



## Facts on Hazardous Cleaning Solvents and Recommended Replacements

Technical White Paper – November 9, 2007 (rev. 1/13/12)

By *Pierce Pillon, Manager of Technology, Techspray*  
*Kevin Pawlowski, Senior Product Manager, Techspray*

n-Propyl Bromide (nPB), Trichloroethylene (TCE), and Perchloroethylene (Perc) are three examples of harmful chemicals that are commonly used in aerosol cleaners in industrial applications. These chemicals are commonly used as cleaning solvents because they are non-flammable, have high solvency, and are relatively inexpensive.

The facilities need to be familiar with every chemical used on the floor, with special attention paid to the following:

- Exposure limits
- Exposure control methods and limitations
- Ramifications of exposure, i.e. severity of the exposure effects

The lack of such knowledge and control can lead to employee ill health, downtime, and potential liability, no matter what the legal standing of a particular chemical. The onus is on the organizations using solvents to select products carefully, and equip the users to safely handle the chemicals.

### Exposure Limits

The personal hazard associated with a solvent is often defined using Threshold Limit Value (TLV), which are the recommended average exposure in an 8-hour per day, 40 hour work week. This is generally set by the American Conference of Governmental Industrial Hygienists (ACGIH). The unit of measure is Parts Per Million (PPM).

The lower the TLV of a particular substance, the less a worker can be exposed to without harmful effects. TLV is stated on the MSDS of chemical products, in addition to recommended safety gear. Every organization using hazardous chemicals within their facility has the responsibility to equip their facility and personnel to maintain exposure levels below the TLV.

The following are three common industrial solvents and their exposure limits (source: ACGIH):

**nPB = 10ppm      TCE = 10ppm      Perc = 25ppm.**

### Exposure Control Methods

Whether these exposure limits are acceptable or not depends on the ability to control fumes and atomized solvents. The use of solvents in spray applications poses much greater concern to worker safety than batch, vapor degreasing as workers are directly exposed to the solvent. The EPA commissioned ICF Consulting to perform a risk study on the issue of nPB, which was released at the May 2002 CleanTech exposition.

In evaluating spray adhesive applications, the ICF found, “Before installation of the spray booths, the overall mean concentration of nPB was 168.9 ppm, with main exposures in each work area ranging from 117.1 ppm in the Saw area to 197.0 ppm in the covers area. Following installation of the spray booths, the overall main nPB exposure concentration was 19 ppm, with individual measurements ranging from 1.2 to 58 ppm.” (*ICF 2002, Attachment A, pp. 26*)

Note that **even with proper engineering controls, some workers outside the booth had exposure as high as 58 ppm.** A spray booth is above-and-beyond typical ventilation control in a cleaning application, so open air spraying, or even spraying under a ventilation hood will most likely cause exposure well over the limits for nPB, TCE, and Perc.

The harm caused by excessive exposure depends on the material. The specifics are not generally covered in detail in MSDS, so facilities considering a particular chemical should do additional research if safety is in question. Multiple studies have shown excessive exposure to nPB, TCE, and Perc can cause severe health issues, so this should be taken very seriously.

### Severity of Effects from Exposure

#### **nPB**

In May 2007, the EPA proposed a ban of nPB used in adhesives or in aerosol solvents because, “...these end uses pose unacceptable risks to human health when compared with other substitutes that are available...If this proposal were to become final, it would be illegal to use nPB or blends of nPB...” (*EPA Federal Register, Vol. 72, No. 103, May 30, 2007, Proposed Rules, pp 30168, 30172*) Final approval of proposal is pending as of this writing.

The EPA’s proposal further explained the findings that led to their recommendation:

“Recent data collected from occupational settings indicate that severe, possibly irreversible, neurological effects may occur at sustained concentrations of approximately 100 ppm or greater (*Beck*

and Caravati, 2003; Majersik, 2004; Majersik, 2005)... Further, effects on sperm motility in the parental and offspring generations are seen at levels generally consistent with multiple reproductive effects seen in both generations and both sexes exposed to nPB, such as estrous cycle length, lack of estrous cycling, the number of estrous cycles in a given period of time, fertility indices, and the number of live pup births (TERA, 2004; ICF, 2006a; SLR International, 2001).” (Ibid, pp 20152)

The following is a case reported to regional poison control centers in Pennsylvania (2007) by attending physicians who treated the affected workers. The cases were investigated by federal and state health agencies.

