Hazardous Chemicals in Carpets

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ABSTRACT

This study was undertaken to investigate whether certain hazardous chemicals were present as components in new carpets, and if so, in what quantities. The study included analysis of eight new carpet samples that were available for retail in the UK. Some of the carpet samples contained high levels of organotins, in particular TBT (up to 47,500 ppb). One sample contained high levels (1600 ppb) of 2,2',3,3',4,4',5,5',6,6'-decabromodiphenyl ether (BDE-209), a brominated flame retardant chemical. Three samples also contained significant levels of permethrin (up to 78 ppb), a pesticide used against dust mites. Five of the samples contained formaldehyde, albeit at low ppm concentrations. None of the samples contained phthalates or triclosan (an anti-microbial chemical) at levels above limits of detection.

The presence of the above hazardous chemicals in carpets is of great concern given the potential for human exposure to these compounds in the indoor environment and possible impacts on health. Exposure may occur via inhalation of contaminated air, ingestion of contaminated dusts or dermal contact. Although possible impacts on health are presently uncertain, the use of chemical treatments and additives in carpets clearly represents a significant source of chemical exposure in the home. The presence of organotins, permethrin and the brominated flame retardant BDE-209 in new carpets is particularly undesirable given their hazardous properties, a matter which therefore demands urgent attention.

INTRODUCTION

The majority of industrially produced carpets contain a range of chemical additives. Chemicals are impregnated during the manufacture of the carpet fibre or are introduced externally as topical treatments on the final product. The proposed purpose of some of these chemicals is to protect against dust mites, bacteria, moulds and fungi. However, the addition of chemicals to carpets results in potential human exposure to hazardous chemicals in the home and other indoor environments. Health impacts resulting directly from such exposure are difficult to elucidate though some observed health effects have been associated with exposure to new carpet. For instance, the US Consumer Product Safety Commission (CPSC) has received numerous health and odour complaints associated with the installation of new carpets (see Schaeffer *et al.* 1996). The nature and timing of the reported health symptoms (primarily immediate onset of sensory and pulmonary irritation and central nervous system effects) suggests the possible involvement of chemical off-gassing from carpet system materials. A recent review of pesticides in carpets noted that while allergy sufferers may welcome a house dust mite free carpet, the consideration of possible sensitivity to pesticides must also be taken into account (Pesticide News 2000).

Contact with consumer products and dusts in the office and home is increasingly widely recognised as an important route of human exposure to various hazardous substances. For instance, the US EPA note that 80% of most people's exposure to pesticides occurs indoors (see Pesticide News 2000). Carpets are often sold with "pest proof" guarantees which can last up to ten years. Therefore, the chemicals applied to carpets for pest control may persist for long periods. Considering the large proportion of time spent indoors by many people, exposure to chemicals in carpets can occur on a frequent basis. For instance, it has been estimated that an average person generally spends about 93% of their time indoors, 5% in traffic and only 2% of time outdoors (Spengler and Sexton 1983). Moreover, for infants and children exposure is even greater that adults. It is estimated that children may ingest 100 milligrams (mg) of house dust per day, five times greater than adults, as they play or crawl on carpets (Ott and Roberts 1998). This is of great concern given that infants and children, being at a stage when organs are developing, are generally more susceptible to toxic insult from chemical exposure.

Regarding consumer protection, it is interesting to note that chemicals introduced into carpets during their manufacture or applied as topical treatments are not covered by the Control of Pesticide Regulations 1986 or the Chemicals (Hazard Information and Packaging for Supply) Regulations 1994. Furthermore, the US Environmental Protection Agency recommend that new carpets are aired outdoor before installation, and indoor areas should be well ventilated for 48-72 hours after carpet fitting (see Pesticide News 2000).

The present study was conducted as part of a broader study on the identification and quantification of chemical additives in carpets and PVC flooring. The intention of the present study was to identify and quantify levels of certain chemicals in new carpets that were selected on the basis of their hazardous nature. Specifically, organotins, phthalates, permethrin, triclosan, brominated flame retardants and formaldehyde were analysed in eight carpets that were available for retail in the UK. The purpose of the study was to provide empirical data on the chemical composition of carpets. It was not the intention of the study to generate data for calculating potential doses of chemicals that individuals may receive from exposure to carpets in the home or to determine potential consequences for human health.

