SOCIO-ECONOMIC EVALUATION ARISING FROM A PROPOSAL FOR RISK REDUCTION MEASURES RELATED TO RESTRICTIONS ON 1,4 DICHLOROBENZENE

Framework Contract
30-CE-0221582/00-92 Lot 2

Final Report

Prepared for
European Commission
Directorate-General Enterprise and Industry

RPA

June 2010

Socio-Economic Evaluation arising from a Proposal for Risk Reduction Measures related to Restrictions on 1,4 Dichlorobenzene

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by

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EXECUTIVE SUMMARY

I. Problem Definition

1,4 dichlorobenzene is currently classified in the EU as a Carcinogen Category 3, based upon its induction of liver tumours in mice. Although it is not considered as a genotoxic agent, there is still some uncertainty whether 1,4 dichlorobenzene may act as a threshold or non-threshold carcinogen

The EU Risk Assessment Report (EU RAR, EC, 2004) for 1,4 dichlorobenzene has concluded that there is a risk of carcinogenicity amongst consumers from inhalation exposure to 1,4 dichlorobenzene present in air fresheners and toilet blocks. Therefore, the problem identified with 1,4 dichlorobenzene is one of discrepancy between the fundamental goals of the Union and the existing situation. This particularly relates to promoting public health (Article 152 of the EC Treaty) and a high level of consumer protection, which includes the protection of health, safety, and economic interests of consumers (Article 153 of the EC Treaty).

The focus of the analysis in the EU RAR was on exposure of consumers at home, therefore, this impact assessment specifically addresses the use of air fresheners and toilet rim blocks by private consumers at home. It is worth noting however that 1,4 dichlorobenzene-based products (particularly urinal blocks) are predominantly used away from home, in public toilets. Consumer use appears to be largely confined to Southern and possibly Eastern EU Member States.

With regard to our analysis of the relevant markets, our findings may be summarised as follows:

- recent developments (regulatory and other) have affected traditional markets for 1,4 dichlorobenzene-based products (for instance moth balls) which have been particularly popular in the past and this has led to an overall reduction in the use of 1,4 dichlorobenzene-based air fresheners and toilet blocks by consumers at home;
- as of the beginning of 2010, only two EU-based companies produce 1,4 dichlorobenzene (with an overall production level of just above 30,000 tonnes/year, as discussed in Section 2.4.1);
- EU imports of the substance from countries such as India and China may account for more than 50% of the total amount of the substance sold to EU-based manufacturers of air fresheners and toilet blocks;
- the estimated tonnage of 1,4 dichlorobenzene used in the EU for the manufacture of air fresheners and toilet blocks is 800 tonnes/y for in total. This material is used in the form of solid flakes;
- available information suggests that, until the mid 2000s, there may have been 15-20 EU-based manufacturers of 1,4 dichlorobenzene-based products, many (if not most) of whom manufactured products predominantly for professional users. It is estimated that there may be around ten or more companies in the whole of the EU who may still

manufacture air fresheners for use at home. These are most likely to be concentrated in Southern and Eastern EU Member States where consumer use of 1,4 dichlorobenzene-based products is ongoing;

- the concentration of 1,4 dichlorobenzene in products for domestic use typically is above 98%. The remainder is normally dye and fragrance;
- the total EU market for 1,4 dichlorobenzene-based air fresheners for consumer use is estimated at ca.83 tonnes per year (in 2009) with a retail value of €2 million per year. The total EU market for 1,4 dichlorobenzene-based toilet blocks for consumer use is estimated at 17 tonnes per year (in 2009) with a wholesale value of €0.36 million per year; and
- the above estimates do not take into account imports of finished products from non-EU countries. We do not hold any information that would allow us to take the relevant import tonnages into account.

II. Analysis of Subsidiarity

Consideration has been given to the appropriateness of action taken at the national as opposed to the EU level. After all, consumer uses of 1,4 dichlorobenzene-based air fresheners and toilet blocks appear to be limited to Southern and Eastern EU Member States. However, national action could face problems because:

- the need for risk management action is derived from the results of the EU RAR undertaken under the Existing Substances Regulation (now repealed by the REACH Regulation). As required by the Regulation, action needs to be undertaken in accordance with EU law, which in this particular case could mean a proposal to amend Annex XVII to the REACH Regulation in accordance with the provisions on transitional measures outlined in Article 137 of the REACH Regulation;
- there is uncertainty with regard to which exactly EU Member States these products are sold in and at what tonnages; and
- action at the national level might be less effective when dealing with products imported from non-EU countries.

Only one Member State (Sweden) has currently in place a national restriction on the substance. Consultation with Competent Authorities indicates that Member States who have made an input to this report overwhelmingly support EU-wide action on 1,4 dichlorobenzene. Therefore, the issue of subsidiarity is not believed to arise and action taken at the EU level is considered to be the most appropriate way forward.

III. Objectives of EU Initiative

The general objective of policy intervention would be to remedy the discrepancy between the objectives of the EC Treaty and the current situation. More specifically, it would be to ensure the protection of consumer health from exposure to 1,4 dichlorobenzene vapours while avoiding any disproportionate impacts on the functioning of the internal market as well as trade between EU Member States and non-EU partners. From a procedural perspective, risk management action would ensure that the requirements of the REACH regulation on transitional measures as outlined in Article 137 of the Regulation are met.

IV. Policy Options

We have considered a range of policy options in the form of operation conditions and risk management measures. We have also considered different policy implementation options ranging from 'command and control' interventions to voluntary agreements and economic instruments. The policy options identified as most appropriate include:

- **Option 1**: Business as Usual (BAU);
- **Option 2**: Conditions on temperature and ventilation for indoor use;
- **Option 3**: 70% concentration limit on 1,4 dichlorobenzene;
- **Option 4**: Weight limit for 1,4 dichlorobenzene-based products; and
- **Option 5**: Prohibition of sales of 1,4 dichlorobenzene-based products to the public.

After consideration of the effectiveness, practicality and monitorability of the above options, Option 2 has been eliminated from detailed analysis as impractical and unenforceable while Option 3 was also excluded as potentially counter-effective (a reduction of the concentration of 1,4 dichlorobenzene would most likely be achieved by using soluble fillers (salts). As a result, the flushing of toilet bowls would dissolve the filler, create gaps in the structure of the product, increase its surface area and subsequently increase the rate of sublimation and exposure of consumers. The use of soluble salts also makes the product more prone to breakage and hence may diminish its useful life).

V. Assessment of Impacts

The assessment of the advantages and drawbacks of the three remaining policy options indicates that **Option 1** maintains the status quo where limited consumer use and therefore exposure of consumers to 1,4 dichlorobenzene at home occurs. Moreover, it avoids any adverse effects to EU manufacturers of the substance and of its products. On the other hand, this policy option does not address the findings of the EU RAR.

Option 4 is relatively easy to implement by manufacturers of products as the changes that might be required to be made to pressing equipment would be quick and would come at a minimal cost but it would not be certain that the reduction in exposure that might be achieved would be sufficient, especially in Southern and Eastern EU Member States where consumer use continues.

Option 5 would eliminate consumer exposure at home. We assume that consumer uses account for 83 tonnes of dichlorobenzene-based air fresheners and 17 tonnes of 1,4 dichlorobenzene-based toilet blocks in the EU. With an assumed weight of 80 g per air freshener and 70 g for a toilet rim block and an average household size of 2.54 persons, we can calculate that over 2.1 million consumers might be exposed to 1,4 dichlorobenzene vapours at home as a result of the use of such products. The impacts that could accompany this policy option are as follows:

- **manufacturers of the substance**: the loss of this market would represent 12.5% of the estimated sales of substance in the EU with an associated turnover of up to €0.3 million/year. If flaking of the substance became uneconomical, all sales by EU manufacturers would be impacted, there might be a need to decommission existing flaking machinery and incinerate excess 1,4 dichlorobenzene products. Loss of outlets for the flaked substance would also affect the production of 1,2 dichlorobenzene (a much more important product used in pesticides) and the global competitiveness of manufacturers;
- **manufacturers of products**: the lost turnover for manufacturers of 1,4 dichlorobenzene-based products would be €2 million for air fresheners and €0.36 million for toilet blocks. This however could partly be balanced by additional sales of alternative products. For specific companies with a significant portion of their turnover associated with sales to private consumers (in Southern and possibly Eastern Europe), impacts could be more significant and could mainly include:
    - costs of decommissioning existing machinery and disruption of a company's investment cycle;
    - costs of new machinery estimated at €80,000 per machine[1];
    - production downtime estimated at 20-25 days with an assumed cost of just above €30,000;
    - staff training costs;
    - costs of numerous new materials for alternative formulations (assumed by one company to be €50,000) and of other inputs (due to the longer production processes required);
    - marketing costs; and
    - employment costs might also arise for a small number of companies if the restriction were to be implemented in the short-term (a manufacturer has suggested laying off four employees if the consumer markets were lost);
- **private consumers**: alternative products are widely available and are considered to be reasonably effective. The purchase of alternative products could lead to an additional cost of:
    - -€1.7 million to €10 million per year for alternative air fresheners – replacement with an average gel product could come at no overall additional cost[2]; and
    - -€0.32 million to €0.21 million per year for alternative toilet blocks – replacement with widely available liquid rim blocks could come at minimal overall cost.

[1] We note above that companies may easily have three of four such machines when using 1,4 dichlorobenzene but it should not be assumed that the same number may be needed for the manufacture of alternatives.

[2] The minus sign and red font indicate savings rather than increased costs due to the lower cost of certain types of alternative products.

- **professional users**: they would be impacted if flaking of the substance were to be discontinued; and
- **manufacturers of alternatives**: limited benefits envisaged due to the small size of consumer markets (compare this to the overall EU markets for air fresheners (900 million articles with a market value of €1,965 million in 2009) and toilet rim blocks (€709 million in 2008)). Larger benefits could arise if the flaking of 1,4 dichlorobenzene were to be impacted, but still very small overall benefits would arise. Notably some of the manufacturers of 1,4 dichlorobenzene-based products may already sell 1,4 dichlorobenzene-free products.

VI. Comparison of Options

Our analysis can be summarised as follows:

- Option 1 is incompatible with the results of the EU RAR as it does not address the conclusion that use of 1,4 dichlorobenzene-based air fresheners and toilet blocks results in unacceptable risks to consumers. However, it is acknowledged that, in recent years, the use of these products has significantly declined and the current consumption by consumers is very modest (estimated at 83+17 = 100 tonnes per year). As we cannot ascertain the extent to which EU consumers are now adequately protected or not, a precautionary approach should be taken which would mean that this measure must be considered to be inappropriate;
- Option 4 could in theory reduce exposure of consumers at home while imposing a minimal cost on industry stakeholders, essentially manufacturers of air fresheners and toilet rim blocks. However, it is not entirely clear whether a real and sufficient reduction in consumer exposure would materialise. Given the lack of certainty on the extent of consumer health risk reduction that could be achieved, it is not possible to consider this option as appropriate;
- following from the above, Option 5 would be the only measure that could guarantee sufficient reduction in risks to consumers. Given the relatively small size of the EU market of consumer uses of these products and the wide availability of effective and competitively priced alternative products, the impacts on consumers would be limited. Impacts on industry however could potentially be significant. The most favourable scenario would be if only a small number of manufacturers of air fresheners and toilet blocks selling their products predominantly in Southern and Eastern EU Member States were to be affected (potentially seriously). On the other hand, if the loss of the consumer markets affected the viability of the flaking operations of the manufacturers of 1,4 dichlorobenzene, impacts on industry would be much more widespread and severe encompassing manufacturers of products for professional use as well as professional users themselves.

It is clear that only Option 5 can deliver reasonable certainty with regard to controlling exposure of consumers to 1,4 dichlorobenzene at home. However, its implementation could result in costs (see Section V above) that might be disproportionately severe in comparison to any benefits to consumer health accrued (given the current regulatory conditions for 1,4 dichlorobenzene-based moth repellents, the major past consumer use of the substance, and the decline in the consumer use of 1,4 dichlorobenzene-based air fresheners and toilet blocks, it is certain that risks to consumers are overall lower than what was assumed in the Risk Assessment Report). It is therefore recommended that such a restriction be introduced in a phased manner to allow for its impacts to be more gradually absorbed. A prolonged implementation would allow manufacturers of products to gradually remove 1,4 dichlorobenzene-based air fresheners and toilet blocks from the consumer market and adjust their production and processes to the new situation (thus also protecting the small number of jobs[3] associated with the production of air fresheners and toilet rim blocks for consumer use). It would also help manufacturers of products located in the Southern and Eastern EU Member States to avoid an immediate severe impact from a restriction which could affect their competitiveness against competitors from other parts of the EU. Moreover, a prolonged implementation could allow the manufacturers of the substance to gradually scale down their flaking operations, prepare for any necessary decommissioning of flaking equipment and identify solutions for the impacts that may arise with regard to global sales of 1,4 dichlorobenzene (including the possibilities for incinerating excess material) and the effects of these changes to their production of the 1,2 dichlorobenzene isomer.

We have received suggestions from the EU-based manufacturers of the substance as well as from a manufacturer of products intended for consumer use at home. Two of these companies indicated that a 12-month period would probably be sufficient for them to adjust the manufacturing processes in order to mitigate the impacts from a restriction. The third company, which believes that impacts from a restriction could be severe, has suggested that 24 months would be required for refocusing their 1,4 dichlorobenzene-based operations.

We would therefore suggest that a 12-24 month delay in implementing a prohibition of sales to consumers be considered.

VII. Monitoring and Evaluation

A restriction on the marketing and use of 1,4 dichlorobenzene would be introduced as an amendment to the relevant entry in Annex XVII to the REACH Regulation. Member States have put in place long-standing mechanisms and have nominated authorities to monitor compliance with existing restrictions under the REACH Regulation (and previously the Limitations Directive). These same structures can be used to monitor compliance with the proposed restriction, which will therefore not create a significant administrative burden. Although Annex XVII of REACH does not contain any mechanism or indicators for monitoring the progress achieved, a satisfactory level of feedback is obtained through cases registered by the poison centres, recommendations/complaints by

3 A major manufacturer of 1,4 dichlorobenzene-based products for professional use (mostly urinal blocks) employs 15 workers in the manufacture of several tonnes of products (production is very simple and uses simple pressing machinery). Manufacturers of products for consumer use are probably even smaller in terms of workforce. With an overall assumed number of EU manufacturers of products for consumer use at >10, the overall number of jobs in this sector is estimated to be very modest.

the Member States and by industry. The Forum under REACH will be in charge of conducting such monitoring.

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1 Background and Lead Directorate-General

A risk assessment was carried out in accordance with Council Regulation (EEC) No 793/93 by the French authorities. The final report was published in 2004 on the European Chemicals Bureau website (EC, 2004). In February 2008, the Commission Communication on the results of the risk evaluation and the risk reduction strategies for 1,4 dichlorobenzene was published in the Official Journal of the European Union[4]. This Communication recommends that, in order to limit the risk for consumers, marketing and use restrictions in Directive 76/769/EEC should be considered for the use of 1,4 dichlorobenzene in air fresheners, moth repellents and toilet blocks.

Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations was replaced by Regulation (EC) No 1907/2006 (the REACH Regulation) on 1 June 2009. Under Article 137 of REACH, by 1st June 2010, the Commission shall, if necessary, prepare a draft amendment to Annex XVII in accordance with any risk evaluation and recommended strategy for limiting risks that has been adopted at Community level in accordance with Article 11 of Regulation (EEC) No 793/93 as far as it includes proposals for restrictions in accordance with Title VIII of REACH but for which a decision under Directive 76/769/EEC has not yet been taken.

As part of the action of the Better Regulation Action Plan and of the European Strategy for Sustainable Development, and later the Lisbon Strategy for Growth and Jobs (2005), before the European Commission proposes new initiatives, it assesses the potential economic, social, health and environmental consequences that they may have.

The lead Directorate-General (DG) for delivering such proposals is DG Enterprise and Industry which has commissioned this assessment to be undertaken by Risk & Policy Analysts Limited (RPA Ltd), an independent consultancy based in the United Kingdom.

The aim of the study is to perform an economic and social analysis of the use of 1,4 dichlorobenzene in air fresheners and toilet blocks. The use of 1,4 dichlorobenzene as a moth repellent is not part of the study; restrictions on that use of 1,4 dichlorobenzene, as recommended by Commission Communication in 2008, are already covered by Commission Decision 2007/565/EC on the non-inclusion in Annex I, IA or IB of the Directive 98/8/EC on biocidal products (Product type 19 - Repellents and attractants) and therefore an additional restriction under REACH is not necessary.

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4 Commission Communication on the Results of the Risk Evaluation and the Risk Reduction Strategies for the Substances: Piperazine; Cyclohexane; Methylenediphenyl diisocyanate; But-2yne-1,4-diol; Methyloxirane; Aniline; 2-Ethylhexylacrylate; 1,4-Dichlorobenzene; 3,5-dinitro-2,6-dimethyl-4-tert butylacetophenone; Di-(2-ethylhexyl)phthalate; Phenol; 5-tert-butyl-2,4,6-trinitro-m-xylene, 2008/C 34/01, OJ C 34, 7.2.2008, p 1.

It should be noted that this report focuses exclusively on the use of 1,4 dichlorobenzene-based air fresheners and toilet blocks by consumers at home and potential restrictions on the use of such products in public toilets (in restaurants, pubs, train and bus stations, airports, etc.) are not considered in the impact assessment of options for policy change. This is due to the fact that this scenario was not specifically addressed in the Risk Assessment Report. However, in order to elucidate the general context in which any policy measure would be set, where appropriate, this report refers to market data and other information relating to the use of the relevant products both at home and away from home. Also Annex 7 provides some background information on the likely impacts from a restriction that would affect professional uses of 1,4 dichlorobenzene-based products.

1.2 Organisation and Timing (Chronology)

The contract for this study was signed by DG Enterprise and Industry and Risk & Policy Analysts Ltd (RPA Ltd) on 28th September 2009. This is the final deliverable under this contract, a Final Report describing the relevant markets, assessing the potential impacts to industry and society from a range of different policy options and outlining our recommendations for the most appropriate option for managing the identified risks from the use of 1,4 dichlorobenzene in the two applications of concern. This document incorporates comments received from the European Commission on a previous version submitted on 1 March 2010[5].

1.3 Expertise and Consultation

1.3.1 Expertise Used

This impact assessment has been undertaken by Risk & Policy Analysts Ltd (RPA Ltd). RPA Ltd is an independent consultancy providing expert advice to both public and private sector clients around the world. The company has a long history of preparing impact assessments of policy interventions in the chemicals and non-chemicals sectors many of which have been prepared for various Directorate-Generals of the European Commission.

In addition to in-house expertise, for the purposes of this impact assessment RPA Ltd has consulted widely with experts from numerous stakeholder organisations. In summary, these have included:

- key trade associations, including Eurochlor, the International Association for Soaps, Detergents and Maintenance Products (AISE), the International Fragrance Association (IFRA), the European Federation of Cleaning Industries (FENI) and the UK Cleaning and Support Services Association;
- companies that manufacture and/or import 1,4 dichlorobenzene in the EU;

5 Comments were received electronically on 30 March 2010.

- companies currently or formerly using 1,4 dichlorobenzene in the manufacture of air fresheners and toilet blocks both within and outside the EU;
- companies importing and/or supplying 1,4 dichlorobenzene-based products in the EU;
- manufacturers and suppliers of urinal systems in the EU;
- representatives of competent authorities in EU Member States plus Iceland, Norway and Switzerland;
- a number of local authorities in the UK which have issued green procurement guidance which requires that 1,4 dichlorobenzene-based urinal blocks be avoided;
- authorities in selected non-EU countries such as Australia, Brazil, Canada, China, India, Japan, Mexico, New Zealand, Russia, South Africa, South Korea and the USA; and
- consumer associations (The European Consumers' Organisation - BEUC), trade union organisations (European Trade Union Confederation – ETUC, Instituto Sindical de Trabajo, Ambiente e Saude - ISTAS) and non-governmental organisations (European Environmental Bureau, WWF, Greenpeace, Health and Environment Alliance, European Public Health Alliance, Friends of the Earth Europe).

1.3.2 Consultation Undertaken

Emails and faxes have been sent to a total of **337** companies, **11** European and international industry associations, **9** trade union, consumer and non-governmental organisations and **14** local authorities in the UK.

Consultation was supported by the use of three questionnaires:

- one for Competent Authorities of EU Member States;
- one for manufacturers and importers of 1,4 dichlorobenzene; and
- one for manufacturers, suppliers and importers of air fresheners and toilet blocks.

These questionnaires, in Microsoft Word format, were disseminated to consultees and also uploaded to the European Commission, DG Enterprise and Industry Internet site[6]. As of 30 April 2010, a total of **95** organisations contacted us with some information, including 10 completed questionnaires. Among Member State/EEA Competent Authorities, we received input from all except five countries, including **18** completed questionnaires. The list of organisations in Annex 1 to this report presents only those organisations that have responded to our communication. The list excludes a small number of companies on confidentiality grounds. The following table outlines the numbers of organisations in the different stakeholder groups contacted and the number of responses received. Please note that some responses received were negative (i.e. the organisation involved may have simply declined to support our analysis).

6 Available here: http://ec.europa.eu/enterprise/sectors/chemicals/documents/specific-chemicals/studies_en.htm.

With particular regard to consultation with manufacturers of either the substance or finished products, there is always a language barrier when contacting companies located in countries outside the EU. Moreover, these companies see no obligation to respond to requests for information and often have very limited understanding of the nature of studies such as this one or of the potential consequences to their business.

Table 1.1: Overview of Stakeholder Consultation

Stakeholder categories	Number contacted	Number of inputs	Geographic remit of consultees
Associations			
• International Association for Soaps, Detergents and Maintenance Products • Eurochlor • International Fragrance Association • European Federation of Cleaning Industries • Eurocommerce • British Association for Chemical Specialties • UK Cleaning Products Industry Association • UK Cleaning and Support Services Association • Vereinigung Deutscher Autohöfe e.V. • Hotels, Restaurants & Cafes in Europe • British Institute of Cleaning Science	11	6	EU, DE, UK
Industry stakeholders			
Current and recent EU manufacturers of 1,4 dichlorobenzene	3	3	DE, IT, PL
Non-EU manufacturers of 1,4 dichlorobenzene	32	10	AU, CA, CN, IN, MX, US
Manufacturers, suppliers and importers of articles based on 1,4 dichlorobenzene	188	66	AT, AU, BE, BG, CA, CN, CY, CZ, DK, FI, FR, DE, EL, IN, IT, LV, MY, NL, PL, PT, RO, ES, SI, SE, CH, TW, UK, US
Professional users of urinal blocks	8	0	DE, UK
Local authorities	14	4	UK
Cash & carry stores/chains	43	3	CZ, DE, IE, UK
Manufacturers, suppliers of sanitary ware	50	4	BG, CZ, FI, FR, DE, HU, IE, NL, NO, PL, PT, ES, SE, CH, UK
Authorities			
Competent authorities (occasionally more than one organisation per country)	30	25	All EU plus IS, NO, CH
Non-EU authorities (occasionally more than one organisation per country)	12	5	AU, BR, CA, CN, IN, JP, MX, NZ, RU, ZA, KR, US
NGOs			
NGOs, consumer organisations, trade union organisations	9	6	EU, DE, ES

1.3.3 Views of Consultees

Below we summarise the positions of key categories of stakeholders.

