

# Health Assessments of Volatiles from Flexible Polyurethane Foam

Polyurethane (PU) foams are made by mixing a diisocyanate, e.g. toluene diisocyanate (TDI), and a polyol. An amine and/or a metallic salt catalyst is used to control manufacturing and properties. Silicone surfactants and, in some cases, blowing agents are also used to give the foam the desired characteristics.

After production the foam blocks undergo a period of curing in the factory. It is during this time that the foam blocks release most remaining volatile chemicals. However, as with any plastic material, the foam blocks can continue to release substances in small quantities for a short time after manufacturing.

There has been some public concern about the safety to health of such releases or emanations. This leaflet reports **two independent studies** undertaken across a time frame of ten years:

- In 2003, **EUROPUR** sponsored a series of intense studies to measure the amount of each substance released and to carry out human health risk assessments on each of them.
- Already in 1993, the **Sleep Products Safety Council (SPSC)** of the USA sponsored a significant study on the health assessment of volatiles from flexible foam: "Assessment of Potential Health Risks Resulting from Chemical Emissions from New Bedding Sets". The study gave very detailed results. We have reproduced here a brief summary by kind permission of the SPSC.

**Both studies provide clear reassurance that the minute amounts of volatile substances released from PU foam do not constitute a risk to health.**

## EUROPUR "Emanations" Project 2003

### Key Points of the Project

- **The results clearly showed that, even when measurable releases of volatiles occur, risks to human health from such releases are negligible.**
- TNO-BIBRA<sup>(1)</sup>, on behalf of EUROPUR, conducted a thorough study of the published literature for hazards on each of the designed volatiles in the UK.
- EUROPUR contracted the analytical work for this project to specialist scientific sampling and analysis consultancy EUROFINS (Denmark)<sup>(2)</sup>. EUROFINS also proposed the exposure model that led to preparing risk assessments for some 29 volatiles.
- EUROPUR reported on this project in 2003 following a series of detailed studies into the release of volatiles from five different commercial samples of PU foam.

(1) <http://www.bibra.co.uk>

(2) <http://www.eurofins.dk>

### Further Information

"Risk" is a function of "exposure" and "hazard". For chemicals, once a hazard has been identified, the likely exposure to it gives a measure of the risk to health. Where both hazard and exposure can be measured accurately, risk can be quantified rather than expressed in general terms. Therefore, the EUROPUR project is a quantitative health risk assessment<sup>1</sup>.

A list of 29 individual substances and groups of substances was created from data measured under controlled conditions at an independent testing laboratory. The next step was to measure the release of the volatile substances from the five commercial foam samples at intervals of up to 160 hours. The sizes of the samples used were comparable to a full-size, single-bed mattress.

### Substances Identified for Health Risk Assessments

The list shown covers all the substances which could possibly be released from PU foam. However, not all of them would be found in a single foam and if any are present, they would fall far below the No Observed Adverse Effect Level, as explained further in the exposure scenario.

Dichloromethane	propanal
siloxanes, dimethyl	hexenal
2-ethyl hexanoic acid	styrene
chlorooctane	xylenes
alkanes, C <sub>6</sub> -C <sub>15</sub> (inc C <sub>12</sub> )	dimethyl dioxanes
tris m.chlorpropyl phosphate (TMCP)	propanol, propenyloxy
phthalates	hexanal, propylene glycol acetal
C <sub>3</sub> alkyl benzenes	methyl propanoic acid, C <sub>8</sub> hydroxy ester
triethylene diamine (TEDA)	α-pinene/3-carene etc
bis (chloroisopropyl) ether	benzaldehyde
butylated hydroxy toluene (BHT)	C4 benzenes
chloropropanol	limonene
dichloropropane	ethyl acetate
dichlorobenzenes	dimethyl amino ethanol (DMEA)
toluene	

The exposure scenario used was one of an unclothed human of average weight lying on an uncovered flexible polyurethane foam mattress for 8 hours per day. For each of the defined substances, EUROPUR undertook an extensive hazard analysis to derive a "No Observed Adverse Effect Level" (NOAEL) value whenever possible.