There appeared to be no research published in the scientific literature regarding the presence of phthalates or organotins in carpet, although their presence in PVC flooring was recently highlighted by Allsopp *et al.* (2000). It was not known whether these chemicals are used in the production of carpets. On the other hand, it was suspected that permethrin and triclosan may be present in carpets that had been treated with anti-microbial/anti-dust mite agents. Formaldehyde has also been reported to be present in some carpets as a preservative and it was possible that brominated flame retardants may be added as fire retardant chemicals.

Further information on each of the chemical groups investigated in this study is given in Appendix 1.

METHODS

Samples

Eight different samples of carpet for analysis were purchased from various retail suppliers in the UK (see table 1). The carpet fibres were analysed for organotins, phthalates, brominated flame retardants, permethrin and triclosan by laboratories and methods given below.

Table 1. List of Carpet Samples.

Sample Number	Sample Brand, and data on carpet composition	Listed as Including Anti-microbial or Anti-Dust Mite Treatment
NGP001	Brintons Limited, Axminster, Annabelle Classique 244/16668 c 1997, Summer Spray,	

	Apple. 80% wood, 20% nylon. Backing, Jute, polyester, polypropylene, conductive EVA latex. Made in England.	
NGP002	Riding Hall Carpets. Weardale, quality British Axminster, Woodland Brown, Ref 149/1. 80% Wood 20% nylon. Made in County Durham.	
NGP003	Whitestone Weavers Ltd. Fine Quality Woven Axminster, 85/8885 Blenheim. 80% Wool 20% nylon. Woven in Poland, British Wool	
NGP004	Rawson Carpets. Primary Colours, (created for the exacting demands of primary school activities) red. 100% polypropylene, Bitumen backing. Made in Britain.	Constructed from Permafresh fibre (100% control of house dust mites, bacteria, mould, mildew and fungi). Treated with Ultrafresh.
NGP005	Kingsmead Carpets Limited. Richards Pristine Twist, 80% wool,, 10 polypropylene, 10% polyester Yarn-Loc. Backing, woven polypropylene.	Scotchguard treated, Dynomite applied (dust mite protection).
NGP006	Kingsmead Carpets Limited. Moderna, 100% Charisma Polypropylene, Backing woven	Scotchgard Treated, Dynomite applied (dust mite protection).
NGP007	Westex . Ultima Major, Paprika. 80/20 Wool/Nylon. Treated with Ultra Fresh built in deodorant (proven to eradicate house dust mites), rotproof, mothproof and Scotchguard protection.	Treated with Ultrafresh (to protect against bacteria, moulds, fungi and dust mites).
NGP008	B & Q. B & Q classic plain carpet tile, emerald. A 5019 17.03:35	

Organotins

Organotin analysis was carried out by GALAB (Geesthacht, Germany), using an accredited method (details available on request). Alleight carpet samples were analysed for monobutyltin (MBT), dibutyltin (DBT), tributyltin (TBT), tetrabutyltin, monooctyltin, dioctyltin, tricyclohexyltin and triphenyltin. The limits of determination and detection were 0.3 and 0.1 μg/kg respectively, with a measurement uncertainty of 10-20% and recovery of 75-100%.

Permethrin

Analysis of permethrin was carried out on all samples by Central Science Laboratory, Sand Hutton, York., (details of method available on request).

Triclosan

Analysis of triclosan was carried out by PIRA International, Randalls Road, Leatherhead, Surrey, UK, (details of method available on request). Analysis was carried out on 6 of the 8 samples, (NGP001, NGP002, NGP003, NGP004, NGP007, NGP008).

Formaldehyde
Analysis of formaldehyde was carried out by ALAB (Analyse Labor in Berlin GmbH), (details of method available on request).