Manufacturers of 1,4 Dichlorobenzene

There are currently two active EU manufacturers of 1,4 dichlorobenzene; one of them supplying a significantly larger portion of the EU consumption for the manufacture of air fresheners and toilet blocks compared to the other. However, for both companies, sales of 1,4 dichlorobenzene to EU manufacturers of air fresheners and/or toilet blocks represent a very small percentage of their overall sales of 1,4 dichlorobenzene.

One of the manufacturers initially indicated that they could not express a view on the potential impacts to their business from an EU-wide ban targeting only the domestic use of 1,4 dichlorobenzene-based air fresheners and toilet blocks by private consumers because information on the volume split between consumer use and professional use is not available to them. Nevertheless, the manufacturer argued that even if the ban were to target only the domestic applications, this would also impact the EU wide use of 1,4 dichlorobenzene-based air fresheners and toilet blocks in professional applications. In the absence of information on the split between domestic and professional use of 1,4 dichlorobenzene-based products, the company assumes that more than 30-40 % of the products are used at home. The company has argued that a restriction prohibiting solely the use of these products at home would affect the whole production for both home and professional use "*because production volume of many producers will become too small to continue the production under economically acceptable conditions. That could force producers to close the whole production line and subsequently that has an impact on the production of 1,4 dichlorobenzene* [by our company]". Additionally, the manufacturer has noted "*recent toxicological results (Aiso et al, 2005) were not taken into account in the underlying toxicological evaluation, probably resulting in unreasonable concerns about these p-dichlorobenzene uses*".

The other EU manufacturer initially expressed concern on the potential impacts to their business from a restriction targeting domestic uses of air fresheners and toilet blocks. The company indicated "*as far as* (we) *know our customers are producing* (…) *for mainly home use. But* […] *our sales to such customers are limited already*[7]*, so we will just have to find new market for this product*". In a telephone conversation held in January 2010, a company representative argued that he was not aware of any adverse effects from 1,4 dichlorobenzene among their workforce and noted that the Biocidal Products Directive (i.e. its requirement that 1,4 dichlorobenzene cannot be used in the manufacture of moth balls) had resulted in significant adverse effects for some of his downstream users, especially small manufacturers of moth balls.

A third EU manufacturer who recently ceased the production of 1,4 dichlorobenzene did not express a view in relation to a potential restriction on the substance.

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7 A low percentage has been given but is not reproduced here for reasons of confidentiality.

There have been suggestions that the substance may additionally be imported into the EU from countries such as China and India and we have indeed identified two companies which supply 1,4 dichlorobenzene to several EU manufacturers of the relevant products located in Germany, Portugal and Spain and possibly other unnamed EU Member States[8]. Only one company has expressed a view on the potential impacts from a restriction on 1,4 dichlorobenzene. It was argued that "*our company will be severely affected if an EU-wide ban on use of PDCB in air fresheners and urinal blocks is imposed in the EU*". The company declined to provide information on whether the products manufactured by its EU-based customers are sold for use by consumers at home or not, hence the true scale of impacts from the proposed restriction cannot be estimated.

Conclusion: those manufacturers of the substance who have expressed an opinion on the likely impacts from a restriction on 1,4 dichlorobenzene were not supportive of such a restriction, even if it only targets domestic use of the relevant products. With regard to the magnitude of the potential impacts from such a restriction, the information provided was limited and non-specific, and arguments made are not necessarily corroborated by other information collected through consultation. An EU manufacturer has argued that domestic uses could account for 30-40% or more of the market but this assumption appears not to be based on supporting information or evidence and could be an overestimate (later in this report, we present our own estimates which are based on information from other industry stakeholders). It is also worth remembering that, for the EU-based manufacturers of 1,4 dichlorobenzene, supplying EU-based producers of air fresheners and toilet blocks accounts for apparently only a small part of their 1,4 dichlorobenzene-based turnover (the majority is associated with sales of liquid 1,4 dichlorobenzene to customers located outside the EU).

Manufacturers and Suppliers of 1,4 Dichlorobenzene-based Products

A significant input to our study was made only by a small number of manufacturers of air fresheners and toilet blocks. The key concern of the vast majority companies was the potential loss of sales from a restriction on 1,4 dichlorobenzene targeting professional uses (not domestic use), as they generally sell their products to cleaning/janitorial companies. Only one company located in Southern EU contacted us only days before the completion of this report. This company has indicated that consumer uses indeed play a significant role in its sales of 1,4 dichlorobenzene-based air fresheners. From the responses received, it would appear that a divide exists between Southern/Eastern EU and Western/Northern EU. Consumer uses of 1,4 dichlorobenzene-based products may be much more prominent in the former but not for the latter. When enquired about the reasons for such difference, the company from Southern EU suggested that they be cultural. The company has clearly expressed a wish to be able to continue selling these products to consumers as they are still popular (although the company's sales in the last five or so years have significantly decreased).

8 The fact that only two specific non-EU companies have been identified by the study team as supplying 1,4 dichlorobenzene to the EU should not be taken as meaning that there cannot be other non-EU companies involved in the same activity.

Among the Western/Northern EU companies which confirmed that they still manufacture or supply 1,4 dichlorobenzene-based air fresheners and/or toilet blocks, several of them were reluctant to make any detailed input to our analysis. 1,4 dichlorobenzene-based products apparently represent only a small part of their business and as a result companies were unwilling to spend time in responding to our questions or they felt they were ill-placed to express authoritative opinions on the possible impacts from a restriction or on the advantages and disadvantages of 1,4 dichlorobenzene-based products.

There have also been companies that have indicated that they no longer use 1,4 dichlorobenzene. As will be discussed later in the report, in recent years, usage of 1,4 dichlorobenzene in the two applications of concern has decreased. Several companies, both larger and smaller ones, stopped using the substance in the 2000s or even earlier. Many manufacturers and suppliers of air fresheners and toilet blocks responded to our emails and questionnaire only to indicate that they do not use the substance and therefore did not wish to make an input to this impact assessment.

Finally, it should be noted that despite investing a significant amount of time and effort in contacting as many companies as possible, we have not been able to establish contact with every single EU manufacturer or indeed with many non-EU manufacturers. Information from EU and non-EU manufacturers of 1,4 dichlorobenzene suggests that there are a number of companies across the EU which purchase the substance and possibly use it in the manufacture of air fresheners and/or toilet blocks. The manufacturers of the substance declined to provide us with the names and details of their downstream users. We have asked them to contact these downstream users and request that they contact RPA directly to discuss the issue of a potential ban on 1,4 dichlorobenzene. Unfortunately, we were not contacted by any of these companies. Similarly, not all companies we contacted responded to our emails; as a result, it is possible that there are additional companies in the EU (and outside the EU) that could be relevant to this study (and that may be affected by a policy change) but whose views could not be taken into account as these were not willing or able to make an input.

Conclusion: very limited information specific to consumer use of 1,4 dichlorobenzene-based air fresheners and toilet blocks in the EU has been collected (with the exception of the detailed information kindly provided by a single company located in Southern EU. It appears that there may still be a certain number of manufacturers of these products for whom sales to consumers are important and to whom an EU-wide restriction would not be welcome. For the vast majority of companies that showed an interest in our work (generally located in Western/Northern EU), impacts from a restriction targeting only domestic use of these products will be very limited, if any at all.

Discussions with a manufacturer of products for professional use indicates that there may still be a small number (around ten, it is suggested) of probably small manufacturers of products sold to private consumers for use at home. A prohibition of sales of these products to the public would indeed affect these companies and all available evidence indicates that these companies are located in Southern/Eastern EU Member States.

On the other hand, one of the manufacturers of 1,4 dichlorobenzene argued that "*small manufactures are not willing to give some information* […] *due to the fact that they don't believe they will be listened (to). But there is a stronger impact that even a European Commission ban, it is REACH* […therefore, you can assume that for manufacturers of products] *the impact will not be significant*".

Evidently, it is not possible to have a clear view of the scale of impacts for this group of stakeholders. On the basis of suggestions that the domestic use of these products may be more prominent in Southern EU Member States, one could assume that impacts on manufacturers located in these countries or supplying them.

Users of 1,4 Dichlorobenzene-based Products, Consumer and Non-governmental Organisations

The users who are relevant to the scope of this impact assessment are consumers potentially using 1,4 dichlorobenzene-based air fresheners and/or toilet blocks at home. We did not approach individual consumers in the course of undertaking this impact assessment but we did contact a number of consumer organisations/NGOs. No input specific to a restriction on 1,4 dichlorobenzene was received (although we were provided with information on past research on the effects of 1,4 dichlorobenzene).

EU/EEA Member State Authorities

Finally, among the questions included in the Member State questionnaire, Competent Authorities were invited to express their views on the suitability, effectiveness and coherence of different risk management options. Please note that these responses may not relate specifically to consumer exposure at home but rather to exposure to 1,4 dichlorobenzene from toilet blocks and air fresheners in general; however, we believe that these comments provide useful background information that should be considered in this study. The responses received are summarised in Table 1.2.

Table 1.2: Views of Member State Competent Authorities on the Suitability of Different Risk Management Options

Question	**Possible risk management options (responses may relate to exposure to 1,4 dichlorobenzene in general and not only to exposure from use at home)**		
	No EU-wide restriction under REACH Annex XVII	**Marketing and use restriction (i.e. a ban)**	**Voluntary action by industry**
Would you support any option? (Y/N)	No: **CY**, **DK** ("*No effects on risk – cannot be supported*"), **LV1**, **NL**, **NO, SI**	Yes: **AT**, **CY**, **CZ** ("*we would prefer common regulation in the EU frame*"), **DK**, **EE**, **FI**, **FR**, **IS**, **LV, NO, PL, SI, SE, CH** Possibly: **NL** No: **LV1**	Yes: **CY**, **IS**, **LV1** (In our opinion there is not reason to determine wide restrictions under REACH, ban of marketing and use of 1,4 DCB, because available research shows, that use of air fresheners and toilets blocks is related to very low concentrations of 1,4 DCB in indoor air and a carcinogenic effect cannot arise), **NL** (In the Netherlands the manufacturers of air fresheners and toilet blocks have switched to alternatives to 1,4 DCB on a voluntary basis but moth balls containing 1,4 DCB are still available. If this application is considered a biocidal application a marketing and use restriction is not effective, because biocides are exempted in REACH. If this application is not considered as biocidal application, marketing and use restriction can be considered, the current Dutch voluntary action doesn't prevent the use of 1,4 DCB in moth balls), **SI** No: **FI**, **NO, PL**
Your views on the effectiveness of each option	**DK**: No **NO**: Inefficient **SI**: Legally binding restrictions are most effective	**AT**: Full effectiveness **CY**: Most effective method **DK**: Most effective, best consumer protection **EE**: Positive **FI**: Good **NL**: see comments on voluntary action to the right **NO**: Effective **SI**: To stimulate use of less dangerous chemicals for humans and the environment **SE**: Effective as seen on national level	**AT**: Very limited effectiveness **DK**: Difficult to control **FI**: seems to have taken place already (most products that were on the market 5 years ago have disappeared) **NO**: Inefficient **PL**: Negative **SI**: To stimulate use of less dangerous chemicals for humans and the environment

Table 1.2: Views of Member State Competent Authorities on the Suitability of Different Risk Management Options

Question	Possible risk management options (responses may relate to exposure to 1,4 dichlorobenzene in general and not only to exposure from use at home)		
	No EU-wide restriction under REACH Annex XVII	**Marketing and use restriction (i.e. a ban)**	**Voluntary action by industry**
Your views on coherence of each option with other legislation	**NO**: Incoherent **SI**: It is counter-productive	**AT**: Full coherence with REACH and other legislation **CY**: Most coherent method **EE**: Positive **FI**: Good - substance is not an approved biocide **NL**: coherent, but consider biocidal use of 1,4 DCB **NO**: Coherent with biocides regulation **SI**: To stimulate use of less dangerous chemicals for humans and the environment **CH**: Marketing and use restrictions i.e. a ban would consolidate the current situation in Switzerland (1,4 DCB is almost phased out) and therefore is a possible option for Switzerland	**AT**: None **NL**: Coherent **NO**: Incoherent **PL**: Negative **SI**: To stimulate use of less dangerous chemicals for humans and the environment
Envisaged implementation/ enforcement problems for each option	**CY**: No control **NO**: Problematic **SI**: Lack or absence of inspection control	**AT**: Enforcement possible and transparent **FI**: None **NL**: Enforcement problems are not expected **NO**: Efficient **SI**: Lack or absence of inspection control **SE**: No specific	**AT**: Enforcement not possible **CY**: No harmonised approach **DK**: Control issue. No enforcement tools **NL**: As it is a voluntary action by industry there are no implementation/enforcement problems **NO**: Problematic **PL**: Negative **SI**: Lack or absence of inspection control
Envisaged budget implications and associated administrative burden for central/local authorities in your country	**SI**: No	**AT**: Low (chemicals inspection already exists) **CY**: It involves administrative burden **FI**: None **NL**: Limited costs **NO**: No major budget implications or additional administrative burden **SI**: No **SE**: Very limited	**AT**: None **NL**: No budget implications for central/local authorities **PL**: Negative **SI**: No

Table 1.2: **Views of Member State Competent Authorities on the Suitability of Different Risk Management Options**

Question	Possible risk management options (responses may relate to exposure to 1,4 dichlorobenzene in general and not only to exposure from use at home)		
	No EU-wide restriction under REACH Annex XVII	**Marketing and use restriction (i.e. a ban)**	**Voluntary action by industry**
Using the space provided below, you may add any suggestions you have on other risk management options which you would like us to consider	**AT, CY, CZ, FI, IS, LV1/LV2, NO, CH**: No views expressed **EE**: As there is no legal basis to restrict the use of the substance in air fresheners or toilet blocks it is also not possible to ban it on the market. From our point of view only the regulative measures can bring the successful results to reduce the risk for the consumers and give the legal ground for effective enforcement actions. **FR**: Options that could be considered include: • *Reducing size of packaging of 1,4 DCB-based products*: we think that modifying the size of packaging is hardy likely to reduce exposure of consumers, as this is essentially the result of the specified use, and high exposure mainly results from consumers' use of excessive quantities of air fresheners; • *Limiting the concentration of 1,4 DCB in commercial preparations*: we think products would become ineffective if concentrations of their active ingredient were reduced so it is not applicable; • *Restricting use of products so as to protect the most vulnerable populations*: apparently no group of individuals has been identified with a particular sensitivity to the carcinogenic effects of 1,4 DCB; • *Ban on the use of 1,4 DCB products intended for the general public*: we think it is the only method likely to bring about an effective reduction in exposure of consumers. **NL**: No views expressed (but see above on issue of moth balls) **PL**: At present we cannot take the unambiguous position to support mentioned options. We do not have enough information in regard to this issue. We think that voluntary actions by industry provide minimally benefits. **SI**: Education of people to stimulate use of less dangerous chemicals for humans and the environment is needed. **SE**: We have not changed our view from supporting the risk reduction measures for consumers for 1,4 DCB of the risk evaluation and strategies for limiting the risks provided for in accordance with the opinion of the Committee set up pursuant to Article 15(1) of Regulation (EEC) No 793/93.Commission communication (2008/C 34/01)		
No specific response	**DE**, **EL**, **LV2** ("*At this time we do not have any strong opinion do to lack of information about substance and its properties*"), **LT**, **MT**, **SK**		
Sources: ***AT**: Austrian Federal Ministry of Environment (2009); **CY**: Cypriot Department of Labour Inspection (2009); **CZ**: Czech Ministry of Environment (2009); **DK**: Danish Environmental Protection Agency (2009); **EE**: Estonian Ministry of Social Affairs (2009); **FI**: Finnish National Supervisory Authority for Welfare and Health (2009); **FR**: Ministry of Ecology, Energy, Sustainable Development and Sea (2009); **DE**: German Federal Institute for Occupational Safety and Health (2010); **EL**: Greek General Chemical State Laboratory (2010); **IS**: Environment Agency of Iceland (2009); **LV1**: Latvian Ministry of Health (2009); **LV2**: Latvian Environment, Geology and Meteorology Centre (2009); **LT**: Lithuanian State Non Food Products Inspectorate (2009); **MT**: Malta Standards Authority (2009); **NL**: RIVM (2009) – we have been advised that the answers above do not represent a formal NL position, but should be considered as a first expert view based on the limited available information; **NO**: Norwegian Pollution Control Authority (2009); **PL**: Polish Bureau for Chemical Substances and Preparations (2009); **SI**: Chemicals Office of the Republic of Slovenia (2009); **SK**: Slovak Trade Inspection (2009); **SE**: Swedish Chemicals Agency (2009); **CH**: Swiss Federal Office of Public Health (2009)*			

1.4 Structure of this Report

This Final Report includes the following sections:

- **Section 2** outlines the problems that require action and describes the baseline scenario;
- **Section 3** outlines the policy objectives for regulatory intervention;
- **Section 4** discusses a range of policy and implementation options for managing the identified risks;
- **Section 5** presents in detail the assessment of impacts which may result from the selected policy options;
- **Section 6** compares the options in terms of their impacts as well as against the key criteria of effectiveness, efficiency and coherence;
- **Section 7** discusses monitoring and evaluation requirements under the recommended policy option;
- **Section 8** presents a comparison between the results obtained and the objectives of the study; and
- **Section 9** provides the list of references used in the preparation of this report.

Seven annexes that provide important background information accompany the main report:

- **Annex 1** provides a list of consultees who have kindly provided information;
- **Annex 2** outlines the legislation on 1,4 dichlorobenzene currently in place at the EU level as well as information on national measures on the substance (this includes both EU/EEA countries and selected non-EU countries);
- **Annex 3** discusses research on exposure to 1,4 dichlorobenzene and its effects that has been undertaken after the completion of the EU Risk Assessment Report and presents the information collected from national authorities in EU/EEA countries on accidents involving air fresheners and toilet blocks containing 1,4 dichlorobenzene; and
- **Annex 4** discusses the manufacture, imports, exports and consumption of 1,4 dichlorobenzene in selected non-European countries;
- **Annex 5** briefly presents the available alternatives to 1,4 dichlorobenzene-based products and compares the hazard profile of 1,4 dichlorobenzene to those of certain key components of alternative formulations; and
- **Annex 6** provides an overview of the current EU market for 1,4 dichlorobenzene-based urinal blocks (the key application for solid 1,4 dichlorobenzene), outlines the advantages and drawbacks of alternative products for professional use and discusses the potential impacts from a restriction on professional uses.

2. PROBLEM DEFINITION

2.1 Nature, Scale and Underlying Causes of the Problem

2.1.1 Hazard Profile of 1,4 Dichlorobenzene

The toxicity profile of 1,4 dichlorobenzene has been extensively reviewed by a number of authoritative reports, including the EC (2004) from which the following summary is drawn.

Table 2.1: Summary Hazard Profile of 1,4 dichlorobenzene	
Property	**Summary**
Mammalian Toxicity Profile	
Toxicokinetics	**Humans**: Respiratory and oral absorption occurs (no information on dermal route) with distribution to fatty tissues, liver and milk. Excretion of metabolites via urine and, to some degree, exhalation. **Animals**: Rapid but incomplete absorption via respiratory (25-59% in rodents) and GI (62-71% in rodents; peak blood levels within 1 hour) tracts; dermal absorption may occur (unquantified). Distributed mainly to fatty tissues and also to kidneys, liver, lungs, gonads and muscles. Metabolised by sulphate and glucoronide conjugation and to free phenols and quinines. Main route of elimination via urine though biliary excretion followed by enterohepatic circulation also occurs. Rat oral half-life of elimination bimodal - 0.4 days (1^{st} phase) and 10 days (2^{nd} phase) so accumulation unlikely
Acute toxicity	**Humans**: Suggested minimal toxic quantity = 300 mg/kg (based on data of uncertain robustness). Odour threshold: penetrating camphor-like smell with a threshold of 0.73 mg/m^3 (0.121 ppm)* **Animals**: Rodent LD_{50}oral = >2000 mg/kg; LC_{50}inhalation (4-hr)= >5.07 mg/L
Irritation	**Humans**: Repeated dermal exposure may cause skin irritancy; occupational exposure also associated with irritancy of mucus membranes. **Animals**: Slight skin irritancy; some signs of respiratory irritancy reported at inhalation levels of 50 and 80 ppm (acquired tolerance may develop)
Sensitisation	Experimentally appears a very weak sensitiser and only one questionable human case identified
Repeat dose toxicity	**Humans**: No robust data available. Occasional reports of hepatic changes following long-term exposures. **Animals**: In rats, main target organs irrespective of route are kidney (in males; considered species and sex specific effect) and, at very high doses, liver. Hepatic effects also noted in mice and rabbits and dogs. For dogs, NOAELoral = 10 mg/kg/day (effects include hepatic hypertrophy and range of other findings). Inhalation exposure of rodents shown to cause hepatic, renal and pulmonary changes. In Wistar rats, NOAEL inhalation = 75 ppm (based on hepatic changes)
Reproductive and developmental toxicity	**Humans**: Very limited data do not suggest any effect. **Animals**: Rat oral reproductive study showed no fertility effect in absence of overt maternal toxicity and only limited effects on offspring only; NOAEL development = 30 mg/kg/day. Rat 2-generation inhalation study again showed similar changes; NOAEC developmental = 211 ppm (N.B. internal dose from these routes would be similar). Not classified for any reproductive endpoints

Table 2.1: Summary Hazard Profile of 1,4 dichlorobenzene	
Property	**Summary**
Genotoxicity	**Humans**: No data. **Experimental**: No clear effect in bacteria and only weak responses in *in vitro* mammalian cell assays; *in vivo* data conflicting (standard tests negative but some positive non-standard tests). Overall weight of evidence suggests it does not have significant genotoxic potential
Cancer	**Humans**: Isolated case reports but no robust epidemiological studies available. **Animals**: 2-year oral studies in F344 rats and B6C3F1 mice showed hepatic tumours in male and female mice and tubular cell kidney adenocarcinoma in male rats. NOAELoral for liver cancer in B6C3F1 mice was 300 mg/kg/day and LOAELoral for kidney adenocarcinoma in F344 rats was 150 mg/kg/day. Limited effect on liver tumours noted in one BDF1 mouse inhalation study, with NOAEC of 75 ppm. Effects may be mediated via a threshold mechanism
Ecotoxicity Profile	
Physicochemical properties	Solid crystalline; melting point = 52.8-3.5ºC; vapour pressure 160-170 Pa at 2ºC; Henry's Law constant = 240-262 Pa.m^3/mol at 20ºC; water solubility = 60-70 mg/L at 20ºC; octanol:water partition coefficient (log P_{ow}) = 3.37-3.39
Environmental partitioning at equilibrium	Air: 98.9%; water: 0.79%; soil: 0.15%; sediment: 0.16% (modelled)
Environmental half-life	33-50 days in air (calculated)
Biodegradation	Rate constants: $k_{surface\ water} = 0.046\ d^{-1}$; $k_{sediment} = 0.002\ d^{-1}$; $k_{soil} = 0.023\ d^{-1}$
Bioconcentration factor	BCF fish = 55-1,400; reasonable worst-case 296 (depending on species; experimental). BCF earth worm = 12.5 kg/kg (wet earthworm; calculated)
Acute toxicity - aquatic	Fish LC_{50} = 1.12- 14.2 (depending on species and conditions); *Daphnia magna* EC_{50} = 1.6-3.2 mg/L (24-hour) & 0.7-2.2 mg/L (48 hour); Algae *(Selenastrum capricornutum*, 72-96-hour EC50 = 3.4 mg/L (QSAR)
Acute toxicity - terrestrial	Earthworm (2 species, 2 soil types) 14-day LC50 = 96 – 258 PNECsoil = 96 µg/kg dw (84.7 µg/kg wet weight)
Repeat exposure - aquatic	Fish (*Brachydanio rerio*) NOEC (14-day) = 0.44 mg/L; LOEC = 0.7 mg/L *Daphnia magna* NOEC (21-28 day) = 0.4-0.22 mg/L PNECaquatic = 20 µg/L (based on algael toxicity) PNECsediment = 900 µg/kg (dry weight; extrapolated)
Repeat exposure - terrestrial	N/A
Classification	Xi; R36 (irritating to eyes); Carc. Cat 3; R40 (limited evidence of carcinogenic effect); N; R50-53 (very toxic to aquatic organisms, may cause long-term adverse effects in aquatic environment)
Relevant exposure standards	See Section A2.5.3
Source: EC (2004) ** US EPA (1998)*	

2.1.2 Summary of Results of the EU Risk Assessment Report

The problem identified with 1,4 dichlorobenzene in the EU Risk Assessment Report under the Existing Substances Regulation (hereafter referred to as EU RAR) is one of discrepancy between the fundamental goals of the Union and the existing situation. This particularly relates to promoting public health (Article 152 of the EC Treaty) and a high level of consumer protection, which includes the protection of health, safety, and economic interests of consumers (Article 153 of the EC Treaty).