The exposure model used permitted a scaling-up of the releases from the test chamber to a 'standardised mattress' in a 'standardised bedroom' to give concentrations expressed in micrograms per cubic metre of air. This value was divided by the NOAEL to arrive at a number representing the ratio between the room concentration and the NOAEL - a ratio that provided the quantitative risk assessment.

For those volatiles where a NOAEL was present, there was no evidence that any risk to health existed. In fact, the least favourable ratio obtained revealed that the concentration was 1/60th of the amount regarded as not representing a risk to human health.

<sup>1</sup> Published by Hillier, K. Schupp, T & Carney, I. Cellular Polymers 22 (4) 237-259 2003

## Sleep Products Safety Council SPSC-‘Versar’ Report

### Key Points of the Report

- The SPSC commissioned Versar Inc. of Springfield, Virginia to carry out the detailed and comprehensive investigation.
- Published in July 1995 the study concluded that the entire ‘bedding set’ did not give rise to any concerns regarding human health risks arising from volatiles released some considerable time following the manufacture of PU foam mattresses.
- In addition, Versar Inc concluded that none of the measured volatiles should represent a cause of odour.

### Further Information



The SPSC initiated a proactive programme in 1993 to evaluate the potential health risks, if any, to customers posed by chemicals released from new bedding sets<sup>2</sup>. The health risk assessment primarily focuses on a study of the potential for adverse acute and other effects that might result from short-term exposure to measured emissions. For the inhalation exposure scenarios, the SPSC used existing sources to identify representative house volumes, room volumes and airflows.

The SPSC report includes a list of ‘target’ chemicals - 32 of them - for investigation, as well as studies taken from published literature on hazards and odour thresholds for each substance. The report evaluates these data to derive the toxicological end-point of a ‘reference dose or reference concentration’ (RfD or RfC value). Europur has used elements of this approach for its study.

The study developed exposure scenarios to assess exposures from new bedding sets to 2 types of individuals during the first seven days of use:

- An average adult who sleeps on the new bedding set for 8 hours per day and,
- A convalescing adult confined to the bed for a 7-day exposure period.



<sup>2</sup>“Bedding Sets” is a term used in the USA to denote the mattress and its base. It does not include the bedclothes

### Assessment of Risk

The SPSC organised the risk assessment according to a format, adopted and modified by the US Environmental Protection Agency for evaluating adverse effects of environmental chemicals and developed by the National Academy of Sciences.

The risk assessment covered both dermal and inhalation exposures. The estimated exposures via both routes were compared with the 'reference' threshold levels developed in the hazard evaluations. The SPSC performed the comparison by dividing the exposure calculated for a chemical with its respective toxicity/irritancy/odour threshold or "reference" value to give a hazard quotient (HQ).

### Results

Risks from Inhalation Exposure: The results showed that from the bedding sets tested, **none of the 'target' chemicals posed significant human health risks** for normal or convalescing individuals at the emission rates measured.

Risks from Dermal Exposure: From the 6 tested bedding sets, **no dermal health hazard quotients greater than 1 were present** for normal or convalescing individuals. This is significant because the SPSC used a dermal exposure model based on very conservative assumptions. The study offers the same conclusion with regard to dermal irritancy.

Exceeding the Odour Thresholds: Based on the evaluation of the chamber test results, none of the chemicals with established odour thresholds (21 out of 34 chemicals) escaped from any of the bedding sets at levels that should pose an odour problem for any individual chemical.

## Overall conclusion from the result of both studies

In no case was there any evidence, using a 'worst case scenario' that any significant risk to human health would result from sleeping on a PU mattress. The margins of safety were very considerable.

The results clearly showed that even when measurable release of volatiles occurred, risk to human health from them was negligible.

Requests for further copies of this leaflet should be directed to EUROPUR

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