Brominated Flame Retardants
Analysis of brominated flame retardants was carried out by the Netherlands Institute for Fisheries Research (RIVO, Ymuiden)(details of method available on request). The analyses included 15 polybrominated diphenylethers (IUPAC nr. BDE-28, BDE-47, BDE 60, BDE-71, BDE-75, BDE-77, BDE-85, BDE-99, BDE-100, BDE-119, BDE-138, BDE-153, BDE-154, BDE-190, BDE-209), 7 polybrominated biphenyls (BB-15, BB-49, BB-52, BB-101, BB153, BB155, BB209), and 3 other brominated flame retardants (tetrabromobisphenol-A or TBBPA, methyl derivative of tetrabromobisphenol-A or Me-TBBPA, and hexabromocyclododecane or HBCD).

Phthalates
Analysis of phthalates was carried out by the Laboratory of the Government Chemist, (Teddington, UK), using UKAS accredited method LGC SOP OTH/C1-0015 (details provided on request). The above eight carpet samples were analysed for six phthalates, as listed by the EU Scientific Committee on Toxicity, Ecotoxicity and the Environment (CSTEE), Di-isononyl phthalate (DINP), Di-ethylhexyl phthalate (DEHP), Di-n-octyl phthalate (DnOP), Di-butyl phthalate (DBP), Di-isodecyl phthalate (DIDP), Butyl Benzyl Phthalate (BBP). The limit of detection for all phthalate compounds tested for was ≤ 0.05 % by weight.

RESULTS

Organotins
Results of analysis of organotins in carpet samples are given in table 2. High levels of tributyltin were evident in sample NGP004 (2700 μg/kg (ppb) and NGP007 (47500 ppb). Monobutyltin and dibutyltin were also found in these samples at >100 ppb, with sample NGP007 containing the highest levels. MBT, DBT, and TBT were detectable at much lower levels (<30 ppb) in most other samples. Other organotins were below the detection limit. It is notable that the samples which contained high levels of organotins were those registered as being treated with “Ultrafresh” (to protect against bacteria, moulds, fungi and dust mites). Given the hazardous nature of TBT, the levels in samples NGP004 and NGP007 are of clear concern.

Permethrin
Results of analysis of carpet samples for permethrin are given in table 5. Samples NGP005, NGP006 and NGP007 contained permethrin at levels of 68, 69 and 78 μg/kg (ppb) respectively. In other samples (NGP001, NGP002 and NGP003), permethrin was detectable, but at much lower levels (2.0 to 4.2 mg/kg), and was below the limit of detection in samples NGP004 and NGP008. It is notable that permethrin was detectable in high levels in 3 of the 4 the carpet samples which were registered as having being treated for dust mite protection. This includes treatment with “dynomite” in samples NGP005 and NGP006, while sample NGP007 was treated with “Ultrafresh” built in deodorant. However, permethrin was not detectable in sample

NGP004 which was listed as being constructed with "Permafresh" fibre for protection against dust mites, bacteria, mould, mildew and fungi.

Triclosan
No triclosan was detected in the samples at the limits of detection employed. It is not know whether this reflects the absence of triclosan or poor efficiency of extraction of triclosan from the carpet matrices.

Formaldehyde
Results of analysis of carpet samples for formaldehyde are given in table 4. In samples NGP004 and NGP008, levels of formaldehyde were below the limit of detection. In other samples, levels ranged from 1.1 to 7.6 mg/kg.

Brominated Flame Retardants
BDE-209 was identified and quantified in three (NGP002, NGP003 and NGP008) of the eight carpet samples at levels of 33, 28 and 1600 μg/kg (ppb) respectively. Given the hazardous nature of brominated flame retardants the level of BDE-209 in sample NGP008 is of particular concern. The levels of other brominated flame retardants were below the limit of detection in all samples (further details available on request).

Phthalates
In all eight samples, (NGP001 to NGP008), no phthalate compounds were detected at levels above the limit of detection (0.05%)

Table 2. Concentration of Organotin Compounds(μg/kg) in samples of carpet

Organotin (μg/kg)	Sample NGP001	Sample NGP002	Sample NGP003	Sample NGP004	Sample NGP005	Sample NGP006	Sample NGP007	Sample NGP008
Monobutyl tin	9.3	5.5	7.4	501	0.5	<0.3	1140	3.3
Dibutyltin	21.5	29.6	10.9	103	1.1	<0.3	7200	29.5
Tributyltin	3.1	6.5	3.2	2700	<0.3	<0.3	47500	1.7
Tetrabutyltin	<0.3	<0.3	<0.3	10.8	<0.3	<0.3	124	<0.3
Monooctyl tin	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Dioctyltin	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Tricyclohexyl-tin	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Triphenyltin	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