The EU RAR identified unacceptable risks for consumers because of carcinogenicity due to inhalation exposure arising from the use of air fresheners and toilet blocks. The EU RAR concluded that there is a need for limiting the risks while taking into account risk reduction measures which are already being applied.

The conclusions on use of 1,4 dichlorobenzene in non-occupational human exposure scenarios were particularly influenced by consideration of the potential risks to consumers of hepatic carcinogenicity as a result of inhalation exposure associated with the use of the substance in moth repellents, air fresheners and toilet blocks. In considering the database, the EU RAR (EU, 2004) noted that the US National Toxicology Program studies on 1,4 dichlorobenzene had found renal tubular cell adenocarcinomas in male F344 rats exposed at or above 150 mg/kg/day in an oral study. The mechanism for the formation of these tumours was, however, male rat specific hyaline droplet nephropathy which is not of relevance to human health and it was not considered appropriate to establish a NOAEL for use in human risk assessment based on this endpoint. However, 1,4 dichlorobenzene also caused hepatocellular carcinoma in orally dosed B6C3F1 mice at 600 mg/kg/day and in BDF1 mice at 300 ppm via inhalation; the respective NOAEL and NOAEC were 300 mg/kg/day and 75 ppm. Furthermore, when B6C3F1 mice were orally dosed at 600 mg/kg/day or BDF1 mice were exposed at 300 ppm via inhalation, hepatocarcinomas associated with other tumour types rarely seen in mice. The other available inhalation studies were considered unsuitable for consideration because of methodological shortcomings.

A detailed mechanistic assessment of carcinogenic effects has been undertaken (EU RAR). This concluded that the carcinogenic effect of concern, liver tumours in mice was not considered to relate to mutagenicity and was probably not the result of peroxisomal proliferation. The definitive mechanism was not elucidated but there was some evidence of a potentially threshold-limited mechanism involving cell proliferation and chronic alteration, a mechanism that could not be ruled out as being of no relevance to humans. Based on the hypothesis that the mechanism was threshold in nature, the NOAEL for liver tumours in mice was 75 ppm, 6 hours per day, 5 days per week via inhalation in rats and mice, which was estimated to be equivalent to 13 ppm or 80 mg /m^3 under conditions of continuous exposure. When this was compared with the EU RAR estimate of human exposure of 0.85 (0.60-1.15) mg/m^3, a margin of safety of 95 was determined. The authors of the EU RAR considered that this margin was inadequate to fully ensure human safety.

Commission Communication 2008/C 34/01 summarises the results of the risk assessment and the recommended strategy for limiting the risks to workers and consumers. The strategy recommends for consumers to consider at Community level marketing and use restrictions for the use of 1,4 dichlorobenzene in air fresheners, moth repellents and toilet blocks [9].

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9 With regard to risk reduction measures for workers, the legislation for workers' protection currently in force at Community level was generally considered to give an adequate framework to limit the risks of the substance to the extent needed and shall apply. Within this framework it was recommended that the Commission Scientific Committee on Occupational Exposure Limits (SCOEL) review the new information contained in the risk

2.1.3 Scale of the Problem

Findings and Assumptions in the Risk Assessment Report

The EU RAR indicates that, for the risk assessment of acute effects, the inhaled concentration taken in account corresponded to an exposure level for a single event. The maximum concentration measured in indoor air was considered to be 23,800 µg/m^3.

Also in the EU RAR, for the risk assessment of chronic effects, the inhaled concentration used corresponded to an exposure level averaged over 24 hours. Based on measurement data showing a wide dispersion of exposures to 1,4 dichlorobenzene in the population (with high values for a few people), a realistic worst-case of daily continuous exposure of 850 µg /m^3 was defined and bordered by a interval of 600 to 1,150 µg/m^3. This exposure is equivalent to a body burden of 0.179 mg/kg/day [0.126-0.242] assuming a ventilation rate of 0.7 m^3/hour, a 60 kg person and a relative absorption by inhalation compared to ingestion of 75% (default values).

Review of State of the EU Market for 1,4 Dichlorobenzene-based Consumer Products

It is important to discuss the extent to which the relevant 1,4 dichlorobenzene-based products are currently used by EU consumers at home. This will put the risks identified in the EU RAR into perspective. The text below presents the information from sources that suggest that domestic use of 1,4 dichlorobenzene-based air fresheners is insignificant as well as information from sources indicating the use of such products by consumers at home (for specific individual companies, such consumer use at home may account for a considerable part of their 1,4 dichlorobenzene-related turnover).

<u>Sources Suggesting Domestic Use is of Very Low Importance</u>

As indicated in Section 1.3.3, the input made by industry stakeholders mainly focused on the use of 1,4 dichlorobenzene-based air fresheners and toilet blocks away from home, especially the use of urinal blocks in public toilets. We have further specifically enquired on the current levels of domestic use of 1,4 dichlorobenzene-based products. The responses received from stakeholders are presented below:

- **Current manufacturer of urinal blocks and air fresheners based on 1,4 dichlorobenzene (DE)**: *"Neither 1,4 dichlorobenzene-based air fresheners nor 1,4 dichlorobenzene-based urine blocks are used in households. The use of 1,4 dichlorobenzene-based products takes place almost exclusively in business sector. In Germany, air fresheners based on the substance cannot be sold to private persons without special guidance any more; therefore these products cannot be bought in supermarkets or other stores. In some cases, one can still buy these products in Southern Europe, but this is gradually decreasing. The private use of urinal blocks in urinals is virtually non-existent. Some years ago, we attempted to supply this*

assessment report and recommend whether there is a need to revise the current community Occupational Exposure Limit (OEL).

market but we found out that the market demand is not there and we gave up. Recently, one can buy urinals for modern private toilets but according to research these are barely purchased; in addition, these are frequently equipped with a lid and therefore unpleasant odours are not released. Therefore, this sector is not relevant";

- **Current manufacturer of urinal blocks based on 1,4 dichlorobenzene (DE)**: "*To my knowledge, 1,4 dichlorobenzene-based air fresheners and urinal blocks are only sold via wholesale for pubs. It cannot be ruled out that one or the other private consumer acquires these products but in general private consumers have no access to these products. We produce exclusively for business use and not for private users*";
- **Current manufacturer of air fresheners, urinal blocks and toilet rim blocks (USA)**: "*We do not sell to distribution servicing retail consumers, just janitorial, industrial and institutional*". The manufacturer has also indicated that toilet rim block products have never been widely accepted in the EU. In any case, the manufacturer believes that 1,4 dichlorobenzene-based toilet rim blocks are not a necessity these days because the design of a toilet (the fact it keeps water in the bowl) means that they are not a long term source of constant malodours that should be controlled by a deodoriser as strong as 1,4 dichlorobenzene;
- **Current supplier of urinal blocks and toilet rim blocks based on 1,4 dichlorobenzene (UK)**: "*We do not sell to the public*";
- **Current supplier of urinal blocks based on 1,4 dichlorobenzene (CZ)**: "*We do not supply to households, nor to retail. We specialise in business-to-business sales*";
- **Current supplier of urinal blocks and toilet rim blocks based on 1,4 dichlorobenzene (UK)**: the company has described its customers as: "*contract cleaners, distributors, end users, various*". They further explained the term end-user as follows: "*end users mean anyone, we don't keep a database of what each company we supply does, so therefore yes end users can also mean householders, restaurants, hotels, schools, etc.*". Therefore, private consumers could in theory be among the users. However, the company appears to predominantly focus on sales to businesses;
- **Current supplier of urinal blocks based on 1,4 dichlorobenzene (UK)**: "*The product is a urinal block and is designed totally for that purpose alone. There should never be any instances where this product would be used by a consumer*";
- **Current supplier of urinal blocks based on 1,4 dichlorobenzene (UK)**: "*(a) We only sell to Industry and Commerce. Our products are not sold to the public or in retail outlets. This does not stop people from taking them from their place of work. (b) Channel blocks and toilet rim blocks are the only products still using 1,4 dichlorobenzene in the formula. The above would be used in a toilet or bathroom and are being phased out over the coming year. (c) Any product can be used at home if one wants to. I would estimate that less than 0.1% of these products end up in the home*";
- **Past manufacturer of urinal blocks, toilet rim blocks and air fresheners (UK)**: "*(a) In the past (over 30 years ago), we manufactured air freshener and toilet bowl freshener products solely from 1,4 dichlorobenzene* (and) *these were sold to both the trade and the consumer. 1,4 dichlorobenzene-based toilet fresheners have been*

steadily phased out over the years as surfactant-based extruded products replaced them. (b) 1,4 dichlorobenzene-based air fresheners were made up until the company stopped producing in the last few years. (c) Consumers may have purchased these products through Cash & Carry and discount high street stores and air freshener 1,4 dichlorobenzene-based products could be used in any room"; and

- **Past supplier of urinal blocks based on 1,4 dichlorobenzene (DE)**: *"Our products have been delivered only to professional customers, as restaurants, industrial plants etc. They were not intended for private customers to use it at home*".

The above comments indicate that sales of 1,4 dichlorobenzene-based air fresheners and toilet blocks to the public for use at home may have been more popular in the past but are not common any more. It is also important to consider that the relevant products may often be sold in quantities too large for domestic use (toilet rim blocks based on 1,4 dichlorobenzene may be sold in large packets (for instance, 36 units)). Also, any private individual could (at least attempt to) purchase on the Internet products that are generally intended for use by professional users or even visit Cash & Carry or discount stores aimed at business customers and purchase such products for use at home.

<u>Sources Suggesting Domestic Use is Still Ongoing</u>

On the other hand, there have been some sources suggesting that use of 1,4 dichlorobenzene-based products by consumers at home may still be ongoing.

Very late in the preparation of this impact assessment, we were contacted by a company based in a Southern EU Member State. The company confirmed it manufactures 1,4 dichlorobenzene-based air fresheners, urinal blocks and toilet rim blocks some of which are sold to private consumers. Within the EU, the company sells to customers in its Member State only (but also sells to some non-EU countries) and indicated that 70% of its products are sold to private consumers.

This testimony is corroborated by an industry expert with long experience in the field of 1,4 dichlorobenzene-based products. The expert has suggested that he has visited Southern EU Member States on a number of occasions, including a recent visit in Spain, and it has always been 'easy' to find 1,4 dichlorobenzene-based air fresheners (but not toilet blocks) on the shelves in small supermarkets. The expert suggested that while larger supermarkets may have Health & Safety departments which keep abreast with legislative developments (e.g. the classification of 1,4 dichlorobenzene as a Carc. Cat. 3) and promptly replace products with safer ones, smaller stores (corner shops, also known as 'mini-markets' in some countries) may not do so and instead continue selling products that have traditionally found wide use (for instance as moth repellents). It is very difficult to contact such stores as they often operate under a franchise model, i.e. while the brand name they operate under could be a well-known household name, decisions on products to be placed on the shelves could be made by the owner of the store.

The same expert has further suggested that air fresheners should be considered to be much more likely to be used by a consumer at home rather than toilet blocks. He further indicated that the use of 1,4 dichlorobenzene-based air fresheners at home is an old-fashioned habit of some people (normally in Southern but also Eastern EU Member States) who believe that the odour of the substance conveys a feeling of 'cleanliness' and has traditionally been associated with the use of 1,4 dichlorobenzene moth balls and animal repellents (used for repelling moles and other small animals in gardens). All these products are essentially identical, based almost exclusively on 1,4 dichlorobenzene with small additions of other components (e.g. fragrance and dye). Also, warmer weather could make toilet rooms develop strong unpleasant odours that require deodorisers with good odour masking properties. 1,4 dichlorobenzene offers such functionality.

The expert has suggested that domestic uses may account for around 20% of the overall consumption of 1,4 dichlorobenzene-based air fresheners in Southern and Eastern Europe but could be below 5% in Western and Northern EU Member States.

Some home use of these products has also been suggested by some Competent Authorities (see Table 2.15). Communication with the Slovenian authorities (Chemicals Office of the Republic of Slovenia, 2010) indicates that the information was collected from "*specialised companies* [involved in the] *distribution of toilet consumables*" which suggested that "*some stores sold these products for consumer use (private consumers)*". Upon further clarification, the authorities confirmed that the term "stores" would include supermarkets and chemist's (Chemicals Office of the Republic of Slovenia, 2010b). However, the distributors advise against this type of sale and domestic use of these products. The Slovenian authorities have confirmed "*these products are* [mostly] *used by cleaners in public buildings*" but could not estimate the percentage of consumption represented by consumer use at home.

Notably, the Slovenian authorities initially suggested that "*1,4 dichlorobenzene air fresheners are sprayed into public toilets*". Upon further inquiry, the authorities indicated that they do not hold any information on sprayed products and noted "*sprays are not used any more*" (Chemicals Office of the Republic of Slovenia, 2010b). It was also suggested that the toilet blocks (tablets) that are used in Slovenia are not hung in a plastic cage or from a hook but are "*poured directly in toilets or urinals*" (Chemicals Office of the Republic of Slovenia, 2010b).

The Latvian authorities (Latvian Environment, Geology and Meteorology Centre, 2010) indicated that their information was collected from two databases, the Biocides Inventory database (this contains data from 2004) and the Register of Chemical Substances and Chemical Preparations (also containing data from 2004, a national data base of chemicals which includes information from the reports of producers and importers about chemical substances and chemical preparations occurring on the Latvian market). The authorities could not conclusively indicate whether consumer use at home is relevant but they believe that it is "*probable*". We consulted with the Latvian company that supplies the product that might be used by consumers. The company indicated that in reality the product (a solid disc with a wire hook) is sold to professional users. Only small amounts (in the kilogram range) are currently sold (it is worth noting that although a reported 5.83 tonnes of toilet blocks were consumed in Latvia in 2007, the imports of these products in 2008 were only 150 kg).

Presence of 1,4 Dichlorobenzene-based Products in Southern EU Member States

On the basis of the above information and testimonies, we assume in this impact assessment that consumer uses of 1,4 dichlorobenzene-based air fresheners and toilet blocks is mainly concentrated in Southern EU Member States and also potentially Eastern EU Member States. This assumption is also supported by the testimony of a non-EU manufacturer of 1,4 dichlorobenzene who has indicated that he sells a considerable tonnage of 1,4 dichlorobenzene to manufacturers of air fresheners and toilet blocks which are based in Southern EU Member States.

Yet it is reasonable to assume that production and consumption of such products in Southern EU Member States have declined significantly in recent years. The reasons for this could be:

- **the loss of the moth ball market**: Southern EU Member States were key consumers of these products. Following the developments described in Section 2.4.4, it is very likely that the use of the substance in hygiene applications has been seriously impacted. Moth balls and air fresheners are effectively the same product when made of 1,4 dichlorobenzene and, traditionally, companies that manufactured moth balls also manufactured air fresheners and toilet blocks based on the substance; and
- **the cessation of supply by the Italian manufacturer**: a comment made by consultees is that transportation costs are high; therefore, Southern European markets have generally been dominated by local players rather than companies from central or Northern Europe. The Italian manufacturer may have been a significant source of the substance for Southern European manufacturers of these products in the past.

The information provided by the manufacturer of products who is located in Southern EU supports the above assumptions. Later in this impact assessment we discuss the estimated tonnages of air fresheners and toilet blocks consumed in the EU. The significant decrease in consumption demonstrates that consumer exposure to the substance at home is now lower than in the past. We cannot estimate the level of reduction. The EU RAR does not make a distinction (especially in terms of tonnages) between 1,4 dichlorobenzene used in domestic applications as opposed to 1,4 dichlorobenzene used in professional applications. As a result we cannot directly compare the current situation with that described in the EU RAR.

Conclusions on the Size of the Domestic Market for 1,4 Dichlorobenzene-based Air Fresheners and Toilet Blocks

Our overall conclusions can be summarised as follows:

- domestic use of air fresheners and toilet blocks based on 1,4 dichlorobenzene is still ongoing;
- air fresheners have been popular among private consumers in the past and they were used alongside other popular 1,4 dichlorobenzene-based products such as moth balls and animal repellent granules. Toilet rim blocks have not had a similar popularity;

- there appear to be differences in consumption levels between EU Member States: while it appears that 1,4 dichlorobenzene-based products may not be sold in some Member States at all, there is information showing that these products may be particularly popular with consumers in Southern and possibly Eastern EU Member States; and
- recent developments (regulatory and other) have affected traditional markets for 1,4 dichlorobenzene-based products (for instance moth balls) which have been particularly popular in the past and this has led to an overall reduction in the use of 1,4 dichlorobenzene-based air fresheners and toilet blocks by consumers at home. This would imply that risk to consumers from 1,4 dichlorobenzene from use at home could be lower than what was assumed in the EU RAR.

2.1.4 Evidence of Accidents Associated with 1,4 Dichlorobenzene

There has been a limited number of incidents involving consumers (usually children) and 1,4 dichlorobenzene-based products (not necessarily relating to air fresheners or toilet blocks). During consultation we have been advised of such incidents in Finland, Ireland and Switzerland (see Section A3.2 in Annex 3 for more details):

- in Finland, one incident involving an air freshener in 2008 and a further six in 2006;
- in Ireland, one incident involving an air freshener and three involving toilet blocks were recorded over 6 years (2004-2009); and
- in Switzerland, four incidents involving air fresheners and ten involving urinal blocks were recorded over 15 years (1995-2009).

Other accidents involving the substance but which apparently are of no relevance to consumer exposure to 1,4 dichlorobenzene-based air fresheners and toilet blocks are also mentioned in Annex 3.

Re-Solv, the UK national charity dedicated to the prevention of solvent and volatile substance abuse, reports that substances like 1,4 dichlorobenzene and naphthalene may be subject to abuse. The most common product of abuse was reported to be moth balls. Moth balls were made of naphthalene or 1,4 dichlorobenzene in the past but are not approved for use under the provisions of the Biocidal Products Directive. Other products subject to abuse may include toilet deodorisers. Re-Solv describes one case study of such abuse which is of relevance to this study: a 21-year-old woman was ingesting two 1,4 dichlorobenzene toilet air freshener blocks each week (for an unspecified period of time) while pregnant; anaemia developed, which did not respond to iron therapy (Re-Solv, 2009). It is not clear where this incident took place.

The charity suggests that since patients rarely volunteer that they abuse moth balls and other common household products and physicians rarely ask directly about the use of such substances as intoxicants, there is currently no way of determining the actual prevalence of this type of substance abuse and the frequency with which it may contribute to medical problems (Re-Solv, undated).

2.1.5 Summary of Identified Problems

Table 2.2 summarises the characteristics of the problems addressed by the proposed policy intervention.

Table 2.2: Characterisation of Identified Problems Requiring Policy Intervention	
Problem	• Risk to consumer health from carcinogenicity through the use of deodorising products • Potential risk of abuse of products – but only very limited evidence available on the abuse of air fresheners and toilet blocks
Driver	• Home use of air fresheners and toilet blocks that are based on 1,4 dichlorobenzene • Inhalation exposure of consumers to 1,4 dichlorobenzene vapours
Underlying cause	• 1,4 dichlorobenzene readily sublimes at room temperature • 1,4 dichlorobenzene is a carcinogen causing hepatic liver tumours in mice • 1,4 dichlorobenzene is currently classified as a Carcinogen Category 3
Scope	• Impact assessment focuses on private use at home (but exposure may occur also in public toilets, e.g. offices, bars, restaurants, airports, railway stations, amusement parks, etc.) • Consumer use appears to be largely confined to Southern and possibly Eastern EU Member States
Scale	• EU RAR assumes a realistic worst-case inhalation exposure level for consumers of 0.85 mg/m^3 • Margin of Safety in the EU RAR: 95 for consumers (this is considered to be insufficient due to the severe carcinogenic effect in mice) • Tonnage of 1,4 dichlorobenzene used in the products of concern has significantly declined in the EU in the last 15 years, and use in other previously popular products (moth balls) has ceased • Air fresheners are apparently much more popular than toilet rim blocks for use by private consumers at home

2.2 Development of Problem over Time and Existing Policies at the EU and Member State Level

There have been regulatory developments in the last five or six years that appear to have significantly affected the use of the substance in the EU. These are discussed in more detail in Section 2.4.4 below. Here, the following 'milestones' can be highlighted:

- the 29th Adaptation to Technical Progress (ATP) of the Classification and Labelling Directive 67/548/EEC in 2004 which classified the substance as a carcinogen category 3;
- the introduction of labelling requirements under the Detergent Regulation in 2004;
- the decision of the Spanish authorities to restrict the use of the substance in biocides in 2005; and
- the non-inclusion of the substance in the Annexes I, IA or IB to the Biocidal Products Directive in 2007.