“In 2007, a male aged 50 years visited an emergency department in Pennsylvania with a history of confusion, dysarthria, dizziness, paresthesias, and ataxia for 24--48 hours. The patient had worked for 8 years at an electronics plant in Pennsylvania, where for 3 years 1-BP [nPB] had been used to clean circuit boards by vapor and immersion degreasing... The patient was hospitalized. Mild sensory peripheral neuropathy was detected by electromyogram in his upper and lower extremities.

One week after the patient went to the emergency department, the Occupational Safety and Health Administration (OSHA) evaluated his workplace and found a 1-BP concentration of 178 ppm by short-term area air sampling... His peripheral neuropathy and ataxia persisted 1 year after the initial visit. The patient also reported having trouble maintaining mental focus and stopped working at the electronic plant because of continuing medical problems.”

(Source: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5748a2.htm>)

### TCE

TCE is currently heavily restricted at the state and local level, with very few restriction imposed at the national level. As of December 31, 2006, TCE is prohibited in use as an adhesive remover, electrical cleaner, and graffiti remover in California (California Environmental Protection Agency Air Resources Board, Advisory No. 341, November 2005). Studies implicate TCE in cases of liver, kidney, and lung cancer:

“Some studies with mice and rats have suggested that high levels of trichloroethylene may cause liver, kidney, or lung cancer. Some studies of people exposed over long periods to high levels of trichloroethylene in drinking water or in workplace air have found evidence of increased cancer...”

(Dept of Health and Human Services, Agency for Toxic Substances & Disease Registry (ATSDR), <http://www.atsdr.cdc.gov/tfacts19.html>)

In its 9th Report on Carcinogens, the National Toxicology Program (NTP) determined that trichloroethylene is “reasonably anticipated to be a human carcinogen.” The International Agency for Research on Cancer (IARC) has determined that trichloroethylene is “probably carcinogenic to humans.” (Ibid)

### Perc

Perc has been an ongoing health and safety issue in the dry cleaning industry (<http://www.cdc.gov/Niosh/97-150.html>), and the culprit for as many as 770 US Superfund clean-up sites ([http://www.uncsbrp.org/resources/superfund\\_contaminants.cfm?item=perc&section=resources](http://www.uncsbrp.org/resources/superfund_contaminants.cfm?item=perc&section=resources)).

The use as an industrial aerosol cleaner is not as widely reported, but there is adequate research to define the health risks associated with such usage:

“Humans - Liver damage such as hepatomegaly, icterus, and elevated, serum SGOT and SGPT (no estimates of dose given), as well as altered renal function (14 year average; TWA of 10 ppm), have been reported for workers exposed occupationally to perchloroethylene (ATSDR 1993).”

(Office of Pollution Prevention and Toxins, US Environmental Protection Agency, Aug 1994, Section III,B,1)

Like TCE, Perc is prohibited in use as an adhesive remover, electrical cleaner, and graffiti remover in California. (California Environmental Protection Agency Air Resources Board, Advisory No. 341, November 2005).

### Safer Alternatives

Common industrial cleaning solvents nPB, TCE, and Perc should only be considered in the workplace if human exposure can be tightly controlled. The very nature of aerosol and hand (bucket) cleaning make it unlikely exposure can be maintained within safe parameters. The potential of costly liability suits and worker downtime, and the availability of effective alternatives, make the use of nPB, TCE, and Perc an unnecessary risk.

Solvent blends combining Versa-Trans with HFC-245fa, HFE, Vertrel, and other chemicals offer the safety of a non-flammable product, but with exposure limits that are much more realistic to maintain. The additional cost, if applicable, should be offset by reduced risk of downtime and litigation.

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Techspray is a formulator and manufacturer of precision cleaners for industrial and electronic applications. More information of Techspray's alternative cleaners, such as G3, can be found at [www.techspray.com](http://www.techspray.com).