Table 3: Concentration of Permethrin (mg/kg) in Samples of Carpet

Sample NGP001	Sample NGP002	Sample NGP003	Sample NGP004	Sample NGP005	Sample NGP006	Sample NGP007	Sample NGP008
2.0	3.1	4.2	<0.05	68	69	78	<0.05

Table 4: Concentration of Formaldehyde (mg/kg) in Samples of Carpet

Sample NGP001	Sample NGP002	Sample NGP003	Sample NGP004	Sample NGP005	Sample NGP006	Sample NGP007	Sample NGP008
2.2	4.1	3.1	<0.5	1.2	1.1	7.6	<0.5

DISCUSSION

In this study, eight different samples of carpet purchased in the UK were analysed for certain hazardous chemicals, namely organotins, permethrin, triclosan, formaldehyde, brominated flame retardants and phthalates. The analysis revealed that some of the carpet samples contained substantial levels of organotins, permethrin and brominated flame retardants. In particular, it was apparent that some of the carpets listed as being treated against dust mites had high levels of organotins and permethrin. With regard to other chemicals, formaldehyde was detectable in six of the eight samples at low ppm levels. While this does not give direct evidence that the carpets will act as a source of formaldehyde to the surrounding air in the home, the presence of such levels combined with the volatility of formaldehyde may result in new carpets acting as a significant additional source of this chemical in the indoor environment. Phthalates and triclosan were not identified in any of the samples at levels above limits of detection for the specific analytical procedures employed.

Organotins, in particular TBT, was found at high levels in 2 of the 8 carpet samples tested (NGP004 and NGP007). These 2 carpets were listed as being treated with “Ultrafresh” for protection against dust mites and other microorganisms. It is possible, though not certain, that biocides used for this treatment incorporated organotins as active agents. The use of organotins in carpets is surprising and is of great concern, given the persistent nature of these compounds and their immunotoxic properties. Measures have already been adopted at international levels to phase out certain uses of these chemicals. Under the OSPAR Convention’s strategy for hazardous substances (OSPAR 1998a), organotins are included as a group on the list of chemicals requiring priority action towards meeting the target of cessation of releases of hazardous substances to the marine environment.. The agreement to cease all discharges, emissions and losses of hazardous chemicals by the year 2020 was undertaken by 15 states of the North East Atlantic Region and the European Commission in 1998 (OSPAR 1998b). As a first step towards implementation of the agreement, OSPAR also agreed in 1998 on the detailed strategy and the “List of Chemicals for Priority Action” (the Priority List). It was further agreed that chemicals on the priority list required the development of measures to address their discharges, emissions, and losses by 2003. For the organotins, the priority action has focused up to now on TBT antifouling paints and triphenyltin compounds in agricultural use (OSPAR 2000a). Following progress within IMO on the development of the draft convention on harmful antifoulants, The Netherlands (as OSPAR lead country for these substances) is now considering whether to extend its focus to include the use of organotins in a range of consumer products (OSPAR 2000b). In Germany, a recent decision was taken to implement national legislation which will prohibit the use of TBT and other organotins after 31 December 2002 for uses including biocides in textiles and paints for shipping. Products, which contain greater than 1 mg organotin/kg will no longer be permitted on the market. It is noteworthy that carpet sample NGP007 in the present would substantially exceed this 1 mg/kg limit for TBT (by 47 times) and also exceed this limit for both mono- and dibutyltin.

Permethrin was detected in 3 of the 4 carpets that were listed as being treated against dust mites. The presence of permethrin in carpet is of concern given the hazardous nature of this pesticide and the potential for long-term exposure in the home environment. Indeed, one study found elevated concentrations of permethrin in domestic homes that was largely a consequence of treated carpeting (Boege et al. 1996). This raises serious questions regarding the use of such hazardous chemicals in the home environment, especially as Brown (1996) demonstrated that permethrin treatment of carpets may not even be effective against dust mite habitation.