More generally, products based on 1,4 dichlorobenzene are considered to be 'old-fashioned' and perhaps more acceptable to older generations which are used to the strong, moth ball-like odour of the substance.

In individual EU/EEA countries, no specific legislation relating to air fresheners and toilet blocks exists with the exception of Sweden where a ban on products containing 1,4 dichlorobenzene and intended to mask odours has been in place since the beginning of 1990 (see Annex 3). Also of note are the national occupational exposure limits (OELs) in countries such as France and Germany which are significantly stricter than the EU-wide limits established under Directive 2000/39/EC. National limits stricter than the EU-wide ones may also be found in Belgium, Denmark, Iceland, Poland and Sweden. Table A2.5 summarises the national OELs in EU countries while Table A2.9 shows the OELs values that apply in a range of non-EU countries.

Apart from regulatory measures, green procurement initiatives may also target the use of 1,4 dichlorobenzene in air fresheners and toilet blocks. For instance, our research suggests that several local authority councils in the UK require that their contractors do not use products based on the substance (see Section A2.5.2).

Finally, restrictions on the use of 1,4 dichlorobenzene in air fresheners and toilet blocks are being considered in Canada and several States in the USA. On the other hand, the use of 1,4 dichlorobenzene in moth repellents is still ongoing in the USA and Japan (see Annex 3).

2.3 Stakeholders Affected

The research undertaken suggests that, in general terms, the stakeholders who might be affected by the issues at hand and from taking regulatory action targeting the use of 1,4 dichlorobenzene-based products at home may include:

- **manufacturers of 1,4 dichlorobenzene**: these include the two identified EU-based manufacturers and several non-EU manufacturers who import the substance into the EU for the manufacture of air fresheners and toilet blocks. For the EU manufacturers, the amount of solid 1,4 dichlorobenzene sold to EU customers for the two applications of concern represents only a very small fraction of their annual production. On the other hand, the amounts of 1,4 dichlorobenzene imported from non-EU countries exceed the amount of the substance supplied to EU-based producers of toilet blocks and air fresheners by EU manufacturers of 1,4 dichlorobenzene. Therefore, there is the potential for more severe adverse impacts on non-EU manufacturers of 1,4 dichlorobenzene. The magnitude for such impacts would evidently depend on what percentage of 1,4 dichlorobenzene-based products are sold to consumers for domestic use. As explained above (and also further discussed in Section 2.4.7), on the basis of available information, domestic use accounts for a limited proportion of the overall use of 1,4 dichlorobenzene-based products in the EU;

- **EU-based manufacturers and suppliers of 1,4 dichlorobenzene-based products**: as discussed in Section 2.4.7, until the mid 2000s, there may have been 15-20 EU-based manufacturers of 1,4 dichlorobenzene-based products. The number of confirmed EU-based manufacturers is small but we have received very limited input from consultees based in Southern and Eastern EU Member States where consumer uses are more widespread. An industry expert estimates that there may be around 10 companies in the whole of the EU who may still manufacturer air fresheners for use at home. While the overall EU market for 1,4 dichlorobenzene-based products is small, a restriction on such uses would particularly impact upon the apparently few companies that sell their products to consumers in Southern and Eastern EU Member States.

  Similarly, the number of suppliers who would be affected from a prohibition on consumer uses of the products under consideration will probably be small and will be concentrated in Southern and Eastern EU Member States. Nevertheless, our research suggests that 1,4 dichlorobenzene-based air fresheners and toilet blocks are sold in most EU Member States, but typically for professional use (in public toilets).

  It is useful to consider that the relevant supply chains could be particularly complicated. A manufacturer of deodorisers (who serves the professional market only) has suggested the following links on his supply chain:

  Manufacturer of 1,4 dichlorobenzene
  ê
  Manufacturer of deodoriser products
  ê
  Other full-range manufacturer who wishes to complete his product range
  ê
  Business-to-business suppliers
  ê
  Wholesaler dealers
  ê
  Retail dealers
  ê
  Business user – Public amenity user – Private user

  Specific information has also been provided by a manufacturer of air fresheners and toilet blocks for private use at home. The company estimates that potentially more than 200 companies may sell its products as a result of distribution across the country.

  The range of actors in the supply chain includes:

  - **distributors**: there is a large distributor that supplies supermarkets and small shops and a further twenty-five smaller distributors;
  - **retailers**: the largest supermarket chain in the country apparently purchases the relevant product and another six smaller supermarkets do as well. Also a large

'cash & carry' store serving professional users only purchases the relevant products. The manufacturer does not sell directly to small shops; and

- **another manufacturer**: a detergent manufacturer purchases the products, adds its own label to them and exports them to non-EU customers.

As there are quite a few actors in the supply chain, there are likely to be a lot of companies impacted but the small scale of the relevant markets would make the magnitude of such impacts relatively modest;

- **non-EU manufacturers of 1,4 dichlorobenzene-based products**: suggestions have been made that such products may be manufactured in the USA, Japan, Latin America, Southeast Asia and Africa and several consultees have suggested that India and China could well be important sources of 1,4 dichlorobenzene-based products. However, we have positively confirmed imports only from the US by a company which does not sell its products to private users. We are not familiar with the numbers of companies involved or the exact tonnages exported into the EU by them, hence we cannot estimate the impacts on these companies;
- **manufacturers and suppliers of alternative products**: with regard to products for use at home by consumers, there are numerous companies which manufacture alternative air fresheners and toilet block products. Furthermore, a proportion of companies manufacturing and supplying 1,4 dichlorobenzene-based products may also have alternative products in their portfolios. The market affected by the proposed policy option is comparatively very small and the individual benefits to manufacturers of alternatives from a restriction on 1,4 dichlorobenzene would probably be insignificant; and
- **consumers**: the probability that consumers may use 1,4 dichlorobenzene-based air fresheners and toilet blocks at home is low, and this appears to be particularly true for toilet rim blocks. These products may also be more popular in Southern and possibly Eastern EU Member States. There is a wide range of alternatives some of which may be very sophisticated and thus more costly than 1,4 dichlorobenzene-based products but there are also products that are very competitively priced, often less costly than 1,4 dichlorobenzene-based products. Whilst it is difficult to predict which alternatives current users may opt for, on the assumption that 1,4 dichlorobenzene-based products are based on 'old technology' and are reasonably inexpensive, it could be assumed that users may opt for less sophisticated, inexpensive alternatives. On this basis, it would be unlikely that EU consumers would suffer a significant financial loss or inconvenience if 1,4 dichlorobenzene-based products ceased to be available. With particular regard to longevity, 1,4 dichlorobenzene-based products tend to last 3-4 weeks, depending on their size and surface area. Alternative products are expected to last a similar period, although the actual duration will depend on the product, its size and the mode of use (for instance, an aerosol is only consumed when the user chooses to use it, as opposed to a 1,4 dichlorobenzene-based air freshener which continually sublimes). Overall, no significant impact to consumers is expected to arise from regulatory intervention on 1,4 dichlorobenzene.

2.4 Potential Future Developments without EU Action

2.4.1 Baseline Scenario – Past and Current Manufacture of 1,4 Dichlorobenzene in the EU

The EU RAR was based on information provided by five producers and importers. EU production in 1994 was estimated at 22,500-30,500 tonnes.

Information received in the course of consultation for this study indicates that, in 2009, there were three EU-based manufacturers of the substance and there are indications that one of these companies may be the largest producer of 1,4 dichlorobenzene globally. However, one of these three companies (the one based in Italy) intended to cease the manufacture of chlorobenzenes at the end 2009 and had stopped supplying the substance for the manufacture of air fresheners and toilet blocks in 2008.

There is an unknown number of non-EU companies that may be importing 1,4 dichlorobenzene to the EU from manufacturing locations in third countries, such as China and India. The table below presents an overview of the manufacturers identified both within and outside the EU.

Table 2.3: Overview of Manufacturers and Suppliers of 1,4 Dichlorobenzene

Country	Number of companies contacted	Number of confirmed manufacturers/ suppliers		Notes
		M	S	
Germany	1	1	-	
Italy	1	1	-	Expected to cease manufacture of chlorobenzenes at the end of 2009
Poland	1	1	-	
Australia	1	-	1	
Canada	1	No info	No info	
China	16	1	No info	Has not exported to the EU in the last 10 years
India	10	5	No info	Two companies export to the EU; another three do not
Mexico	9	No info	8	Based on information submitted by one company
USA	3	0	No info	Three companies ceased producing the substance between 2002-2008

Given the small number of companies involved, for confidentiality reasons, specific information on the tonnages of the substance currently manufactured within the EU cannot be provided. In general terms, our research has revealed the following:

- EU-based production is dominated by one player;
- the Polish plant appears to have historically been the only plant manufacturing 1,4 dichlorobenzene in the twelve EU Member States which joined the EU in recent years. In the 1980s, 1990s and 2000s, all other EU manufacturing plants were located in the 'old' EU Member States;
- a comparison of 1,4 dichlorobenzene production volumes in 1994 and 2008 is complicated by the fact that the European Union has undergone three waves of enlargement since 1994 and the relevant production volumes thus relate to very different geographical areas. The tonnage of 1,4 dichlorobenzene manufactured in the EU in 2008 is assumed to have been at the levels of the upper range limit (30,500 t/y) indicated in the EU RAR for the year 1994. Since only two EU companies are active in this field, for reasons of confidentiality we cannot provide the specific tonnage of 1,4 dichlorobenzene currently being produced in the EU; and
- as will be discussed later in this report, the profile of consumption of the substance has changed with new applications becoming dominant – and this has arguably maintained the overall EU production tonnage to its 1994 level despite regulatory pressures on the use of solid 1,4 dichlorobenzene in 'traditional' applications such as moth balls, air fresheners and toilet blocks.

Physical State of 1,4 Dichlorobenzene Production

A distinction needs to be made between the liquid and the solid form of 1,4 dichlorobenzene. We have been advised that the manufacturing process of 1,4 dichlorobenzene is a process ending with liquid/molten material. Some material is afterwards flaked in separate equipment. 1,4 dichlorobenzene flakes can be used globally for applications in the hygiene sector like toilet blocks and air fresheners but also other applications (such as the manufacture of grinding or abrasive paper where 1,4 dichlorobenzene is not a part of the end product).

The available information suggests that the vast majority of 1,4 dichlorobenzene sold to EU users is in the form of flakes (liquid 1,4 dichlorobenzene is generally sold to non-EU users).

2.4.2 Baseline Scenario – Past and Current EU Exports of 1,4 Dichlorobenzene

In 1994, in addition to supplying a significant proportion of the 14,494 tonnes of 1,4 dichlorobenzene used in industrial production in the EU, European producers of the substance also exported 14,835 tonnes of the substance, suggesting that export markets consumed at least 50% of 1,4 dichlorobenzene produced in Europe.

More recent data confirm that a very high proportion of EU-based production of 1,4 dichlorobenzene is being exported to customers outside the EU. For confidentiality reasons, we are unable to reproduce data relating to the current EU exports; however, it can be said that, overall, EU manufacturers appear to derive most of their 1,4 dichlorobenzene-related revenue from exporting the substance to non-EU customers in the form of a liquid; some export of flaked 1,4 dichlorobenzene may also take place.

2.4.3 Baseline Scenario – EU Imports of 1,4 Dichlorobenzene

Some consultees have suggested that companies from countries such as China and India may import the substance in the EU. We have confirmed that this is the case for two companies located in India. For one of them, the combined tonnage of 1,4 dichlorobenzene sold to customers in Southern EU Member States for the manufacture of air fresheners and toilet blocks exceeds the combined EU sales of both EU manufacturers of the substance for these two applications. Therefore, despite some claims that the substance may be too heavy to export[10] and that losses during transport may be high[11], it seems that, in practice, losses can be adequately controlled[12] and the sale of imported 1,4 dichlorobenzene to EU manufacturers of air fresheners and toilet blocks is feasible and indeed takes place.

2.4.4 Baseline Scenario – EU Consumption of 1,4 Dichlorobenzene

Historical Information

The EU RAR provides data on the use of 1,4 dichlorobenzene in industrial production in the EU-12[13] in 1994[14]. These data suggest that that, at the time, the consumption of the substance in EU-12-based production of toilet blocks and air fresheners totalled almost 3,200 tonnes. The full dataset is presented below.

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10 It has been argued that EU imports of 1,4 dichlorobenzene related to the manufacture of air fresheners and toilet blocks should be expected to be small. This market is relatively small and this was argued to make transportation of the substance from non-EU countries into the EU uneconomical. Indeed a non-EU manufacturer of 1,4 dichlorobenzene-based products who sells solid product to EU and other countries has agreed that 1,4 dichlorobenzene is a material that is too heavy to ship internationally.

11 It has been argued that transportation of the substance may result in losses of up to 10% due to sublimation, the exact percentage depending on temperature and ventilation conditions. Exporters may dispatch quantities larger than what has been ordered to ensure that the customer collects the desired quantity. Upon arrival, the shipment is weighed and the relevant invoices are settled taking into account the losses during transport.

12 Another company indicates that 1,4 dichlorobenzene transported to manufacturers of air fresheners and toilet blocks is in the form of pellets. These are packed in sacks which are equipped with a plastic interlayer. From the heat sealed sacks, no appreciable sublimation at typical ambient temperatures is expected.

13 Please note that the EU RAR (EC, 2004) does not specifically refer to consumption of 1,4 dichlorobenzene in the EU-12 and instead refers to usage of the substance in 'Europe'. However, due to the fact that total usage given in EC (2004) for 'Europe' corresponds with that for the then EU-12, we believe that usage data for 1994 reported in the EU RAR relate to the EU-12.

14 These data are based on estimates provided by CEFIC-Eurochlor. Please note that the EU RAR refers to this dataset as quantifying "*use of 1,4 dichlorobenzene*." A more detailed explanation suggesting that these data refer to use in industrial processes is offered in AFFSE (2004).

Table 2.4: Industrial Consumption of 1,4 Dichlorobenzene in the EU-12 in 1994		
Use	**Quantity (tonnes/year)**	**% of total**
Intermediate (industrial purposes)	7,154	49.3
Production of toilet blocks	1,268	8.8
Production air fresheners	1,902	13.1
Production of moth repellents	4,070	28.1
Production of grinding wheels	100	0.7
Total for all industrial applications	***14,494***	***100***
Source: EC (2004) and AFFSE (2004) *Note: in EC (2004) the data refer to 'European' consumption but we infer that the data relate to EU-12.*		

AFSSE (2004) provides more recent (2003) consumption data based on information submitted by a manufacturer who supplied over 80% of the EU market for 1,4 dichlorobenzene. The 2003 usage data (see Table 2.5) indicate that the total consumption of the substance in toilet blocks and air fresheners in the EU-15[15] in 2003 was below 2,300 tonnes. According to the original submitter of this information, the figures refer to the volume of sales (tonnage) of 1,4 dichlorobenzene in the different European countries related to the substance (1,4 dichlorobenzene) and not to the finished product (moth balls, air fresheners or toilet blocks).

Table 2.5: Estimated EU-15 Consumption of 1,4 Dichlorobenzene in Selected Applications - 2003					
Country	**Size of market (tonnes)**	**Moth repellent share**		**Air fresheners & toilet blocks share**	
		%	**tonnes**	**%**	**tonnes**
France	3,400	70	2,380	30	1,020
Spain	2,300	100	2,300	0	0
Italy	2,100	100	2,100	0	0
Germany	350	20	70	80	280
Rest of EU	1,230	20	245	80	985
Total for moth repellents, air fresheners and toilet blocks	***9,380***	***76***	***7,095***	***24***	***2,285***
Source: AFSSE (2004)					

It has to be noted that the tonnage information in the EU RAR and the Risk Reduction Strategy document is <u>not</u> split between consumption at home and consumption in public toilets. We have asked the original contributor of the 2003 figures to provide information on the split between consumer and professional uses but we were advised that no such information is available. Therefore, we cannot quantitatively assess the significance of the EU market for home use of these products in 2003 or earlier.

15 Please note that these data refer to 1,4 dichlorobenzene consumption in the EU in 2003 and as such they are likely to relate to EU-15 only (i.e. the EU prior to the 2004 and 2007 enlargements).

Updated Information

In recent years, there have been certain developments which have affected the consumption patterns for 1,4 dichlorobenzene in the EU. Our research has highlighted these key developments as having been:

- the change in the classification of the substance with Commission Directive 2004/73/EC of 29 April 2004. This classified the substance as a carcinogen category 3 (attracting a risk phrase R40). According to some industry consultees, some users of room air fresheners and urinal blocks became unwilling to use products based on 1,4 dichlorobenzene. It has also been mentioned by a supplier of air fresheners and urinal blocks that the presence of a carcinogen category 3 substance in their products meant that it would be unlikely for the company to win public contracts (i.e. supply such products to airports, railway/bus stations, schools, etc.). Hence, the company switched to alternatives;
- the introduction of labelling requirements under the Detergent Regulation in 2004. Although the products under consideration cannot be described as cleaning products, as many companies in the detergents/cleaning sector also manufacture and supply air fresheners and toilet/urinal blocks, the new requirements may have also added to market pressures on the substance;
- the non-inclusion of the substance in Annex I, IA or IB of the Biocidal Products Directive. This appears to have been the result of two factors: first, the new carcinogenicity classification deterred some key players from submitting a dossier for the substance under the Directive. Secondly, the Spanish authorities banned the use of 1,4 dichlorobenzene in moth balls on 1 November 2005. At the time, Spain was one of the main markets for this application in Europe. On the assumption that other countries would follow the Spanish decision, EU manufacturers decided not to register the substance.

  The result is that the substance cannot be used in moth balls in the EU any more. As shown in Table 2.5, this application has in the past been a very important one in the EU. We have been advised that several small companies which were involved in the manufacture of moth balls in the EU either closed down or had to dramatically change their processes. An industry expert has also suggested that, in the past, consumers might in fact purchase moth repellents based on 1,4 dichlorobenzene and would even use them as indoor deodorisers or to deter moles and other small animals from entering home gardens;
- the worldwide increase in the use of the substance in its liquid form in the manufacture of polyphenylene sulphide (PPS) and other polymers which find application in the automotive and aircraft industries or in coal power plants[16]. The production of these

[16] We are advised that PPS is a very promising polymer for the automotive and aircraft sector, because it enables the replacement of metal parts by lighter polymer components, especially at locations of heavy thermal stress. Other recent developments include the implementation of PPS exhaust pipes and high thermo resistant exhaust gas filter bags in coal fired power plants. Notably, the polymer PPS is widely imported into the EU from non-EU countries for automotive and aircraft use and the corresponding monomer has to be registered under REACH.

polymers takes place outside the EU (countries identified as producers of such polymers include the United States, Japan and China)[17]; and

- 1,4 dichlorobenzene-based products (especially air fresheners) are considered to be 'old-fashioned': their smell is intense and quite peculiar and is reportedly familiar and acceptable to older generations but perhaps not to younger people. In addition to this, 1,4 dichlorobenzene-free products (toilet blocks) are marketed as having additional functionalities that 1,4 dichlorobenzene cannot offer, e.g. cleaning, bleaching or disinfecting properties.

The result of the above developments is that the use of the substance in the production of air fresheners and toilet blocks has significantly decreased, and its most popular application is currently as a (liquid) intermediate in the manufacture of polymers outside the EU. The applications that appear to be of relevance to the EU at present in solid form include:

- intermediate;
- toilet blocks; and
- air fresheners.

The following table presents our assumptions on the tonnage of 1,4 dichlorobenzene currently being used in the EU for the manufacture of air fresheners and toilet blocks. This table is largely based on information received from EU manufacturers of the substance which has been validated with information on imports by a non-EU manufacturer. Given the small number of information sources, the confidentiality issues arising from the small number of EU manufacturers and the uncertainty on imports, we cannot provide information for individual companies and the tonnages below should be considered as indicative only.

Table 2.6: Estimated Consumption of 1,4 Dichlorobenzene in the Manufacture of Air Fresheners and Toilet Blocks in the EU-27 in 2008 (for both professional and consumer use)

Use	Volume sold (in tonnes)	Annual turnover (in € million)
Production of air fresheners	400	0.8
Production of toilet blocks	400	0.8
Total for both types of products	***800***	***1.6***

The table would appear to suggest that air fresheners are equally important to toilet blocks. Consultation with manufacturers and suppliers of these products does not support this – toilet blocks (specifically, urinal blocks) appear to be by far the most critical application. On the other hand, while in this report we aim to separate air fresheners from toilet blocks and treat them as mutually exclusive products, such a distinction is not 100% clear-cut as some products may appear as toilet rim blocks but could be marketed as "air fresheners" (this issue is further discussed in Section 2.4.6). For this reason, **we believe**

17 An EU company was producing PPS in Belgium between 1989 and 1992 but due to a variety of reasons the plant was closed down. To date, no company has resumed PPS production in the EU.

that it is more appropriate to refer to a total EU consumption of 800 tonnes of 1,4 dichlorobenzene per year as a whole rather than making a distinction between consumption for air fresheners and toilet blocks.

It is also important to note that the above tonnages reflect consumption in the manufacture of air fresheners and toilet blocks for both professional and home use. The overall private use at EU homes accounts for only a small proportion of these figures (but it is suggested to be proportionately more common in Southern and Eastern EU Member States)[18].

A direct comparison of datasets presented above for 1994, 2003, and 2008 may not be possible given the changes in the size of the Union (EU-12 in 1994, EU-15 in 2003 and EU-27 in 2008); however, it can be concluded that the use of the substance in EU-based production of toilet blocks and air fresheners declined considerably between 1994 and 2008.

