. It is unlawful to use a material in place of an ozone depletor if it is deemed unacceptable by the SNAP program. <sup>(2)</sup>

While waiting for approval under the SNAP program, foam fabricators are allowed to use NPB based adhesives. As of the June 3, 2003 proposed rule, the only use condition that the EPA proposed for use in adhesives is that the NPB does not contain any more than 0.05% isopropyl bromide (2-bromopropane) by weight before adding stabilizers or other chemicals. <sup>(2)</sup> The EPA additionally proposed that the TWA exposure level be kept below 25 ppm, however the EPA expects users to defer to any permissible exposure limits ultimately established by OSHA. OSHA is studying the issue and as of yet has not issued a TWA exposure limit for NPB.

## Health Concerns with NPB

As foam fabricators began using NPB based adhesives, health issues started to arise, particularly, in the area of neurotoxicity (causing damage to nerves). First, there was a request on March 17, 1998 by the North Carolina Department of Labor (NCDOL) for the National Institute for Occupational Safety and Health (NIOSH) to perform a health hazard evaluation (HHE) at a North Carolina foam seat cushion company. Adhesive spray operators at this factory reported during their medical surveys that they had symptoms such as having a headache at least once per week, having painful tingling in hands or feet, reporting a tremor, and feeling drunk when not drinking more so than non-sprayers.<sup>(3)</sup> The initial TWA exposures to NPB were measured and ranged from 60.0 to 381.2 ppm.<sup>(3)</sup> After installation of new spray booths the TWA exposures were measured and ranged from 1.2 to 58.0 ppm.<sup>(3)</sup>

Then in April of 1999 the NCDOL responded to reports that four employees of a North Carolina foam fabricating company had been treated at a local hospital for neurologic symptoms of an unclear cause.<sup>(4)</sup> The four employees had been hospitalized in March 1999 for complaints of lightheadedness and or dizziness, lower extremity weakness, varying degrees of difficulty standing or walking and varying degrees of bilateral lower extremity numbness, along with abnormal sensations such as burning, prickling or tingling also in the lower extremities.<sup>(4)</sup> NCDOL issued a request for a health hazard evaluation to NIOSH. In performing the HHE, NIOSH found the initial NPB TWA exposures in the range of 18.1 to 253.9 ppm.<sup>(4)</sup>

On August 28, 2000, NIOSH received a confidential request for an HHE at another North Carolina foam fabricating company by employees of that company.<sup>(5)</sup> Two sprayers had been admitted to the emergency room of a local hospital in June of 2000. One of the sprayers had been using NPB adhesive for about one year and the other had been using it for about 6 months.<sup>(6)</sup> The first sprayer developed sore throat, difficulty swallowing, stumbling, incontinence of urination, and numbness with a burning sensation in the legs, thighs, hips and lower back as well as numbness in the perineum, and ultimately became unable to stand up by herself.<sup>(6)</sup> The second sprayer developed a staggering gait, tingling, burning or numbness in the hands, legs, lower back, hips and perineum, urinary incontinence, slurred voice, and difficulty swallowing.<sup>(6)</sup> Air sampling was performed by an independent party before the initial NIOSH visit. At the end of October 2000, this party determined the TWA exposure to NPB to be in the range of 60 to 261 ppm, after the ventilation had already been improved.<sup>(6)</sup> During the initial NIOSH visit in mid-November 2000, the TWA exposure to NPB was found to be in the range of 41.3 to 143 ppm.<sup>(5)</sup>

In February 2003, The Occupational Safety and Health Division of The Utah Labor Commission performed a site visit of a foam cushion fabricator in Utah.<sup>(7)</sup> Several sprayers of this fabricator had been admitted to the emergency room of a local hospital with many of the same symptoms as listed in the above cases. This case, however, provided some interesting follow up information. Three of the most severely affected sprayers were followed up as outpatients for 2 years. The most affected sprayer was a 29 year old female, whose ability to walk was so impaired, that she needed a cane to walk, even two years after her initial examination in the emergency room.<sup>(8)</sup> She and another female, 43 years of age, were still not able to work two years after their initial visits to the

ER. <sup>(8)</sup> A male sprayer, 46 years of age, had originally visited the ER with mild to moderate lower extremity weakness, difficulty walking, and tingling, burning or numbness in the lower extremities. At his 2 year follow up evaluation, he continued to have headache, mild weakness in his lower extremities with debilitating pain. <sup>(8)</sup> The TWA exposure to NPB during the Utah OSHD inspection was found to be in the range of 91.8 to 126.7 ppm. <sup>(7)</sup>

Neurotoxicity is not the only health concern regarding NPB. The Center for The Evaluation of Risks to Human Reproduction (CERHR) issued a report in October 2003. It concluded the following, “There is sufficient evidence to conclude that inhaled 1-BP causes reproductive toxicity in male and female rats....These results are assumed relevant for human hazard assessment. The human data on potential effects of 1-BP are too limited in content to conclude that 1-BP is a human reproductive or developmental toxicant.” <sup>(9)</sup> Based on this conclusion, the Office of Environmental Health Hazard Assessment (OEHHA) listed NPB on Proposition 65 effective December 7, 2004. <sup>(10)</sup> Therefore, NPB is listed as a chemical known to the State of California to cause reproductive toxicity.

## Conclusion

The EPA has issued a new proposed rule under the SNAP program. This notice in the Federal Register “proposes to list NPB as an **unacceptable** substitute for methyl chloroform, chlorofluorocarbon (CFC)-113, and hydrochlorofluorocarbon (HCFC)-141b when used in adhesives or in aerosol solvents because NPB in these end uses poses unacceptable risks to human health when compared with other substitutes what are available.” <sup>(11)</sup> As stated in the new proposed rule, this action to eliminate NPB in adhesives has been taken because of the rising health issues that occur with the elevated exposure levels that are typically seen in adhesive spraying operations.

As stated previously, OSHA has yet to issue an exposure limit for NPB in the workplace. The American Conference of Governmental Industrial Hygienists (ACGIH) set a threshold limit value (TLV) of 10ppm for NPB and the EPA had proposed an exposure level of 25ppm. Although the EPA and ACGIH exposure values are highly respected values that employers can target for protecting the health and safety of employees in their workplace, the ultimate authority of enforcement is with OSHA.

So where does this leave us as suppliers and manufacturers in the foam fabricating industry, that have to answer to employees, the government, and the bottom line? Here is a thought worth considering from (Harney et al., Aug 2002) OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91-596, sec. 5(a)(1)]. Thus employers should understand that not all hazardous chemicals have specific OSHA exposure limits. An employer is still required by OSHA to protect their employees from hazards, even in the absence of an OSHA exposure limit. <sup>(5)</sup> So with the increasing threat of employee lawsuits and the ultimate rejection by the EPA, it would behoove any user of NPB based adhesive to switch to an alternate as soon as possible.

## References

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- (10) [http://www.oehha.ca.gov/prop65/prop65\\_list/1bpnote.html](http://www.oehha.ca.gov/prop65/prop65_list/1bpnote.html)
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