One brominated flame retardant, BDE-209, was found in 3 of the eight carpet samples tested. In one sample (NGP008), levels were particularly high (1600 ppb). This is of concern given the fact that brominated flame retardants are toxic and persistent chemicals. Fire safety is clearly a central issue which should not be compromised, but can be achieved through the use either of less hazardous fire retardants or through redesign and/or reformulation of materials to achieve lower flammability. This has already been recognised both at national and international levels. For instance, due to the fundamental problems posed by brominated flame retardants, the Swedish National Chemicals Inspectorate (KEMI 1999) has proposed a national ban on the manufacture and use of brominated flame retardants. The World Health Organisation has also recommended their substitution with less hazardous alternatives wherever these are available (WHO 1998). Brominated flame retardants are also included on the OSPAR List of Chemicals for Priority Action (OSPAR 2000c).

CONCLUSION

In conclusion, organotins, permethrin and BDE-209 (a brominated flame retardant) were identified in a number of carpet samples purchased in the UK. The presence of these chemicals in carpets in the indoor environment inevitably results in human exposure. Although the consequences of long term exposure to chemicals such as these in the indoor environment is uncertain, the above chemicals have properties which make them potentially hazardous to human health and the environment. Recently, a recent report by the British Society for Allergies noted that it is likely that increase in exposure to synthetic and pollutant chemicals makes a substantial contribution to increases in allergic disease (Eaton *et al.* 1999). The presence of the above chemicals in carpets highlights an important product sector which will need attention to prevent human exposure to hazardous chemicals and possible health consequences.

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APPENDIX 1

Chemical Groups Investigated in this Study

1. Organotins

Organotins are a group of compounds that have been used for a variety of applications following their initial use as a moth repellent in the 1920's (Moore *et al.* 1991). Organotins, specifically tributyltin (TBT), have been used on a worldwide basis as an antifouling agent in paints for boats and ships. According to Sadiki and Williams (1999), two thirds of current global consumption of organotins results from their use as stabilisers in PVC (especially mono- and dibutyltin). Organotins are also used as biocides in industrial applications and some consumer products and as pesticides in agriculture.

Studies on laboratory rodents have shown that TBT is toxic to the immune system (see e.g. Kergosien and Rice 1998). As a consequence of its use in paint for marine shipping, TBT has caused major reproductive problems in many species of shellfish, in some instances leading to massive populations declines (Gibbs 1988, 1993, Bryan *et al.* 1986, 1987). This has led to national and regional restrictions on its use for ships (including bans on use on small vessels) and more recently to a decision for a global phase out for this use by 2008 adopted under the International Maritime Organisation Assembly Resolution A.895(21). Concern has also been expressed about the level of intake of TBT from consumption of contaminated fish and shellfish (Belfroid *et al.* 2000). Organotins as a group are included on the list of chemicals identified by the OSPAR Commission as requiring priority action, as part of its strategy to reach the target of cessation of releases of hazardous substances to the marine environment by 2020 (OSPAR 2000c).

A recent study in Germany raised concern about the presence of comparatively high levels of TBT and other organotins in PVC flooring (Oeko-Test 2000), a use subsequently confirmed by Allsopp *et al.* (2000). To the knowledge of the authors, however, no research has been published in the scientific domain on the identification or quantification of organotins in carpet.

2. Permethrin

Permethrin is a synthetic pyrethroid which is used as a pesticide. It is used in agriculture and in public health schemes for the control of insects, including mosquitoes. Permethrin is also used as an anti-dust mite chemical in carpets. In 1996, a German study demonstrated that elevated concentrations of permethrin found in domestic homes arose mainly from pyrethroid-treated carpeting (Boege et al. 1996). House dust found in carpets readily attracts and holds indoor chemical pollutants. Since permethrin absorbs to dust and surfaces, ingestion of permethrin may be an important route of exposure in the home in addition to inhalation (IEH 1999). Studies on laboratory animals have shown that permethrin can be toxic to the nervous system (eg. Ray 1991).