Finally, air fresheners and toilet blocks may be manufactured in the EU but could subsequently be exported to non-EU customers. For instance, information obtained from some EU manufacturers/suppliers of these products (for professional use) indicates that customers may be located in countries outside the EU such as Croatia, Serbia and Turkey and non-European countries (such as Asian and African ones). Very limited tonnage data on exports have been made available from only a few industry stakeholders in isolated cases.

Price of 1,4 Dichlorobenzene

Consultation indicates that the current price of 1,4 dichlorobenzene may vary depending on the volume supplied and may range between €1,000-3,000 per tonne; a different source suggests a narrower range of €1.20-2.20 per kilogram. This price relates to 2010 and is the price at which it may be sold to manufacturers of products (not the price paid by end-users). Material purchased from non-EU manufacturers generally has a low price but transportation costs add to the final price which may be €1.5-1.6 per kilogram. For better quality product which can be purchased from an EU manufacturer, the price is higher. Prices evidently also vary with the amount purchased every time – to take advantage of the lower prices, orders as large as 5-10 tonnes may need to be placed.

18 An expert estimate was provided earlier according to which consumer uses may account for 20% of the Southern and Eastern EU markets for 1,4 dichlorobenzene-based products. The relevant percentage for Western and Northern EU was estimated at 5%. Therefore, across the EU, the overall percentage will be between 5% and 20% (for instance, assuming that Southern and Eastern EU accounts for ca. 40% of the total EU population, the overall percentage across the EU would be around 10-11%, but this is only a quick estimate). Please also note that the estimated consumption at home of 83+17 tonnes is small compared to the EU sales of 1,4 dichlorobenzene (800 tonnes, as shown in Table 2.6).

2.4.5 Baseline Scenario – Information Obtained From EU/EEA Competent Authorities

Table 2.7 summarises the information collected from Competent Authorities in EU Member States, Iceland, Norway and Switzerland with regard to the manufacture, import and use of 1,4 dichlorobenzene in their areas of jurisdiction. Please note that this table refers only to flows of 1,4 dichlorobenzene itself, not the products that may contain it.

Table 2.7: Overview of Data on Manufacture, Import and Consumption of 1,4 Dichlorobenzene in EU Member States, Iceland, Norway and Switzerland (reference period indicated where available)

Country	Manufacture (tonnes)	Imports (tonnes)	Consumption (tonnes)	Source
Austria	No data	No data	No data	Austrian Federal Ministry of Environment (2009)
Cyprus	0	0	0	Cypriot Department of Labour Inspection (2009)
Denmark	0	0	0	Danish EPA (2009)
Estonia	0	2007: 0.0011	No data	Estonian Ministry of Social Affairs (2009)
	0	2008: 0.0018	No data	
Finland	No data	2009: amount not public	No data	Finnish National Supervisory Authority for Welfare and Health (2009)
Germany	No data	No data	No data	German Federal Institute for Occupational Safety and Health (2010)
Greece	0	No data	No data	Greek General Chemical State Laboratory (2010)
Latvia	No data	2004: Not specified 2007: 5.83 2008: 0.15	No data	Latvian Environmental, Geology and Meteorology Centre (2010); Latvian Environmental, Geology and Meteorology Centre (2009); Latvian Ministry of Health (2009)
Lithuania	2003-2007: 0	2003-2007: 0	2003-2007: 0	Lithuanian State Non Food Products Inspectorate (2009)
Malta	No data	No data	No data	Malta Standards Authority (2009)
the Netherlands	No data	No data	No data	RIVM (2009)
Poland	No data	No data	No data	Polish Bureau for Chemical Substances and Preparations (2009)
Slovak Republic	No data	No data	No data	Slovak Trade Inspectorate (2009)

Table 2.7: Overview of Data on Manufacture, Import and Consumption of 1,4 Dichlorobenzene in EU Member States, Iceland, Norway and Switzerland (reference period indicated where available)

Country	Manufacture (tonnes)	Imports (tonnes)	Consumption (tonnes)	Source
Slovenia	2008: 0	2008: 9.84	2008: 8.52 +3.17 (export)	Chemicals Office of the Republic of Slovenia (2009)
	2007: 0	2007: 13.875	2007: 9.6776 +2.24 (export)	
	2006: 0	2006: 11.84	2006: 6.91 +3.135 (export)	
	2005: 0	2005: 8.77	2005: 6.516	
	2004: 0	2004: 6.6845	2004: 5.98	
	2003: 0	2003: 3.18	2003: 2.61	
	2002: 0	2002: 17.944	2002: 7.571 +10 (export to Croatia)	
	2001: 0	2001: 20	2001: 20 t (export to Croatia)	
	2000: 0	2000: 2.5	2000: 2.5	
Sweden	Confidential data	Confidential data	Confidential data	Swedish Chemicals Agency (2009)
Iceland	0	2008-9: 0	0	Environment Agency of Iceland (2009)
Norway	2008: 0	2008: 0	2008: 0	Norwegian Pollution Control Authority (2009)
Switzerland	No data	No data	No data	Swiss Federal Office of Public Health (2009)

Notes: the Norwegian Product Register has some information on this substance, however it is confidential. The substance occurs as technical impurities in another substance. The declaration of this substance to the product register was made by well known companies on the European market (Norwegian Pollution Control Authority, 2009).

The above table presents very limited data with only a few countries providing specific tonnages. Member States where 1,4 dichlorobenzene appears to be currently (or recently) produced (Germany, Italy, Poland) did not have relevant data available. The same can be said about Member States where, according to consultation, 1,4 dichlorobenzene is likely to be used in the production of toilet blocks or/and air fresheners.

Conclusions on Manufacture, Imports and Exports of 1,4 Dichlorobenzene

The key points of the information presented in this Section can be summarised as follows:

- as of the beginning of 2010, only two EU-based companies produce 1,4 dichlorobenzene;
- EU imports of the substance from countries such as India and China may account for more than 50% of the total amount of the substance sold to EU-based manufacturers of air fresheners and toilet blocks;

- the demand for 1,4 dichlorobenzene in its solid form for use in EU-based production of toilet blocks and air fresheners considerably declined between 1994 and 2008;
- the estimated tonnage of 1,4 dichlorobenzene used in the EU for the manufacture of air fresheners and toilet blocks is 800 tonnes/y for in total. This material is used in the form of solid flakes; and
- the decline in the demand for 1,4 dichlorobenzene from EU-based manufacturers of toilet blocks and air fresheners (and moth balls) appears to have been offset by an increase in the demand for the substance in liquid form from manufacturers of high performance polymers which are based in locations outside the EU.

2.4.6 Baseline Scenario – Relevant Applications

Introduction

Generally, 1,4 dichlorobenzene has been used for many years, either as a fragrance base or in addition to other fragrances where it is an efficient fragrance boost, promoting longer life deodorising properties (Bush Boake Allen, 1989).

According to NICNAS (2000), the major process involved in the manufacture of air freshener and toilet deodorant blocks is the addition of dye and perfume to 1,4 dichlorobenzene and then compression of flaked or granular 1,4 dichlorobenzene into disks or blocks. Due to a tendency for transported material to become fused whilst in transit, prior processing of the material is required, either melting/recrystallising and flaking or milling. The 1,4 dichlorobenzene is added to a hopper from which it enters an enclosed tank and reduced to a molten state by heating to 60°C. A small quantity of dye and perfume are added prior to spreading the liquefied material onto a stainless steel conveyor belt, which results in the formation of a thin layer of blended material suitable for flaking. Alternatively, the solid material is milled and then mixed with dye and perfume. The next step involves the pressing of the blended material into blocks of the required weight. Subsequently, the blocks are wrapped in cellophane, labelled and boxed for distribution.

Air Fresheners

<u>Potential Applications and Composition</u>

Open literature and consultation with stakeholders has revealed the following applications for 1,4 dichlorobenzene-based air fresheners:

- in relatively small size (possibly in the form of a cylindrical tablet) and in solid form, 1,4 dichlorobenzene-based air fresheners may be used:
  - inside a plastic box/cage (for instance, made of polypropylene) or paper carton container to deodorise rooms, by hanging on the wall;
  - as deodorisers in diaper pails (Healthy Child, 2009);

- as coffin hygiene agents (BUA, 1994);
- in large size (often called 'super blocks' in the US) and in solid form, 1,4 dichlorobenzene-based air fresheners may be used in an industrial setting as deodoriser/odour masking blocks for 60-90 days in:
  - sewer systems where they are suspended from manhole covers throughout the sewer line network and prevent/reduce significantly the release of sewer gases into the streets;
  - industrial waste collection containers and water treatment facilities; or
  - lift shafts.

Some of these uses are not relevant to the EU[19]. The EU-based companies we have consulted with have confirmed only the use of smaller products as room deodorisers (e.g. hanging on walls) in the EU, normally inside a box (typically plastic). Larger air freshener blocks ('super blocks') are not used at home and will not be considered further in this impact assessment. The term "air fresheners" used hereafter in this report should be assumed to refer to solid, small size room air fresheners, normally inside a plastic box/cage which may be hung on a wall.

The following table summarises the available information on the composition of air fresheners that are based on 1,4 dichlorobenzene. This information is based on Safety Data Sheets that are freely available on the Internet and on consultation responses provided by companies and Competent Authorities in EU Member States. It is worth noting that while the relevant Safety Data Sheets may still be found on the Internet, some of these products may no longer be manufactured and/or sold.

Table 2.8: Example Compositions of Air Fresheners Containing 1,4 Dichlorobenzene

Identified country of sale	**Origin of supplier**	**Concentration of 1,4 dichlorobenzene (%)**	**Other named ingredients (CAS Number and concentration by weight)**	**Source**
Czech Republic	Spain	>99	Perfume: <1%	Marca (1999)*
Germany	Germany	99	Perfume; dye	Consultation
Portugal	Portugal	98-99	Unknown	Consultation
Slovenia	Unknown	95 (average)	Unknown	Chemicals Office of the Republic of Slovenia (2009)

19 We have also been advised that it is possible to dissolve 1,4 dichlorobenzene in some fragrances, various aromatic organic solvents, VOC solvents and low-vapour pressure solvents. In this way, it is possible to create such a product that could possibly deodorise in an evaporative manner. However, such products are not yet commercially available, according to a non-EU manufacturer of 1,4 dichlorobenzene-based products who has done research on this.

Table 2.8: Example Compositions of Air Fresheners Containing 1,4 Dichlorobenzene				
Identified country of sale	**Origin of supplier**	**Concentration of 1,4 dichlorobenzene (%)**	**Other named ingredients (CAS Number and concentration by weight)**	**Source**
Unknown	China	N/A	Fragrance	Ningbo Zhenghua Import & Export (2009)
Unknown	China	99.5	Unknown	Zhejiang China (2010)
Unknown	China	99.94	Unknown	Shanghai Yuejia Cleaning Products (2010)
Middle East, Africa	China	N/A	Unknown	Zhejiang Yuantian (2010)
Unknown	Malaysia	>99	Unknown	Fukuta Corporation (2010)
Unknown	China	99.5	Unknown	Zhejiang Yuantian (2010b)
** This product has been discontinued*				

Table 2.8 indicates that air fresheners typically contain 1,4 dichlorobenzene at a concentration between 95% and >99%, normally around 99%.

<u>Location of Use</u>

Due to their strong fragrance, room air fresheners would be expected to be used in toilet rooms/bathrooms of private homes. The manufacturer of such air fresheners who is based in Southern EU confirmed that his products are used in private bathrooms. However, there have been suggestions that this may not always be the case. A past manufacturer of urinal blocks, toilet rim blocks and air fresheners (based in the UK) has indicated that, when they supplied 1,4 dichlorobenzene-based products, these could be used by consumers in any room. A non-EU source (Ningbo Zhenghua Import & Export, 2009) also notes "*Use no matter where a pleasant aroma is desired or an odour problem exists (bathroom, pet areas, trailers, kitchens, basements, garages, hampers, closets, laundry, wardrobes, offices)*". Therefore, we will assume in this impact assessment that 1,4 dichlorobenzene-based air fresheners may be used in any room of a house, although it is extremely unlikely that use in bedrooms might occur.

<u>Size of Products</u>

We have two sources of information from the EU. A manufacturer who sells his air fresheners to both private consumers and professional users indicated that his products weigh 65 or 80 grams. Another EU manufacturer who sells to professional users only produces cylindrical tablets with a diameter of 50-60mm and a height of ca. 20mm. The weight of these is around 50 g.

Additional information is only available from non-EU sources and is summarised in the following table.

Table 2.9: Weights of Identified 1,4 Dichlorobenzene-based Air Freshener Products – Non-EU Manufacturers	
Weight per product (g)	**Source**
80	Zhejiang China (2010)
80	Zhejiang Yuantian (2010)
90, 100, 130, 150	Fukuta Corporation (2010)
80	Zhejiang Yuantian (2010b)

The above information suggests that 80 grams is a fairly common weight for air fresheners based on 1,4 dichlorobenzene.

With regard to industrial/professional air fresheners based on 1,4 dichlorobenzene, products displayed on the Internet suggest that other products may have a shape of a rectangular block with a weight up to 675 g[20]. 'Super blocks' may weight more than 9 kg and may be placed inside a plastic mesh and have a hanger for positioning at the desired location but these are intended for professional use only.

Toilet Blocks

Potential Applications and Composition

Our research suggests that as toilet block, 1,4 dichlorobenzene-based products may be (or have been) used as:

- a solid deodorising cube, sphere, disc, etc. for standing urinals (BUA, 1994), often deposited on a plastic screen;
- a solid block contained in a plastic urinal screen i.e. plastic pliable screen (see pictures of products by JaniSan, 2009); and
- a solid block hanging from the rim of a toilet bowl (Grainger, 2010; Aronson *et al*, 2007; Bush Boake Allen, 1989). Rim blocks may comprise:
    - a plastic box with a hanger insider which a cylindrical or cuboid block is placed,
    - a cuboid block upon which a plastic hanger is attached, or
    - a tablet with a hole in the middle through which a plastic or metal wire hook is put through to allow hanging on the rim of a toilet bowl (see pictures of products available in JaniSan, 2009).

20 For the purposes of our analysis we consider that 'room air fresheners' and 'toilet rim blocks' are considered separate, mutually exclusive products. See for example products available on the US market displayed here: http://www.michaelgroupinc.com/clientuploads/JanitorialFoodservicePaper/94-97_Urinal_Bowl_2009.pdf.

1,4 dichlorobenzene cannot be used in cistern blocks (these are placed in the flushing tank). The substance does not dissolve in water and, therefore, it would be totally ineffective.

The main application of toilet blocks in this area is in the form of urinal blocks in public toilets where urinal bowls are present. On the other hand, the only type of toilet block that could feasibly be used by private consumers at home is toilet rim blocks.

With regard to the composition of 1,4 dichlorobenzene toilet rim blocks, the only Safety Data Sheet related to an EU manufacturer or supplier that has been identified shows a concentration of 1,4 dichlorobenzene of 60-100% (Evans Vanodine, 2005). Consultation with a manufacturer of toilet rim blocks for consumer use suggest a concentration of 1,4 dichlorobenzene of 98-99%. Some information from non-EU manufacturers and suppliers is summarised below. A much larger number of Safety Data Sheets for 1,4 dichlorobenzene-based urinal blocks has been found through Internet searches – this would again suggest that urinal block products find much wider use than toilet rim blocks based on 1,4 dichlorobenzene.

Table 2.10: Example Compositions of Toilet Rim Blocks Containing 1,4 Dichlorobenzene

Identified country of sale	**Origin of supplier**	**Concentration of 1,4 dichlorobenzene (%)**	**Other named ingredients (CAS Number and concentration by weight)**	**Source**
USA	USA	99	Unknown	Fresh Products (2007)
USA	USA	99	Stabilised bacteria spore	Fresh Products (2007b)
Unknown	Taiwan	>99	Fragrance	River Stone Enterprises (2010)
Unknown	China	98	Unknown	Dongguan Wan Po (2010)
USA	China	99.7	Unknown	Zhejiang Yuantian (2010c)
Unknown	China	N/A	Unknown	Shanghai Highmoon Products (2010)

The composition of toilet rim blocks and urinal blocks is essentially the same. They have traditionally contained more than 98% 1,4 dichlorobenzene plus a small percentage of fragrance and dye[21]. Concentrations apparently as low as 20% are mentioned in some Safety Data Sheets for urinal blocks (especially older ones); however, we have no reason to believe that such products are still marketed within the EU[22].

21 A supplier of these products has noted that other substances may also be used to "stabilise the blocks".

22 It is also possible that the concentration ranges used in the Safety Data Sheets 'disguise' actual concentrations close to 100%. However, at least one manufacturer supplies urinal blocks with only 70% dichlorobenzene; the remainder is covered by a filler component (a soluble inert crystalline material), which acts to reduce the overall price of the product.

In the remainder of this report, the term "toilet blocks" will refer to toilet rim blocks to be used at home by private consumers. It is also important to note this: the EU RAR refers to air fresheners and toilet blocks but does not make a clear distinction between the two products. For the purposes of our analysis, where the available information allows, we have attempted to distinguish between these two product types. However, while this may generally be correct[23], there may be products that 'cross the boundaries' between a toilet block and an air freshener. For instance, we have identified a product which is in the form of a disc with a hole in the middle. This may be used inside a urinal bowl as a urinal block. However, the use may use a wire hook through the hole which would allow the product to be used as a toilet rim block or even to be hung on the wall and act as an air freshener. Wire hooks may be sold separately. The factsheet for this product notes "*The block has a centre hole, enabling it be suspended on a hook over the edge of the toilet bowl. It is suitable for use as an air freshener or as a gents channel block* (i.e. a urinal block)" (Evans Vanodine, 2010).

<u>Size of Products</u>

The available information on the size of toilet rim block products identified in the course of this study is presented in Table 2.11.

Table 2.11: Weights of Identified 1,4 Dichlorobenzene-based Toilet Rim Block Products

Weight per product (g)	Source
58	Positive Hands (2010)
45	Evans Vanodine (2010)
50, 70	Consultation with an EU manufacturer
98, 112	Fresh Products (2010)
98	Fresh Products (2010b)
120	River Stone Enterprises (2010)
113	Dongguan Wan Po (2010)
70	Zhejiang Yuantian (2010c)
110	Shanghai Highmoon Products (2010)

The average weight of the products above is around 80 grams, however, we cannot be certain whether the weight indicated includes or not the weight of the plastic container (where present). We are certain however, that the weights provided by an EU manufacturer during consultation are for the toilet block only, excluding the plastic container. In the remainder of the report, we will tentatively assume that the typical 1,4 dichlorobenzene-based toilet rim block weighs 70 grams.

For urinal blocks instead, products weighing between 25 and 115 grams have been identified.

23 See for example products available on the US market displayed here: http://www.michaelgroupinc.com/clientuploads/JanitorialFoodservicePaper/94-97_Urinal_Bowl_2009.pdf.

Other Products

In addition to collecting information on air fresheners and urinal blocks, we have identified Safety Data Sheets for other types of deodorising products that contain 1,4 dichlorobenzene. Such products include:

- granular deodorants and powders containing 1,4 dichlorobenzene (ABC Compounding, undated; Zep Manufacturing, 2004; Dodge, 2007). These may be used as animal repellents in open spaces but cannot be used in the EU any more (cf. Biocidal Products Directive);
- toilet limescale remover (<0.5% 1,4 dichlorobenzene – Cannon Hygiene, 2003);
- corrosion inhibitors and odour control agents in tablet form (<8% 1,4 dichlorobenzene – Momar, 2006); and
- embalming powder (30-50% 1,4 dichlorobenzene mixed with paraformaldehyde – Hizone Brands, undated).

We do not have information confirming or otherwise the use of the last three of these products by private consumers in a domestic environment in the EU.

It is also worth noting that there are some indications that moth balls based on 1,4 dichlorobenzene might still be placed on the EU market. A quick search on websites of popular online merchants and online auction sites reveal that there may still be companies selling to EU consumers moth balls that could be based on 1,4 dichlorobenzene. Also, some information from the Netherlands (RIVM, 2009) suggests that 1,4 dichlorobenzene-based moth balls may still be marketed in the Netherlands. A certain Dutch company appears to be placing on the market "fragrance balls" made of 1,4 dichlorobenzene. Despite our efforts to contact the company and the relevant Dutch authorities, it has not been possible to conclusively establish whether these products are indeed sold at present.

Conclusions on 1,4 Dichlorobenzene-based Products Relevant to Domestic Use

The key points of the information presented in this Section can be summarised as follows:

- the types of 1,4 dichlorobenzene-based products that may be used by private consumers in the EU are solid air fresheners (cylindrical/cuboid in plastic or carton containers) and to a much lesser extent toilet rim blocks (inside a plastic container or with a plastic/wire hook through their centre);
- the concentration of 1,4 dichlorobenzene in products for domestic use typically is above 98%. The remainder is normally dye and fragrance;
- the size of products that could be used at home may vary. Air fresheners could be as small as 50 g or as large as 150 g – hereafter we assume a typical weight of 80 g for products sold to private consumer. For toilet blocks, weights vary between 45 and 120 g – hereafter we assume a typical weight of 70 g for products sold to private consumer; and

- although efforts have been made to distinguish between air fresheners and toilet rim blocks, the design of some products means that the exact same product may be used as an air freshener (hanging on a wall), a toilet rim block (hanging on the rim of a toilet bowl) or a urinal block (without a hook/hanger, simply thrown inside a urinal bowl in a public toilet).

2.4.7 Baseline Scenario – Market Information for 1,4 Dichlorobenzene-based Products

Locations of Key Players

Manufacturers of 1,4 Dichlorobenzene-based Products

We have collected information from open literature and direct consultation with manufacturers of the substance and manufacturers of the relevant products. We have particularly tried to confirm whether companies identified in relevant Safety Data Sheets are still active in this market.

Table 2.12 summarises confirmed information on companies currently manufacturing 1,4 dichlorobenzene-based air fresheners and/or toilet blocks. For a number of manufacturers (manufacturers of the substance have suggested them to be active), it has not been possible to confirm their current activities. The manufacturers of the substance declined to provide the names and contact details of their customers; we asked for these companies to be notified of our study but almost no company contacted us directly to express an interest in making an input.

Table 2.12: Verified Current Manufacturers of 1,4 Dichlorobenzene-based Air Fresheners and Toilet Blocks

Country	Does the company manufacture now?	Products manufactured		Notes
		Air fresheners	Toilet blocks	
AT	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm
BE	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm
FI	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm
FR	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm. There are indications that production may have been discontinued in 2007
FR	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm. There are indications that production may have been discontinued in 2007
DE	Yes	ü	ü	Identified and contacted by RPA
DE	Yes	ü	ü	Identified and contacted by RPA

Table 2.12: Verified Current Manufacturers of 1,4 Dichlorobenzene-based Air Fresheners and Toilet Blocks

Country	Does the company manufacture now?	Products manufactured		Notes
		Air fresheners	Toilet blocks	
DE	No	(û)	(û)	Identified and contacted by RPA. Temporarily discontinued the use of the substance but may resume in the future.
DE	Not confirmed		?	Identified and contacted by RPA. 1,4 dichlorobenzene product Safety Data Sheets dated 2009 are available on the company's website
EL	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm; the Greek Detergents and Soaps Association indicates no use by their members
HU	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm
IT	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm – information from industry relayed to us by the Italian authorities suggests no use of the substance
IT	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm – could potentially be the same as the Italian company indicated above. If not the same company as above, there are indications that production may have been discontinued in 2006
PL	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm – could be more than one company
PT	Yes	ü	ü	Company confirmed the manufacture of air fresheners, urinal blocks and toilet rim blocks
PT	Probably but not confirmed	ü	ü	Unknown number of companies; information provided by a non-EU manufacturer of 1,4 dichlorobenzene
ES	Probably but not confirmed	ü	ü	
UK	Yes	?	ü	Identified and contacted by RPA but company was unwilling to make an input. We believe that 1,4 dichlorobenzene urinal/toilet blocks are being produced.
UK	Not confirmed	?	?	Suggested by a manufacturer of the substance; unable to confirm. There are indications that production may have been discontinued in 2005

Only one company has confirmed sales of its products to private consumers for use at home. The company indicated that consumer uses account for well above 50% of the products sold.

Consultation with industry further suggests that manufacture of such products may also take place in countries such as USA, Japan, Mexico, Brazil, India, China, Southeast Asia and African countries. We have confirmed sales of urinal blocks (and in the past air fresheners too) by a US company to EU customers but we have not positively identified any non-EU company selling 1,4 dichlorobenzene-based air freshener or toilet rim block for use by consumers in a domestic environment.

Suppliers of 1,4 Dichlorobenzene-based Products

We established communication with only a small number of companies that distribute 1,4 dichlorobenzene-based toilet blocks. These companies generally supply urinal blocks, not toilet rim blocks, and they target professional users, not private consumers. Table 2.13 summarises the available information on confirmed suppliers of 1,4 dichlorobenzene-based products in the EU.

Table 2.13: Verified Current Suppliers of 1,4 Dichlorobenzene-based Air Fresheners and Toilet Blocks

Country	Products supplied		Notes
	Air fresheners	Toilet blocks	
AT	?	?	Details of products have not been provided
CZ	û	ü	Supplier of urinal blocks
FR	û	?	Company declined to provide information
DE	?	ü	Supplier of urinal blocks
DE	û	ü	Supplier of urinal blocks
UK	û	ü	Very small part of the company's business and company declined to make further input – unknown if toilet blocks include toilet rim blocks
UK	û	ü	Only one product (urinal block) with 1,4 dichlorobenzene sold
UK	û	ü	Small part of the business – two products (urinal block and toilet rim block) are the only products still using 1,4 dichlorobenzene. These are being phased out over the coming year
UK	û	ü	
UK	?	ü	Sells toilet rim blocks. Declined to provide detailed information and recommended contact with the manufacturer

In any case, the real number of companies involved in the distribution of 1,4 dichlorobenzene-based products must be significantly larger. Information on where such products are being sold has been collected from consultation with industry and Competent Authorities in EU/EEA countries. A summary of the available information is provided in Table 2.14.

Table 2.14: Confirmed Sales of 1,4 Dichlorobenzene-based Toilet Blocks in EU/EEA Countries (only countries with available information)	
Member State	**Information**
Austria	**IND**: Sales confirmed but tonnage is unknown
Belgium	**IND**: Sales confirmed but tonnage is unknown
Cyprus	**CA**: No sales
Czech Republic	**IND**: Estimated sales of 1,4 dichlorobenzene based urinal blocks in 2009 may be approximately 4.7 tonnes of products sold
Denmark	**CA**: No sales
Estonia	**IND**: Sales confirmed but tonnage unknown **CA**: No sales
Finland	**IND**: Sales confirmed but tonnage unknown **CA**: Sale of 1 product identified by the authorities, possibly more products sold
France	**IND**: Sales confirmed but tonnage is unknown
Germany	**IND**: Sales confirmed by industry but tonnage involved is unknown **CA**: No information available from authorities
Greece	**IND**: Sales confirmed but tonnage is unknown
Hungary	**IND**: Sales confirmed but tonnage is unknown
Iceland	**CA**: No sales
Italy	**IND**: Sales confirmed but tonnage is unknown
Latvia	**IND**: Sales confirmed but tonnage unknown **CA**: In Latvia, 5.83 tonnes of 1,4 dichlorobenzene was imported (and in all likelihood sold) in toilet blocks in 2007 but only 0.15 tonnes of products were imported and sold in Latvia in 2008
Lithuania	**IND**: Sales confirmed but tonnage unknown
Luxembourg	**IND**: Sales confirmed but tonnage is unknown
Netherlands	**CA**: No sales **IND**: Sales confirmed but tonnage is unknown
Poland	**IND**: Sales confirmed but tonnage involved is unknown
Portugal	**IND**: Sales of air fresheners and toilet blocks confirmed for both professional and consumer uses for
Slovakia	**IND**: Sales confirmed by industry but tonnage involved is unknown
Slovenia	**CA**: 11 tonnes of 1,4 dichlorobenzene toilet blocks placed on the market in 2008 **IND:** Sales confirmed but tonnage is unknown
Sweden	No sales due to ban on 1,4 dichlorobenzene-based odour control products
Switzerland	**CA**: Sales of 1 product identified by the authorities **IND**: Sales also confirmed by industry
United Kingdom	**IND**: Sales confirmed but tonnage is unknown
Note: CA: Competent Authority input; IND: industry stakeholder input	

The available information suggests that 1,4 dichlorobenzene-based products are sold in most EU Member States. This is based largely on claims by (a small number of) industry consultees, while the information provided by Competent Authorities is much more scant (see Table 2.15). The above information relates to sales mostly to professional users (since almost all the companies that provided this information sell their products exclusively to professional users). **The table does not show in which EU countries 1,4 dichlorobenzene-based products are used by private consumers at home**. As indicated earlier in this report, we believe that consumer uses are probably concentrated in Southern and Eastern EU Member States.

Table 2.15: Information Provided by National Competent Authorities on the Manufacture, Marketing and Use of 1,4 Dichlorobenzene-based Air Fresheners and Toilet Blocks in Certain EU Member States, Iceland, Norway, and Switzerland

Country	Year	Air fresheners					Toilet blocks				
		Manufacture in this country?	(Number of) products on the market	Products used by consumers or I&I users?	Tonnage of products on the market	1,4 DCB concentration (%)	Manufacture in this country?	Number of products on the market	Products used by consumers or I&I users?	Tonnage of products on the market	1,4 DCB concentration (%)
AT	-	No data									
CY	2009	No	None found	No	-	-	No	None found	No	-	-
DK			None					None			
EE	2009		None found					None found			
FI	2009	-	-	-	-	-	No	1 (notified but possibly more on the market)	CON: ? I&I: Yes	No data	No data
DE	2009	No*	-	-	-	-	Yes	-	-	-	99%
EL	2009	No	No data								
IT		Information from the national association *Associazione Nazionale detergenti e specialità per l'industria e per la casa* suggests that the substance is not being used in Italy for some time. A similar response has been received from the Employers' Association of Turin. NO other information has been collected from the authorities									
LV1	2004-2007	-	-	-	-	-	No	2	I&I: Yes CON: Probably	≥5.83	60-100
	2008	-	-	-	-	-	No	1		0.150	>60
LV2	-	No data									
LT	N/A	No data									
MT	2009	No data									
NL	2009	No	1 (but intended against moths)	No (with the exception of the 1 product)	Unknown	Unknown	No	No	No	None	0
PL	-	No data									
SE	-	Not known	Not known	Not known	Not known	Not known	Not known	Not known	Not known	Not known	Not known
SI	2009	/	Yes	Both	Not given	Not given	/	Yes	Both	Not given	Not given
	2008		1		0	95%		7		10.922 t	95%

Table 2.15: Information Provided by National Competent Authorities on the Manufacture, Marketing and Use of 1,4 Dichlorobenzene-based Air Fresheners and Toilet Blocks in Certain EU Member States, Iceland, Norway, and Switzerland

Country	Year	Air fresheners					Toilet blocks				
		Manufacture in this country?	(Number of) products on the market	Products used by consumers or I&I users?	Tonnage of products on the market	1,4 DCB concentration (%)	Manufacture in this country?	Number of products on the market	Products used by consumers or I&I users?	Tonnage of products on the market	1,4 DCB concentration (%)
	2007		1		0	95%		8		11.780 t	95%
	2006		1		0	95%		8		7.761 t	95%
	2005		1		0.076 t	95%		8		7.764 t	95%
	2004		1		0.149 t	95%		6		6.454 t	95%
	2003		1		0.62 t	95%		7		2.318 t	95%
	2002		1		0.227 t	95%		7		7.589 t	95%
SK	-	No data									
IS	-	No	No				No	No			
NO	2008	No data									
CH	2009	No	No	-	-	-	Yes	1	I&I	No data	99%

Sources:
***AT**: Federal Ministry of Environment (2009); **CY**: Department of Labour Inspection (2009); **DK**: Danish EPA, Ministry of Environment (2009); **EE**: Ministry of Social Affairs (2009); **FI**: National Supervisory Authority for Welfare and Health (2009); **DE**: German Federal Institute for Occupational Safety and Health (2010); **EL**: Greek General Chemical State Laboratory (2010); **IT**: Federchimica (2010) & Unione Industriale Torino (2010); **LV1**: Latvian Environment, Geology and Meteorology Centre (2009); **LV2**: Latvian Ministry of Health, Department of Health Policy Planning (2009); **LT**: Lithuanian State Non Food Products Inspectorate (2009); **NL**: National Institute for Public Health and the Environment (2009); **MT**: Malta Standards Authority (2010); **PL**: Bureau for Chemical Substances and Preparations (2009); **SE**: Swedish Chemicals Agency (2009); **SI**: Chemicals Office of the Republic of Slovenia (2009); **SK**: Slovak Trade Inspection (2009); **IS**: Environment Agency of Iceland (2009); **NO**: Norwegian Pollution Control Authority (2009); **CH**: Swiss Federal Office of Public Health (2009): There used to be 1,4 dichlorobenzene-based air-fresheners and toilet blocks on the Swiss market. Since the adaptation of the Swiss chemical regulation, there are no longer products registered in the relevant database (with the exemption of one product). This may be due to the official classification as a Carc. Cat 3 substance (harmonised with the EC), which came into force in Switzerland in 2005. The remaining product registered in the database is a professional used toilet block with 98.7% 1,4 dichlorobenzene.*
Note:
'No data', blank space and '-' denote no data availability.
** Not the case, according to consultation with industry consultees.*

Market Statistics for the EU Air Freshener and Toilet Block Markets

Air Freshener Market Data

Consultation with stakeholders suggests that, in 2009, the EU air fresheners market amounted to 900 million units with a sales value of £1,750 million (ca. €1,965 million). These figures appear to include aerosol sprays, perfumed candles, liquid wick, gel potpourris, electrical devices, car fresheners and similar products.

Toilet Block Market Data

FAR (2005) and Henkel (2005) note that, in 2004, sales of toilet blocks in Germany amounted to €136 million and represented one of the largest segments in the washing and cleaning products sector. Using data on national GDP (Eurostat, 2009), we estimate that 2004 sales of toilet blocks in countries which are now Member States of the EU-27 may have been in the region of €640 million. In a scenario with no annual change in sales of toilet blocks between 2004 and 2008, 2008 toilet block sales in the EU-27 can be estimated to have been in the region of €709 million (please note that inflation rate between 2004-2009 is taken into account (Eurostat, 2009b)). We assume that this value does not encompass urinal blocks that are used by professional users in public toilets.

Size of the EU Market for 1,4 Dichlorobenzene-based Air Fresheners

We have very little concrete information from industry on the consumption of 1,4 dichlorobenzene-based air fresheners in the EU. One source of information is a company from Western Europe which supplies air fresheners to professional users only and provided an estimate of its assumed EU market share. Another source is a Southern European company which manufactures air fresheners for sale to both professional and consumer use. This company sells its products only within its own country and also claims to be the only manufacturer in its country.

The extrapolation of the information from the Western European company into the whole of the EU would mean that the overall consumption of 1,4 dichlorobenzene air fresheners in the EU was 100 tonnes in 2009. This however may reflect only product sold for professional uses and may not reflect the situation in Southern and Eastern EU Member States as it is based on sales in a Western European country only.

On the other hand, we could use the tonnage of air fresheners sold by the Southern European company to consumers and extrapolate to the rest of the EU. In doing so, we opt for using population data provided by Eurostat and assume that consumer consumption in Western and Northern EU Member States[24] is nil. This extrapolation indicates that **the EU consumer market for 1,4 dichlorobenzene-based air fresheners is ca. 83 tonnes per year**. If we assumed that the patterns of use in Western and

[24] For the sake of calculation, we assume these to be Austria, Belgium, Denmark, Germany, Finland, Ireland, Luxembourg, the Netherlands, Sweden, United Kingdom. Countries such as France, Italy, Spain are assumed to belong to Southern EU Member States.

Northern EU Member States were similar to those in Southern and Eastern EU Member States, the extrapolation would give an overall consumer market of ca. 140 tonnes per year. Due to the small number of information sources, for reasons of confidentiality, we cannot provide a detailed account of the tonnages sold by the companies referred to in the calculations above.

As the starting points for the two extrapolations are different, the results cannot be combined. In the absence of more specific information, we have chosen to use the figure of 83 t/y as the size of the EU market for 1,4 dichlorobenzene-based air fresheners used by private consumers at home (this is assumed to relate to the year 2009).

We have been advised that products with a weight of 65-80 g are sold for €1-2 per unit. As we have assumed a typical weight of 80 grams, we also assume a price of €2. Therefore, the value of the EU market for these products would be calculated to be (83,000,000/80) x €2 = **ca. €2 million per year**.

Size of the EU Market for 1,4 Dichlorobenzene-based Toilet Blocks

We have a range of sources of information on the size of the EU market for 1,4 dichlorobenzene-based toilet blocks. These are presented below:

- **information from a manufacturer of urinal blocks**: one stakeholder provided information relevant to making EU-wide market estimates (other stakeholders provided national level information only) and this information relates exclusively to urinal block products (not toilet rim blocks). This estimate suggests that the EU market may consume approximately 800 tonnes of 1,4 dichlorobenzene in urinal blocks in 2009;
- **information from a manufacturer of both urinal blocks and toilet rim blocks**: the company (located in Southern EU) has provided information on its sales of toilet rim blocks to consumers (which notably are more significant than sales to professional users). An extrapolation of this tonnage to the whole of the EU gives an annual consumption tonnage of ca. 17 t/y when nil private consumer consumption is assumed in Western and Northern EU Member States or 28 t/y when uniform private consumer consumption is assumed across the whole of the EU;
- **information from Competent Authorities**: extrapolation of data provided by industry or Competent Authorities for individual Member States to the whole of the EU suggests that annual consumption of 1,4 dichlorobenzene in toilet blocks in the EU may have been between 830 and 980 tonnes in 2009 (depending on whether extrapolation on the basis of population or on the basis of GDP in Purchasing Power Standard is performed[25]). However, please note this extrapolation is based on national

[25] The extrapolation was performed by means of averaging national per capita/per unit of GDP PPS in the Czech Republic, Latvia and Slovenia for 2009 and subsequently applying the average consumption figure onto the rest of the EU, with the exception of Member States where no sales of 1,4 dichlorobenzene-based toilet blocks take place.

data provided for the Czech Republic, Latvia and Slovenia[26] whilst only taking into account that there are no sales of such products in some Member States (Cyprus, Denmark, Sweden) but not taking into account potential differences in per capita/per unit of GDP consumption in other Member States.

In the absence of better information, we will assume that **the EU consumption of toilet rim blocks by private consumers at home in 2009 was ca. 17 t/y**. This tonnage indicates that, as suggested by some consultees, toilet rim blocks are much less popular than air fresheners among private consumers and also that urinal blocks (used by professional users only) is by far the key application of 1,4 dichlorobenzene among those examined in this impact assessment.

We have been advised that products with a weight of 50-70 g are sold for €0.70-1.50 per unit. As we have assumed a typical weight of 70 grams, we also assume a price of €1.50. Therefore, the value of the EU market for these products would be calculated to be (17,000,000/70) x €1.50 = **ca. €0.36 million per year**. This evidently suggests a very small market.

Conclusions on the EU Market for 1,4 Dichlorobenzene-based Air Fresheners and Toilet Blocks

The key points of the Information presented in this Section can be summarised as follows:

- suggestions by manufacturers of the substance would indicate the presence of manufacturers of 1,4 dichlorobenzene-based products in several countries in the EU (AT, BE, FI, FR, DE, EL, HU, IT, PL, PT, ES, UK). However, these suggestions may relate to the situation in the past and several of the suggested manufacturers may no longer use 1,4 dichlorobenzene. Generally, we have very limited specific information on whether these manufacturers serve the retail consumer market or the professional market only. Only one company has confirmed sales to consumers;
- on the basis of suggestions from industry stakeholders, we can assume that 1,4 dichlorobenzene-based products are sold in the majority of EU Member States. This however reflects sales for both professional use and consumer use at home. We assume that consumer use at home takes place mostly in Southern and Eastern EU Member States;
- the total EU market for 1,4 dichlorobenzene-based air fresheners for consumer use is estimated at ca.83 tonnes per year (in 2009) with a retail value of €2 million per year. However these are estimates based on limited quantified information;

[26] Please note that data for Latvia and Slovenia were not available for 2009 but only for 2007-08. Moreover, the Latvian imports of toilet blocks have reduced from 5.83 tonnes in 2007 down to 150 kgs in 2008. We have sued this latest figure and we have assumed unchanged annual consumption between 2008 and 2009 in Latvia and a decline in 2009 consumption in Slovenia in line with the decrease experienced between 2007 and 2008.

- the total EU market for 1,4 dichlorobenzene-based toilet blocks for consumer use is estimated at 17 tonnes per year (in 2009) with a retail value of €0.36 million per year. Again, these estimates are based on limited quantified information;
- as explained at the end of Section 2.4.5, the estimated tonnage of 1,4 dichlorobenzene used in the EU for the manufacture of air fresheners and toilet blocks is 800 tonnes/y. This is a much larger quantity than the estimated consumption of such products by consumers in the EU (83+17 t/y). It is believed (but not conclusively proven) that the majority of the remainder is used by professional users within the EU, although some exports of finished products to customers in non-EU European countries, Asia and Africa also take place; and
- the above estimates do not take into account imports of finished products from non-EU countries. We do not hold any information that would allow us to take the relevant import tonnages into account.

2.4.8 Comparison of Market Data and Projected Market Trends

The data presented above are summarised in the following table.

Table 2.16: Comparison of Available Market Data (Consumption figures for the EU)

	1,4 DCB-based air fresheners used by consumers	**Air fresheners in the EU***	**1,4 DCB-based toilet blocks used by consumers**	**Toilet blocks in the EU**
Tonnage (t)	82 (est.)	900 million articles	17 (est.)	N/A
Market value (€)	2 million (est.)	1,965 million	0.36 million (est.)	709 million (est.)
Year	2009	2009	2009	2008

** also include car air fresheners (and potentially other products) which do not directly compete with 1,4 dichlorobenzene-based air fresheners*

From the above table, it is clear that for both air fresheners and toilet blocks based on 1,4 dichlorobenzene, the relevant private consumer markets are likely to be extremely small in comparison to the wider air freshener and toilet block markets in the EU.

Projection of Future Market Trends

It is difficult to provide projections of future market trends for air fresheners and toilet blocks used by consumers at home. However, on the basis that their consumption is very small and apparently accounts for an insignificant proportion of the overall EU markets for air fresheners and toilet blocks, and given that 1,4 dichlorobenzene-based products are considered to be 'old fashioned', it could be reasonable to assume that consumption of such products at home will further decline in the future even in the absence of regulatory intervention.

For air fresheners, some consultees have conceded that suitable alternatives are available at present. For toilet rim blocks, it is common knowledge that there is a great variety of rim block (and in-cistern) products readily available on the market, some of which are very sophisticated products (liquid multi-compartment articles, blocks combining solid blocks and gel deodorants, etc.).

However, such projected future trends may not necessarily lead to the elimination of the use of 1,4 dichlorobenzene in the EU. The main application is in the form of urinal blocks. For urinal blocks, a combination of low cost, good odour masking properties and low water solubility means that a certain demand for these products in the EU is likely to be sustained in the future. Particular applications for which these blocks may continue to attract a following among professional users include high-traffic toilet rooms and urinals operating with standing water or frequent flushing (i.e. 'traditional' urinals). This has been confirmed by manufacturers of the substance who have seen their sales in this market segment stabilise in the last few years.

Given the limited use of 1,4 dichlorobenzene-based products by consumers in EU homes and the 'old-fashioned' nature of these products, it is possible that their consumption may further decline although there will be no guarantee of complete cessation, in the absence of a restriction.

Box 2.1: Possible Future Developments in the EU Market for 1,4 Dichlorobenzene-based Urinal Blocks

A manufacturer of urinal blocks which abandoned 1,4 dichlorobenzene in the mid-2000s has indicated that it took him a considerable amount of time to persuade his downstream users to switch to alternative urinal blocks and there are still users who insist on using 1,4 dichlorobenzene-based products. He has further asserted that, in his country, not only has the market share of 1,4 dichlorobenzene-based blocks decreased to 20-25% of the total urinal blocks market, but the overall size of the market has also decreased by 25-30% in the last ten or so years.

Another manufacturer has suggested that 1,4 dichlorobenzene-based urinal blocks for use in public toilets may have a future of 10 years ahead before they are replaced by alternatives. Although we cannot be certain of the timeframe, we believe that a gradual replacement by alternatives is likely, as building contractors and managers increase their efforts to conserve water resources by opting for controlled or low-flush urinals, or even waterless urinals which do not require the use of 1,4 dichlorobenzene-based blocks. Future development of alternative urinal blocks that are resistant to quick water dissolution and chemical agent attack will also add pressure to the decreasing market for 1,4 dichlorobenzene-based urinal blocks

2.5 Right of the EU to Act

As indicated above, the issue dealt with relates to articles of the EC Treaty and the objectives the Treaty sets out. More specifically, the need for risk management action is derived from the results of the EU RAR undertaken under the Existing Substances Regulation (now repealed by the REACH Regulation). As required by the Regulation, action needs to be undertaken in accordance with EU law, which in this particular case could mean a proposal to amend Annex XVII to the REACH Regulation in accordance with the provisions on transitional measures outlined in Article 137 of the REACH Regulation.