According to Brown (1996), a study by Allanach et al. (1990) showed that fabric treated with permethrin repelled dust mites. A mite culture (1000 mites plus food) was applied to permethrin- treated overlay fabric of a wool mattress and untreated fabric was used as a control. The fabric was left for 3 months after which the treated fabric was found to contain 761 dust mites while the untreated fabric contaminated 50,000 dust mites. However, another study (Brown 1996) indicated that carpet that was treated with permethrin did not prevent habitation of dust mites. Samples of wool carpet were treated with a range of concentrations of permethrin, and untreated carpet was used as a control. The treatment process used in the study results in penetration of permethrin into the fibre of the carpet with little absorbed onto fibre surfaces. The samples of permethrin-treated and untreated carpet were placed on a fitted wool carpet of a house that was known to be inhabited by dust mites. After a period of 14 months, analysis of the carpet samples showed there was no difference in the numbers of dust mites between the treated and the untreated carpet. The study suggested that permethrin treatment of carpet had no influence on habitation of house dust mites, even at high concentrations. It was noted that the different finding to the study by Allanach et al. (1990) described above, in which dust mites were reported to be repelled by permethrin-treated fabric, suggested that surface residues of permethrin may have been present in the fabric samples and acted as contact insecticides for the house dust mite. By contrast, permethrin would not be present on the surface of the carpet samples in the study by Brown (1996) but was impregnated into the carpet fibre. Such penetration is characteristic of typical commercial permethrin-treated carpets (Brown 1996).

3. Triclosan

Triclosan, (5-chloro-2 (2,4-dichlorophenoxy) phenol), is a chlorinated diphenyl ether. It has been used for more than 30 years as a general antibacterial agent and is used in commercial products as diverse as carpets, toothpaste, cosmetics, antiseptic soaps, washing-up liquid, plastic kitchenware, toys, socks and underwear (see Adolfsson-Erici et al. 2000, Levy et al. 1999). It has been shown that dioxins, a group of persistent chemicals renowned for their toxic impacts on health and the environment, may be formed on incineration of triclosan and under the influence of sunlight (Kanetoshi et al. 1988). Dioxins may also be formed during the manufacture of triclosan.

Triclosan has not yet been shown to be toxic to mammals, but it is acutely toxic to aquatic organisms such as fish . A recent study showed that triclosan is resistant to degradation during sewage treatment and is available for absorption by aquatic organisms in the environment (Adolfsson-Erici et al. 2000). High levels of triclosan (up to 80 μg /g) were present in the bile of fish that were placed in cages for 3 to 4 weeks downstream of sewage treatment works in Sweden and triclosan was also present in wild fish caught further downstream (Adolfsson-Erici et al. 2000). In addition, the study also found triclosan in breast milk samples from 5 women. High levels of triclosan were present in 3 of the 5 samples (up to 300 μg/kg). Following this research, concerns on the aquatic toxicity of triclosan led soap and detergent manufacturers in Europe to agree a ban on any increase in its use over 1998 levels (ENDS 2000a).

There has been a recent proliferation in the use of antibacterial products in the European market place. This appears to be a consequence of companies rushing to introduce them to avoid the need for authorisation. The 1998 EC directive on biocides was due to be implemented in April 2000, after which any biocidal products launched onto the market will require authorisation (see ENDS 2000b). The increased and widespread use of triclosan in commercial products is of great concern given the possibility that biocide use in household products may increase resistance among bacteria. Research showed that triclosan is bactericidal due to its action as a powerful inhibitor of an enzyme used in fatty acid synthesis (Levy et al. 1999). In Sweden, the use of phenolic antibacterial agents like triclosan was abandoned in most hospitals several years ago. In April 2000, the Swedish government's *Swedenvironmental* journal called for an end to "unnecessary uses of biocides", with triclosan being targeted in particular (ENDS 2000a). It was endorsed by the Swedish National Chemical Inspectorate (KEMI), and 5 consumer, medical and public health protection agencies. The report included a survey that showed that washing-up liquids containing antibacterial agents were no more effective than other detergents. It noted that the benefits of antibacterial agents are doubtful and the risks have not been fully investigated.

4. Formaldehyde

Formaldehyde is used in the manufacture of a wide range of products including plastics, fibre-board, in the dyeing, rubber, and explosives industries and is also an antiseptic, germicide and fungicide. Some carpets and textiles contain formaldehyde and this can contribute to domestic exposure. It has been shown to cause cancer in laboratory animals. In a study on organic chemicals emitted from carpets, the U.S CPSC did not find significant quantities of formaldehyde were released (Schaeffer et al. 1996). Nevertheless, new carpets clearly represent an additional source of indoor exposure to formaldehyde.