Consideration has been given to the appropriateness of action taken at the national as opposed to the EU level. After all, consumer uses of 1,4 dichlorobenzene-based air fresheners and toilet blocks appear to be restricted to Southern and Eastern EU Member States. However, national action could face problems because:

- there is uncertainty with regard to which exactly EU Member States these products are sold in and at what tonnages; and
- action at the national level might be less effective when dealing with products imported from non-EU countries.

As shown in Table A2.4 and referred to above, only Sweden has currently in place a national restriction on "*chemical products containing 1,4 dichlorobenzene and intended to mask smells*". This was introduced in January 1990. Generally, Member States that have responded to the RPA questionnaire have not expressed an explicit objection to EU-wide action in respect to the management of risks identified from the use of 1,4 dichlorobenzene-based air fresheners and toilet blocks (see a summary of the responses received in Table 1.2). Exceptions to this appear to be a response from the Latvian Ministry of Health (2009), which favours voluntary action by industry, and the response of the Dutch National Institute for Public Health and the Environment (RIVM, 2009) which has not expressed a specific preference for any one option.

Therefore, in relation to subsidiarity, while action at the national level could potentially be possible, action taken at the EU level is considered to be the most appropriate way forward.

3. OBJECTIVES

3.1 General Policy Objectives

On the basis of the identified problems outlined in Section 2, the general objective of policy intervention would be to remedy the discrepancy between the objectives of the EC Treaty and the current situation. This particularly relates to promoting public health (Article 152 of the EC Treaty) and a high level of consumer protection, which includes the protection of health, safety, and economic interests of consumers (Article 153 of the EC Treaty). The specific objectives of policy intervention would be to ensure that:

- exposure of consumers at home is below what would be accepted as a safe level (in accordance with the EU RAR on the risks posed by 1,4 dichlorobenzene);
- any policy option chosen is coherent with existing policies on 1,4 dichlorobenzene (for instance, regarding biocides, detergents, plant protection products and cosmetics - see Annex 2 for additional detail);
- the protection of human health does not affect disproportionately the functioning of the internal market as well as the trade between EU Member States and non-EU partners;
- the requirements of the REACH regulation on transitional measures as outlined in Article 137 of the REACH Regulation are met; and
- national authorities in EU Member States adopt the needed measures to comply with the requirements of the preferred policy option.

3.2 Consistency with other EU Policies

There have been several chemical substances that have been assessed for risks under the Existing Substances Regulation and, subsequently, restricted under the Marketing and Use Directive (76/769/EEC). These legal instruments have now been replaced by the REACH Regulation. Action taken to control risks from 1,4 dichlorobenzene would be in accordance with Article 137 of the REACH Regulation[27].

[27] Article 137 (Transitional measures regarding restrictions): **1.** By 1 June 2010, the Commission shall, if necessary, prepare a draft amendment to Annex XVII in accordance with either of the following: (a) any risk evaluation and recommended strategy for limiting risks that has been adopted at Community level in accordance with Article 11of Regulation (EEC) No 793/93 as far as it includes proposals for restrictions in accordance with Title VIII of this Regulation but for which a decision under Directive 76/769/EEC has not yet been taken; (b) any proposal, which has been submitted to the relevant institutions but has not yet been adopted, concerning the introduction or the amendment of restrictions under Directive 76/769/EEC. **2.** Until 1 June 2010, any dossier referred to in Article 129(3) shall be submitted to the Commission. The Commission shall, if necessary, prepare a draft amendment to Annex XVII. **3.** Any amendment to the restrictions adopted under Directive 76/769/EEC from 1 June 2007 shall be incorporated in Annex XVII with effect from 1 June 2009.

Therefore, action taken on 1,4 dichlorobenzene would be in line with similar action already taken for other chemicals. Moreover, any restriction on the use of the substance would be consistent with existent measures prohibiting its use in biocides (moth balls) under the Biocidal Products Directive.

4. POLICY OPTIONS

4.1 Possible Policy Options and Policy Instruments for Meeting the Objectives

4.1.1 Overview of Possible Policy Options

In identifying possible options for meeting the objectives of policy intervention (i.e. ensuring adequate control of risks for consumers from inhalation exposure to 1,4 dichlorobenzene) we have considered:

- the Guidance on Information Requirements and Chemical Safety Assessment - Chapter R.13: Risk Management Measures and Operational Conditions for REACH[28];
- the Risk Management Measure Library, published by CEFIC[29]; and
- the Commission's Impact Assessment Guidelines 2009.

Operational conditions and risk management measures related to consumers may include the following:

Operational conditions:

- conditions on the duration and frequency of exposure;
- conditions on the applied amount of chemical;
- temperature conditions; and/or
- conditions on the capacity of surroundings (including ventilation conditions).

Risk management measures (RMMs):

- product-integrated RMMs under the control of the supplier:
  - chemical-related RMMs (composition, physical state, etc.);
  - physical-related RMMs (aesthetics, packaging, etc.);
- consumer/user instructions/ communication on safe use:
  - technical use instructions;
  - instructions on use of protective clothing and behaviour;
  - storage instructions;
  - disposal instructions; and/or
- a restriction on the marketing and use of the relevant products (with or without appropriate conditions or derogations).

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28 Available from the European Chemicals Agency Internet site (http://guidance.echa.europa.eu/docs/guidance_document/information_requirements_r13_en.pdf?vers=20_08_08).

29 Available at: http://www.cefic.org/files/downloads/RMM%20Library%20.xls.

4.1.2 Overview of Possible Policy Instruments

In identifying possible policy instruments for implementing policy options, we have consulted the Impact Assessment Guidelines 2009. Annex 7 to the Guidelines indicates the following range of possible policy instruments:

- **self-regulation**: the Commission may consider it preferable not to make a legislative proposal where voluntary agreements already exist and are sufficient to achieve the objectives set out in the Treaty and do not create competition problems;
- **open method or co-ordination**: EU measures could be complemented or reinforced by Member States' actions. This implies encouraging co-operation, the exchange of best practice and agreeing common targets and guidelines for Member States, sometimes backed up by national action plans;
- **provision of information and guidelines**: EU objectives may be reached by ensuring that citizens, consumers and producers are better informed. This type of policy instrument includes information and publicity campaigns, training, guidelines, disclosure requirements, and/or the introduction of standardised testing or rating systems;
- **market-based instruments**: these may be used to influence the behaviour of market players by providing (negative/positive) monetary incentives or by guaranteeing some basic rules of the game;
- **direct public sector financial interventions**: public sector financial interventions should be used when the use of other instruments is less effective in achieving policy objectives. They are often used in emergency cases or as transitional measures. These financial interventions usually mean public sector provision of goods and services through public expenditure programmers;
- **co-regulation and standards**: co-regulation is a mechanism in which a Community legislative act entrusts the attainment of the objectives defined by the legislator to parties which are recognised in the field;
- **framework directives**: framework directives set out general principles, procedures, and requirements for legislation in different sectors. Subsequent 'daughter' directives in each sector must conform to the general requirements of the framework directive; and
- **prescriptive regulatory actions**: these may include traditional 'command and control' policies or performance-oriented standards.

4.2 Selection of Policy Options and Policy Instruments for Further Assessment

4.2.1 Selection of Policy Options for Further Assessment

Specific operational conditions that could (in theory) be adopted might include:

- **conditions on the duration and frequency of exposure**: theoretically, the amount of time spent by consumers in the presence of 1,4 dichlorobenzene-based air fresheners and/or toilet blocks could be restricted to reduce exposure to 1,4 dichlorobenzene vapours. However, it would be unrealistic to expect the consumers to meticulously control the time spent in their own bathroom or other room at home in the presence of 1,4 dichlorobenzene vapours even if it were possible to prescribe a specific time limit or a frequency limit. This option is unrealistic and will not be considered further;
- **conditions on the applied amount of 1,4 dichlorobenzene-based products**: theoretically, there might be a restriction on the amount of air freshener or toilet blocks used either in a specified space (i.e. a 'standard room size') or within a specified time period (i.e. number/weight of articles used at any one time or number/weight of articles used during a specified period, e.g. 30 days). However, it would be difficult for a consumer to decide how often to replace an article (especially if this has not been fully exhausted) on the basis of the size of the (toilet) room, as the size of each (toilet) room varies. Also, any limit on the number of articles used within a given period without consideration of the size of the articles would be arbitrary and most likely ineffective, let alone unenforceable. Instead, it would be more effective to control the size of articles. As this is addressed under "physical-related RMM", this option will not be considered further;
- **temperature conditions**: temperature is an important parameter in the sublimation of 1,4 dichlorobenzene: the higher the temperature, the faster the sublimation and therefore the higher the likely exposure of the user. In theory, a limit on temperature could be set for spaces in which air fresheners and toilet blocks are used; and
- **conditions on the size of spaces in which 1,4 dichlorobenzene-based products are used or conditions on ventilation**: theoretically, there might be a requirement on 1,4 dichlorobenzene-based products to be used only where spaces are of minimum size or when adequate ventilation is ensured.

Specific RMMs that could in theory be adopted might include:

- **chemical-related RMMs**: theoretically, the reduction in the concentration of 1,4 dichlorobenzene in air fresheners and toilet/urinal blocks could reduce the levels of consumer exposure to the substance. We have not identified any other chemical means of reducing exposure to 1,4 dichlorobenzene vapours;
- **physical-related RMMs**: a possible option could theoretically be to restrict the size of the packaging of these types of products thus reducing the size of individual air fresheners and toilet blocks with the aim of reducing exposure of consumers to the

vapours of the substance. We do not believe that altering the appearance of these products could have any positive effect on the identified risks;

- **technical use instructions**: theoretically, air fresheners and toilet blocks could be accompanied with use instructions including information on potential hazards and risks. However, unacceptable risks have been identified when air fresheners and toilet blocks find normal use rather than as a result of abuse or misuse. Also, these products are only handled to a very limited extent: they are simply unwrapped and placed at the desired location; therefore, there is limited scope for providing very specific 'use instructions'. This option will not be considered further – it is assumed however that (additional) guidance would still be provided to users if conditions (temperature, ventilation, etc.) on the use of the products were to be introduced;
- **instructions on use of protective clothing (PPE) and behaviour**: it is not realistic to request consumers to use protective clothing or other PPE when using these products. This option will not be considered further;
- **storage instructions**: the identified risks do not relate to the storage of the relevant products. This option will not be considered further;
- **disposal instructions**: the identified risks do not relate to the disposal of the relevant products (in fact, the products are not disposed, they simply sublime and disappear during use). This option will not be considered further;
- **prohibition of sale of products to the general public**: this could comprehensively prevent exposure of consumers at home although the available evidence suggests that use at home in the EU is very low; and
- **total restriction on the marketing and use of 1,4 dichlorobenzene**: this could prevent exposure both at home and in spaces (toilet rooms) away from home. As the scope of this impact assessment excludes the use of 1,4 dichlorobenzene-based products away from home, this option will not be considered further.

Overall, the policy options that could be considered suitable include:

1. temperature conditions;
2. ventilation conditions;
3. a concentration limit on 1,4 dichlorobenzene in products;
4. a size limit on 1,4 dichlorobenzene-based products; and
5. a prohibition of sale of products to the general public.

4.2.2 Adaptation of Policy Options to the Specific Products and Risks

In this Section, we consider the specific forms that the above measures could take in order to effectively address the specific risks from 1,4 dichlorobenzene and to reflect the environment and manner in which the relevant products are used.

Temperature Conditions

A manufacturer of room air fresheners and urinal blocks has indicated that, under normal room temperature (20°C), a 1,4 dichlorobenzene-based urinal block manufactured by his company (ca. 80-90 g weight) could last for 2-3 weeks per block, while at 25°C it could last for fewer than 10 days. Such a higher temperature would thus result in higher exposure of the user of the toilet room. A possible policy option would then be as follows:

- toilet blocks and air fresheners based on 1,4 dichlorobenzene should only be used by private consumers at home at an indoor temperature of 20°C or below.

Room Size and Ventilation Conditions

Theoretically, a large (toilet) room size and adequate ventilation of rooms could ensure that 1,4 dichlorobenzene levels in the air are sufficiently low, thus preventing adverse effects via inhalation. Room size restrictions could apply (so that users cannot use 1,4 dichlorobenzene-based products in smaller rooms) and ventilation conditions could be prescribed on the packaging of the products. However, any size threshold set in legislation would be arbitrary. To be able to set such a threshold we would need to have more detail on the emission rate from product (default rates are available but we know the actual rates vary considerably and would be influenced by such factors as temperature). We would also need to make assumptions on the number of units used at a time and define air exchange rates over a 24 hr period (as these would significantly affect steady state level). The exposure of consumers would also depend on ventilation rates and frequency of opening of doors. Given that the size of the room is fixed and cannot be altered by the user, we believe that it would be more practical to introduce a requirement on ventilation rather than a room size threshold. A possible policy option would then be as follows:

- toilet blocks and air fresheners based on 1,4 dichlorobenzene should only be used by private consumers at home under conditions of adequate ventilation.

Given that ventilation affects the temperature in rooms, we will consider this option in conjunction with the above option on temperature conditions.

Concentration Limit on 1,4 Dichlorobenzene

Theoretically, a lower concentration of the substance would reduce the levels of exposure by inhalation. Traditionally, air fresheners and toilet blocks have contained >98% 1,4 dichlorobenzene. There is limited practical experience with lower concentrations in the EU although we have been advised of one urinal block product containing 70% 1,4 dichlorobenzene with the remainder being a soluble crystalline filler. We have also been advised that, outside the EU, efforts have been made towards the development of hybrid products that contain both 1,4 dichlorobenzene and substances normally found in alternative products; however, so far, these have not found their way into the open market. In these products the concentration of 1,4 dichlorobenzene could potentially be as low as 50%.

Box 4.1: Current Research on Hybrid Products

We have been advised that research on products with a 1,4 dichlorobenzene concentration lower than 70% has recently been undertaken outside the EU. A variety of materials have been tested (including surfactants, detergent and binders, the latter in particular may be used alongside gelling agents to slow down the dissolution of surfactants and other components – some example substances have been disclosed but this information is considered to be commercially sensitive and is not given here); these products may be water soluble, however they do not exhibit the high solubility of fillers such as natural salt, therefore, there is a greater likelihood that the end product will not crumble to pieces during use and the sublimation rate of 1,4 dichlorobenzene would not be expected to increase. It has also been suggested that if mixtures of 1,4 dichlorobenzene with other substances were to be used in the manufacture of toilet blocks, the manufacturing process of these hypothetical products would likely utilise non-1,4 dichlorobenzene methods, rather than the compression methods currently used, so a more homogeneous blend could be created (as opposed to pressing 1,4 dichlorobenzene flakes physically next to salt crystals). Other options that have been considered in recent R&D efforts is the creation of 'layered' or 'sectioned' blocks that utilise both technologies (1,4 dichlorobenzene and that of alternative blocks), but do not necessarily incorporate small pieces of 1,4 dichlorobenzene into a block.

These hypothetical products (they have not yet marketed, therefore their effectiveness or success with customers is uncertain), would most probably be more costly than pure 1,4 dichlorobenzene products because of the use of more costly components and the use of more complicated production processes. More importantly, we have not identified any drive or R&D efforts in the EU that is focused on the development of hybrid products. For instance, a large supplier of both 1,4 dichlorobenzene-based and 1,4 dichlorobenzene-free urinal blocks has told us that he is not aware of any product that may contain less than 99% 1,4 dichlorobenzene. Moreover, the product that contains natural salt appears to be reasonably popular; it represents a double-digit percentage (by weight) of the sales or urinal blocks for the company that manufactures them. Hence, there is currently little incentive to undertake research on hybrid products.

It is important to note that 1,4 dichlorobenzene is not only the active substance of these products but also their one and only structural component (although blocks and fresheners may be used inside a carton or plastic container). Therefore, any reduction in concentration could have a very direct impact on the structural integrity, functionality and effectiveness of these products. Moreover, stakeholders have not been able to indicate whether there is any concentration level below which these products would lose their functionality. Taking the above into account, a possible policy option could then be as follows:

- toilet blocks and air fresheners based on 1,4 dichlorobenzene may only be placed on the market for use by private consumers at home if the concentration of 1,4 dichlorobenzene does not exceed 70% by weight.

There is very sparse information on air fresheners or toilet rim blocks having a concentration of 1,4 dichlorobenzene below the typical >98%[30]. Theoretically, substances used to reduce the concentration of 1,4 dichlorobenzene in urinal blocks could be used in air fresheners and toilet rim blocks too, but there seems to be no experience among stakeholders with this. In practice, for an air freshener, any such filler would simply remain inside the plastic or carton case of the air freshener once 1,4 dichlorobenzene has

30 We have identified one Safety Data Sheet indicating a concentration of 60-100% but there is no information from any other source that would indicate a concentration of 1,4 dichlorobenzene falling below 98% in traditional deodorising products. The relevant company has declined to make an input to our work.

completely sublimed - this would probably leave an unsightly residue at the end of the useful life of the product. For a toilet rim block, a crystalline filler could simply be flushed away during the use of a toilet rim block. For rim blocks, the use of a soluble filler could be more appropriate with the filler gradually dissolving from the product with every flushing of the toilet bowl. As a result, concentration limits will only be considered for toilet rim blocks, not air fresheners. Nevertheless we should consider that, as the product would be hung from the rim of a toilet block, the loss of the filler could promote the disintegration of the block and pieces could fall inside the standing water in the toilet bowl (as opposed to a urinal block which is normally used with a plastic screen to prevent the loss of broken pieces inside the drain).

Size Limit on 1,4 Dichlorobenzene-based Products

Some information is available on the different sizes of air fresheners and toilet rim blocks, as shown in Section 2.4.6. We cannot be certain which these products are indeed used at home by consumers in the EU; only one manufacturer has confirmed the use of air fresheners weighing 65 and 80 g and toilet rim blocks weighing 50 and 70 g by consumers at home. We have also been advised that 20 g could be the minimum weight for an air fresheners or toilet blocks, as below 20 g, it is difficult to compact the material in the required shape.

Considering that products of 50 g size are feasible to produce and given that sizes could be up to ca. 2.5 times higher (ca. 125 g), in the absence of any other specific information, we will consider as a possible policy option the introduction of a size limit of 50 g for 1,4 dichlorobenzene-based air fresheners and toilet blocks sold to the public for use at home.

Apart from weight, the dimensions of the product are also important; for instance, it is not weight that dictates the rate of sublimation of 1,4 dichlorobenzene-based urinal blocks - it is rather the surface of the block and therefore, it is important to ensure that the surface of products placed on the market does not lead to excessive exposure of the public. For instance, we have been advised by consultees that the ratio of surface area:volume of a typical 85 g urinal block is ca. 1.75:1. This ratio helps to prevent the potential development of thinner, higher surface area ‘faster subliming’ 1,4 dichlorobenzene-based blocks.

We have assumed below a cylindrical block of 1,4 dichlorobenzene weighing 50 g with a density of 1.2 g/cm^3. This would give a volume of ca. 41.7 cm^3. We have plotted possible radius values against different height (thickness) values for this volume and we have calculated the surface area:volume ration for each shape. The results are given in Table 4.1.

Table 4.1: Dimensions of a Cylindrical 50 g Block/Air Freshener

Radius (cm)	Height (cm)	Volume (cm^3)	Surface area (cm^2)	Surface area:volume ratio (cm^{-1})
1.5	5.9	41.7	69.9	1.68
1.6	5.2	41.7	68.4	1.64
1.7	4.6	41.7	67.4	1.62
1.8	4.1	41.7	66.8	1.60
1.9	3.7	41.7	66.7	1.60
2.0	3.3	41.7	67.0	1.61
2.1	3.0	41.7	67.5	1.62
2.2	2.8	41.7	68.4	1.64
2.3	2.5	41.7	69.6	1.67
2.4	2.3	41.7	71.0	1.70
2.5	2.1	41.7	72.7	1.74
2.6	2.0	41.7	74.6	1.79
2.7	1.8	41.7	76.8	1.84
3.0	1.5	41.7	84.4	2.02
3.1	1.4	41.7	87.3	2.09
3.2	1.3	41.7	90.5	2.17
3.3	1.2	41.7	93.7	2.25
3.4	1.2	41.7	97.2	2.33
3.5	1.1	41.7	100.8	2.42
3.6	1.0	41.7	104.6	2.51
3.7	1.0	41.7	108.6	2.60

Note: we have assumed that the radius would realistically not fall below 1.5 cm and neither will the height fall below 1 cm.

The table suggests that in order to keep the surface area:volume ratio as low as possible (ca. 1.60 cm^{-1}), the radius of the block must be ca. 2 cm and the height of the cylinder should be ca. 4 cm. However, this ratio of surface area and volume may cause considerable inconvenience to manufacturers, especially for toilet rim blocks. The prescribed dimensions (4 cm diameter and 4 cm height) would mean that air fresheners and toilet blocks would not have the shape of a disc any more (i.e. a height much shorter than their diameter). This could create problems with placing air fresheners in reasonably flat plastic cases or with inserting a hook or hanger through the toilet block as the height/thickness of the block would substantially increase. This issue could make this policy option difficult to implement. More generally, given the small size of the relevant markets, the introduction of a complex array of product design requirements which may have an uncertain impact on consumer exposure would pose unnecessary burden. As a result, a prescribed value for the surface area:volume ratio will not be considered further.

Taking the above into account, a possible policy option would then be as follows:

- air fresheners and toilet rim blocks based on 1,4 dichlorobenzene may only be placed on the market for use by private consumers at home if their weight does not exceed 50 grams.

Prohibition of Sale of Products to the General Public

This would be a straightforward marketing and use restriction encompassing all air fresheners and toilet blocks under Annex XVII of REACH.

We have also considered possibilities for conditional marketing and use restrictions:

- **a restriction which would allow the continued use of 1,4 dichlorobenzene-based air fresheners and toilet rim blocks where their use has particular benefits**: contrary to what has been argued by several stakeholders about the advantages of the professional use of 1,4 dichlorobenzene-based urinal blocks[31], we have not identified any specific applications for which the products under consideration offer significant advantages to consumer users. Therefore, this policy option will not be considered further;
- **a restriction with a time-limited derogation**: this would mean that the restriction would come into force at some point in the future. This would in theory allow manufacturers and users to test new materials and smoothly make the transition to alternative products. As no stakeholder has made the case for a specific time-limited derogation (with specific regard to the domestic use of these products) during the main part of our analysis, this policy option will not be considered further. Only at the end of the study, some key consultees made suggestions for a delay in implementing a restriction. This information has been taken into account in the discussion in Section 6.