5. Brominated flame retardants

Brominated flame retardants, including polybrominated biphenyl (PBBs), polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane (HBCD) and tetrabromobisphenol-A (TBBPA), are used in the manufacture of a wide range of products. According to Bergman (2000), brominated flame retardants made up about 25% of all flame retardants used ten years ago and, although recent world data on production is not easily accessible, there is no reason to believe that the production profile has undergone any major changes. These chemicals may be included in carpets and soft furnishings, computers, televisions, kettles and other electronic goods and in materials used in vehicle and aircraft construction. However, brominated flame retardants are released to the environment not only during their manufacture, but also during the routine use and final disposal of household products which contain them. They are toxic, persistent, and bioaccumulative (build up in the tissues of animals and humans), (Kamrin and Fischer 1991, Robertson *et al.* 1991, Jansson *et al.* 1993, Kholkute *et al.* 1994). Recent research has confirmed the widespread presence of these contaminants in fish, marine mammals and in human tissues (Klasson Wehler *et al.*1997, de Boer *et al.* 1998, Ohta et al. 2000).

Understanding of the breadth of toxic effects of these groups is developing rapidly (Hornung *et al.* 1996, Kang *et al.* 1996). For example, Eriksson *et al.* (1998) reported subtle impacts on brain development in rodents, resulting in permanent changes in behavior, memory and learning, although the mechanisms have yet to be elucidated. It is also known that PBDEs can reduce the levels of circulating thyroid hormones in blood plasma (Darnerud and Sinjari 1996) and impact retinoid levels (Olsson *et al.* 1998). Some are suspected endocrine disruptors (Olsson et al. 1998, Meerts et al. 1998).

Like the organotins, brominated flame retardants are included as a group on the OSPAR List of Chemicals for Priority Action (OSPAR 2000c). The World Health Organisation has recommended that brominated flame retardants should not be used wherever less hazardous alternatives are available (WHO 1998). In addition, the proposed EU Directive on restrictions on the use of hazardous substances in electrical and electronic equipment (CEC 2000) includes the intention to phase out the use of two groups of brominated flame retardants, including the polybrominated diphenyl ethers (PBDEs).

6. Phthalates

Phthalates are a group of chemicals that have been used extensively in a broad range of applications, including as additives in plastics, paints, pesticides, inks, perfumes, cosmetics and insect repellents. By far the largest use of phthalates is for plasticisers in soft PVC products which accounts for approximately 90% of phthalate use. Due to their widespread industrial uses, phthalates have become globally ubiquitous contaminants in the environment. They are moderately persistent (Jobling et al. 1995). Studies on laboratory animals have shown that phthalates exhibit a wide range of toxic effects (KEMI 1994, US ATSDR 1997). In humans, a recent study in the USA that investigated levels of phthalate metabolites (breakdown products) in urine concluded that human exposure to phthalates was greater than previously assumed (Blount *et al.* 2000). A recent study (Oie *et al.* 1997) hypothesised that exposure to the phthalate DEHP in the home, especially from inhalation of particulate matter containing DEHP, may increase the risk of inflammation of the lung airways and as a consequence, increase the risk of asthma. Further research in Norway indicated that PVC flooring may increase the risk of bronchial obstruction in young children (Jaakkola *et al.* 1999). Exposure to phthalate plasticisers from surface materials in the home, such as PVC flooring, was hypothesised to be the causal agent. The present study analysed for the possible presence of phthalates in carpets since no previous research on the analysis of phthalates in carpet appeared to be published in the scientific literature.

The OSPAR list of chemicals for priority action also includes certain phthalates, specifically DBP and DEHP (OSPAR 2000c). Moreover, according to the progress report presented by Denmark and France to OSPAR's working group on point and diffuse sources (PDS) in December 2000, the OSPAR background document on phthalates will also now include consideration of the need for measures for three other phthalates, specifically BBP, DINP and DIDP (OSPAR 2000d).