Conclusion

In summary, the policy options that will be taken forward to the impact assessment stage include:

- **Option 1**: Business as Usual (BAU);
- **Option 2**: Conditions on temperature and ventilation for indoor use;
- **Option 3**: 70% concentration limit on 1,4 dichlorobenzene;
- **Option 4**: Weight limit for 1,4 dichlorobenzene-based products; and
- **Option 5**: Prohibition of sales of 1,4 dichlorobenzene-based products to the public.

31 Particular benefits may arise from the use of such urinal blocks in cases such as (a) toilets where high-frequency flushing of urinals occurs and/or supervision/cleaning is not regular; (b) standing water urinals; or (c) trough urinals where frequent flushing is also the norm.

The following table indicates which of the options will be considered for the different 1,4 dichlorobenzene products.

Table 4.2: Overview of Policy Options by Application of 1,4 Dichlorobenzene		
Policy options	**Room air fresheners**	**Toilet rim blocks**
Option 1: Business as usual	ü	ü
Option 2: Temperature and ventilation	ü	ü
Option 3: 70% concentration limit	û	ü
Option 4: Weight limit	ü	ü
Option 5: Prohibition of sales to the public	ü	ü

As there is currently no specific EU-wide legislation on 1,4 dichlorobenzene in air fresheners and toilet blocks, there is no scope for reducing the identified risks by improving implementation or enforcement of existing legislation.

With particular regard to the General Product Safety Directive, this is targeted at consumer products placed on the market which are not covered by sector-specific European safety legislation. Given that this work on 1,4 dichlorobenzene emanates from the inclusion of the substance in the priority lists of the Existing Substances Regulation (now repealed by REACH), it is considered more appropriate to take risk management action under a framework that is specifically aimed at risks from chemical substances and which would allow action to be taken on the specific substance and the specific applications involved.

4.2.3 Selection of Policy Instruments

Our initial assessment of the possible policy implementation instruments is as follows.

Self-regulation

The Commission's Impact Assessment Guidelines 2009 indicate that the Commission may consider this option where voluntary agreements already exist. As discussed in Section A2.4.1, a voluntary agreement on air fresheners exists between large players in the EU market under the auspices of AISE; however, our research indicates that the current EU manufacturers of 1,4 dichlorobenzene-based air fresheners and toilet blocks may not be among these big players. Indeed, all those companies that have indicated a current manufacture or supply of 1,4 dichlorobenzene-based products are generally much smaller SMEs.

Action that has led to a gradual decline in the use of 1,4 dichlorobenzene in air fresheners and toilet blocks has already been taken for the reasons mentioned elsewhere in the report (new classification, developments in the biocidal products field, etc.). There are currently several alternatives to 1,4 dichlorobenzene-based air fresheners and toilet blocks for home use which may offer technical and aesthetic advantages while being competitively priced. This explains why these 1,4 dichlorobenzene products apparently find limited use in the

EU at present. However, there appears to be no drive among current users of the substance to completely discontinue the use of the substance (especially for urinal blocks).

Unilateral action by the manufacturing industry would not encompass imports of such products from non-EU countries. For these to be affected, voluntary action would have to include importers and distributors of the relevant products. In conclusion, given the nature and diversity of the companies that would have to be included in a voluntary agreement (a high proportion of SME and the necessity to include importers, distributors and potentially retailers) and the reluctance on the part of some stakeholders in the sectors concerned to provide input into this study, it appears that self-regulation may be difficult to achieve. Therefore, sustained and organised action by industry may not materialise in the absence of regulatory pressure. This option will not be considered further.

Open Method or Co-ordination

According to the Impact Assessment Guidelines 2009, this option would entail action at the national level especially in areas where there is little scope for legislative action at the Community level – as long as it does not distort the internal market. However, given the framework under which risks have been identified and the expressed opinions of Member States on the need for EU-wide action (see summary of responses in Table 1.2), this implementation option is not relevant and will not be considered further.

Provision of Information and Guidelines

As the Impact Assessment Guidelines 2009 note, this instrument is generally most useful in areas where sociological and psychological factors have a great impact on behaviours. We do not believe that the case of risks from the use of 1,4 dichlorobenzene-based products predominantly relates to such factors. This implementation option is assumed to be ineffective and will not be considered on its own further.

Market-based Instruments

Economic instruments could take several forms: subsidies, taxes or unit charges. Several other instruments exist but are rather geared towards environmental releases and pollution control. These instruments could, theoretically, be used to encourage the EU industry to reduce or discontinue the use of 1,4 dichlorobenzene in the selected applications. Given that the relevant market for these products is small (both in terms of turnover and annual consumption) and the practical implications and administrative costs of setting up and implementing economic instruments across the Community, aiming to control risks through economic instruments is not considered realistic and will not be considered further.

Direct Public Sector Financial Interventions

This option is generally considered in emergency cases as a transitional measure for public sector provision of goods and services through public expenditure programmes. Therefore, it is considered to be irrelevant and will not be considered further.

Co-regulation and Standards

Co-regulation could entail a voluntary agreement between industry and the EU authorities under specified provisions, timelines and monitoring arrangements.

Voluntary agreements between industry and authorities do not appear to have positive prospects as far as manufacturers and suppliers of the substance and its products are concerned; those identified companies that have made an input to this study generally are of little relevance to the use of such products at home and they also disagree with the view that there is a need for controls on the substance as far as professional uses might be concerned.

Successful co-regulation agreements ideally require the existence of a central organisation that would co-ordinate the efforts of interested parties. In this case, there is an EU-wide detergent and soap association, AISE. However, a voluntary agreement involving AISE appears to neither be appropriate nor desirable. Whilst AISE's membership includes very large multinational companies that account for the vast majority of the air care market, the smaller companies that use the substance at present do not appear to be members. Moreover, AISE has advised us that, as a trade association, it cannot commit to encouraging/supporting a voluntary ban as it believes that it would raise issues of enforcement and anti-trust laws (AISE, 2010).

We have discussed the issue of a voluntary agreement involving professional users of 1,4 dichlorobenzene-based products; however, as this use falls outside the scope of this study, we will not expand on this issue further.

Co-regulation is also likely to suffer from the same obstacles to implementation as those discussed above for self-regulation. In conclusion, the scope for a successful co-regulatory agreement targeting the use of 1,4 dichlorobenzene-based products is very limited. As a result, this instrument will not be taken forward to a full impact assessment.

Also, the introduction of any European Standard for the reduction of risks to consumers from 1,4 dichlorobenzene is not relevant and will not be considered further.

Framework Directives

The framework under which this risk management work is undertaken is very specific: the need for measures arose from the Existing Substances Regulation which has now been replaced by the REACH Regulation. Therefore, there is no scope for action within a framework directive (and any subsequent 'daughter' directives). This implementation option will not be considered further.

Prescriptive Regulatory Actions

The possible policy options identified earlier all fall under the 'command and control' category of prescriptive regulatory action (as opposed to performance-oriented standards). Such regulatory action could be taken at the EU level in the form of an amendment to Annex XVII to the REACH Regulation. Other legal instruments such as the General Products Safety Directive do not address professional use of products (the main source of consumer exposure to 1,4 dichlorobenzene) and thus cannot be considered a suitable vehicle for delivering the required risk management policy intervention.

Conclusion

Overall, for both air fresheners and toilet blocks, we have concluded that the only possible implementation option is 'command and control' prescriptive regulatory action that specifies the use of certain practices, technologies, or designs. Action at the EU level also appears to be preferred by the Member States that have responded to the RPA questionnaire (see Table 1.2).

5. ANALYSIS OF IMPACTS

5.1 Analysis of Effectiveness, Practicality and Monitorability

5.1.1 Introduction

In this first part of the assessment of impacts, we assess the identified policy options against the key criteria of effectiveness, practicality and monitorability, i.e. on the basis of:

- how well or to what extent they could reduce the identified risks;
- how feasible their implementation and enforcement might be; and
- how easily and reliably progress with risk management could be monitored.

The aim is to establish whether one or more of the identified options could not realistically provide and demonstrate a sufficient level of risk management and therefore to focus on the most appropriate remaining options.

5.1.2 Option 2: Temperature and Ventilation Conditions

Effectiveness

Theoretically, keeping the temperature sufficiently low could reduce the rate of release of 1,4 dichlorobenzene thus reducing the exposure of consumers to the substance at home. However, to achieve this, temperature and ventilation conditions would need to be carefully monitored by the consumer.

Practicality

Whilst actually monitoring the temperature in a private (toilet) room would be fairly straightforward (by means of a thermometer), controlling and influencing the temperature would not necessarily be easy. For instance, in Southern EU Member States where temperatures in the summer may reach 35-40°C or even higher, consumers would have great difficulty in keeping the temperature lower – this would require the use of mechanical means (forced ventilation/air conditioning). Even where mechanical ventilation systems may exist, controlling the temperature at a specified low level would be costly, if not impossible.

It would also be difficult to prescribe very specific ventilation conditions and a requirement for 'adequate ventilation' may not be correctly understood or be given sufficient attention to by consumers. During winter, windows and doors are normally kept shut and in the summer, when the weather is hot, there may be little air circulation even when the windows are open. It is considered unrealistic to expect users to opt for mechanical ventilation, especially in a toilet, specifically with the aim of keeping exposure to 1,4 dichlorobenzene low (although an extractor fan is present in many household toilet rooms and many households do have air conditioning systems installed nowadays).

Monitorability

Monitoring of implementation by authorities would be an impossible task to undertake.

Conclusion

Based on the above we conclude that a policy option based on conditions for temperature and ventilation would encounter severe problems with implementation and enforcement and could not provide guarantees of successful reduction in consumer exposure to 1,4 dichlorobenzene at home. This option will not be assessed in further detail.

5.1.3 Option 3: 70% Concentration Limit on 1,4 Dichlorobenzene

Effectiveness

Theoretically, a lower concentration of the substance would reduce the levels of exposure by inhalation. However, our research suggests that this assumption will crucially depend on what material is used to reduce the concentration of 1,4 dichlorobenzene. At present, there is at least one urinal block with 70% dichlorobenzene that is sold in the EU. The balance is natural salt, a substance with considerable solubility in water. The discussion below assumes that approaches taken in urinal blocks could also be relevant for toilet rim blocks as, composition-wise, they are effectively identical products.

The presence of salt has three distinct effects:

- first, it reduces the cost of the end-product;
- second, it may lead to the (urinal) block breaking down during use as the grains of salt are dissolved in water. We have been advised that for this reason, it is not advisable to lower the concentration of 1,4 dichlorobenzene in the block below 70%; and
- finally, as the salt dissolves and separates from the block, it leaves gaps in the crystalline structure of the block. This effectively increases the active surface of the block and hence augments the sublimation rate of 1,4 dichlorobenzene. The end result is that the concentration of vapours in the room and the subsequent consumer exposure may increase. Under such conditions, consumer exposure by inhalation could be even higher than when a block with >98% 1,4 dichlorobenzene is used. The manufacturer of the said urinal blocks has confirmed that the addition of salt makes the product more potent but also one that is depleted faster than ordinary 1,4 dichlorobenzene-based urinal blocks.

We have been advised that other fillers may be used instead of natural salt; these may have a water solubility similar to that of natural salt, in which case the issues described above would also arise.

As discussed earlier, the concentration of 1,4 dichlorobenzene in the block is only one of the many parameters that may affect consumer exposure. There are several other factors in the real world (temperature, ventilation, air movement, etc.) which may affect the release of vapours and the longevity of the product.

Practicality

It is evident that a 70% concentration is feasible, since at least one (urinal block) product is available on the EU market. On the other hand, the presence of a filler could result in the breaking of toilet rim blocks and the loss of their pieces in the toilet bowl (where the substance will not be able to dissolve). If the product falls apart quickly, the consumer may have to replace it more often than originally intended.

Monitorability

We would not expect any significant issues with the monitoring of the implementation of such a policy option; authorities in Member States should have in place adequate provisions for implementing and enforcing a straightforward concentration limit on chemical products.

Conclusion

The above analysis suggests that, although a 70% concentration limit is currently possible for toilet blocks (as the relevant know-how is available in the EU), the use of water soluble fillers would not only impact the functionality, longevity and aesthetic properties of toilet rim blocks but would be unlikely to result in a reduction of consumer exposure. Overall, it is considered that this policy option is not practical and potentially counter-productive with regard to the control of consumer exposure. As a result, this option will not be assessed further.

5.1.4 Option 4: Weight Limit on 1,4 Dichlorobenzene-based Products

Effectiveness

A limit on the weight of air fresheners and toilet rim blocks could result in a decrease in consumer exposure in the spaces in which these products are used. This assumes that (some) products currently placed on the EU market exceed the weight limit prescribed under this policy option, which is correct but the extent to which this happens is unclear. Also, the results of the EU RAR are not linked to a particular size of household products, therefore, we cannot conclusively ascertain the extent to which a 50 g limit on air fresheners and toilet blocks would reduce exposure of consumers at home. Parameters such as temperature and ventilation would also play a significant role in the levels of exposure.

Practicality

The implementation of this option appears to be practical, since air fresheners and toilet rim blocks of ca. 50 g are currently manufactured in the EU and are currently placed on the EU market.

It is possible that for some manufacturers whose products are of a different shape or size to that specified in the proposed regulatory text (50 g with a specified surface area:volume ratio), a need for changes to their pressing machinery could arise. This will be discussed later in this report.

Monitorability

We would expect that the relevant authorities in Member States would be able to monitor the enforcement of such a requirement on the weight of blocks, although we are unclear as to whether similar limits may apply to other chemical products.

Conclusion

Although there are specific issues to be addressed, this option is considered to be in principle potentially effective and will be assessed further later in this Section of the report.

5.1.5 Option 5: Prohibition of Sale of Products to the General Public

Effectiveness

This option would be effective at eliminating exposure of consumers to 1,4 dichlorobenzene vapours at home. As discussed earlier, the possibility of such exposure taking place at home is much lower than exposure in a public toilet, as the use of room air fresheners and toilet rim blocks based on 1,4 dichlorobenzene appears to be limited in the EU. Moreover, at least in Germany, the classification of the substance as a carcinogen category 3 (R40) prevents the direct sale of these products to the public.

Practicality

No particular problems of implementation can be envisaged, especially given the very limited home use of these products and the availability of suitable alternatives for both room air fresheners and toilet rim blocks.

Monitorability

We would expect that the relevant authorities in Member States would be able to monitor the enforcement of such a restriction which largely applies already as a result of the substance's classification.

Conclusion

This option is considered to be effective and feasible and will be considered further.

5.1.6 Options taken Forward for Further Assessment

In summary, the policy options that will be assessed further for economic, social and environmental impacts include:

- **Option 1**: Business as Usual (BAU)
- **Option 4**: Restriction of the weight of air fresheners and toilet rim blocks to 50 g per unit
- **Option 5**: Prohibition of sales of 1,4 dichlorobenzene-based products to the public

It should be noted that there are a number of impact areas identified in the Commission's 2009 Impact Assessment Guidelines that are considered to be of limited relevance to this analysis and have therefore been omitted. These are outlined in Table 5.1.

Table 5.1: Impact Types Excluded from the Full Impact Assessment

Impact Category	Impact Type
Economic Impacts	• Property Rights • Macroeconomic Environment
Social Impacts	• Gender Equality, Equality Treatment and Opportunities, Non-discrimination • Individuals, Private and Family Life, Personal Data • Governance, Participation, Good Administration, Access to Justice, Media and Ethics • Crime Terrorism and Security • Access to and Effects on Social Protection, Health and Educational Systems • Culture • Social Impacts in Third Countries
Environmental Impacts	• The Climate • Transport and the Use of Energy • Biodiversity, Flora, Fauna and Landscapes • Land Use • Renewable or Non-renewable Resources • Animal Welfare • International Environmental Impacts • The Likelihood or Scale of Environmental Risks

5.2 Economic Impacts: Assessment of Impacts from Policy Options

5.2.1 Functioning of the Internal Market and Competition

Option 1: Business as Usual

No impacts on the functioning of the internal market and competition are envisaged, although it is of note that the apparent decrease in the number of EU companies manufacturing and supplying 1,4 dichlorobenzene-based products that has considerably improved the turnover of a small number of companies that have remained active in the relevant markets (for professional uses).

Option 4: Weight Restriction

No significant impact on the functioning of the internal market would be anticipated; this would however, depend on the ability of different air freshener and toilet block manufacturers to meet the requirements of this policy option. If a manufacturer does not normally manufacture products of the weight prescribed by the policy option, changes to machinery could be required. The general consensus among industry consultees who have expressed an opinion is that any changes required would be easy to implement.

Option 5: Prohibition of Sales to the Public

The information available indicates that the market for 1,4 dichlorobenzene air fresheners and toilet rim blocks is very small in comparison to the overall EU air fresheners and toilet block markets. As a result, a prohibition on the use of such products at home would not affect the functioning of the overall internal market for air fresheners and toilet blocks. However, two issues may be highlighted:

- **role of the size of the consumer markets for 1,4 dichlorobenzene-based products**: a manufacturer of 1,4 dichlorobenzene assumes that domestic use of these products could account for a significant portion (more than 30-40% of the EU market for 1,4 dichlorobenzene-based air fresheners and toilet blocks). On this basis, the company believes that a restriction on domestic use of these products could still make the EU-based flaking of 1,4 dichlorobenzene uneconomical – in fact, the company has informed us that, in recent years, the amount of flaked 1,4 dichlorobenzene produced by them was close to the tonnage level below which flaking becomes uneconomical. The loss of the EU markets would mean, according to the company, that flaking would have to be phased down and the flaking machinery would be scrapped. The cessation of flaking would mean that the manufacturer would abandon the solid 1,4 dichlorobenzene market in the EU (note that flaked 1,4 dichlorobenzene is used in the EU as an intermediate as well as in air fresheners and toilet blocks). The company expects that this could lead to an increase in the price of solid 1,4 dichlorobenzene by approximately 10%. Another manufacturer has similarly asserted that the loss of the domestic market would mean that they would also abandon the solid 1,4 dichlorobenzene market in the EU. However, our assumption is that the relevant markets are far smaller that the above 30-40% suggested by the manufacturer; and
- **the imbalance in the patterns of use of the products across the EU**: consumer uses are more prominent in Southern and Eastern EU Member States rather than Western or Northern ones. Therefore, a prohibition of sales of these products to the public could have more adverse effects on a few companies in the Southern and Eastern EU Member States. Some companies may derive a significant proportion of their turnover from sales to private consumers and a restriction on consumer uses could wipe out a significant source of revenue. It could further make the manufacture of products for professional use uneconomical. This would affect those companies' competitiveness against other manufacturers for which consumer uses current account for a very small or no part of their turnover.

5.2.2 Competitiveness, Trade and Investment Flows

Option 1: Business as Usual

In the last 5-6 years, the intra-EU sales of 1,4 dichlorobenzene appear to have significantly diminished and imports into the EU of the substance (and potentially its products too) from countries such as China and India appear to be quite substantial, indeed exceeding the level of intra-EU sales. This would suggest that, currently, non-EU manufacturers may have a competitive advantage over their EU-based counterparts. It is difficult to make assumptions on how the situation may change in the future, especially in light of the registration requirements of the REACH Regulation. We do not have concrete information at present on what companies' plans are with regard to registration.

Option 4: Weight Restriction

The number of pressing machines owned by each manufacturer might differ. For companies specialising in such solid deodorisers, a number of machines could be used and these may produce articles of variable sizes. The types of pressing machines used are two: (a) extender presses – every block is pressed individually, this is used for bigger and heavier tablets/stones; and (b) rotary run press – blocks are pressed in a carousel-process; this is used for smaller blocks. An industry stakeholder has suggested that such machines have only a few electronic components in them, they are simply mechanical presses. Therefore, with good maintenance, these machines can operate for 30-50 years. However, one has to take into account that the direct compacting tools are regularly renewed, as there is wear and tear.

The changes that would be required by manufacturers of air fresheners and toilet blocks would be easy to implement and would come at a very low cost (according to the testimony of one such manufacturer). We would not expect any significant impacts on the competitiveness of EU manufacturers of these products.

Option 5: Prohibition of Sales to the Public

Given the limited use of 1,4 dichlorobenzene-based air fresheners and particularly toilet rim blocks by consumers in the EU, a prohibition would probably not affect the competitiveness of EU companies in the global market. EU-based manufacturers, however, do not share this view:

- as discussed in Section 5.2.1, one of the manufacturers is concerned that the loss of the air freshener and toilet block market for home use could spell the end of the bulk of flaking of 1,4 dichlorobenzene in the EU and this would affect the sales of flaked 1,4 dichlorobenzene to customers outside the EU thus damaging the competitiveness of EU manufacturers of the substance against other manufacturers on the global stage. The manufacturer considers that significant overcapacities of 1,4 dichlorobenzene production in India and China might then focus on other applications and might cause losses to the EU manufacturer from a loss of markets for other applications of 1,4 dichlorobenzene and related isomers;

- we are advised that 1,4 dichlorobenzene results from the chlorination of benzene, a reaction which produces a mixture of 1,2 dichlorobenzene and 1,4 dichlorobenzene at a nearly fixed ratio. 1,2 dichlorobenzene is the leading compound because it is requested as an intermediate in the crop protection sector. If manufacturers of chlorobenzenes could not identify alternative markets for the flaked quantities of 1,4 dichlorobenzene currently sold to the hygiene sector, they might need to reduce the production of 1,2 dichlorobenzene accordingly. This could in theory affect the competitiveness of the manufacturers at the global scale; and
- the other manufacturer similarly expects to lose his entire EU sales of flaked 1,4 dichlorobenzene which would lead him to seek new markets outside the EU. This would entail costs at least for marketing and establishing new downstream users, although this market loss does not appear to be a very significant one.

Following from the above, if we indeed assumed that the restriction on domestic uses would affect all uses (i.e. professional uses too) of these products, manufacturers of 1,4 dichlorobenzene-based products would also be affected and the competitiveness of these companies against Chinese and Indian manufacturers would suffer. However, in this report we work on the basis that the relevant domestic markets are far smaller than what is assumed by the manufacturer of 1,4 dichlorobenzene (a total of 83+17 tonnes of products used across the EU), hence the above adverse effects are unlikely to arise, at least not to the extent envisaged by the manufacturer of 1,4 dichlorobenzene.

5.2.3 Operating Costs and Conduct of Business/Small and Medium Enterprises

Option 1: Business as Usual

As discussed in Section 2.4.8, our expectation is that the market for air fresheners and toilet rim blocks for use at home will gradually decline as a result of the presence of a wide range of more modern, sufficiently effective and competitively-priced alternatives. This will involve losses for those companies still involved in the manufacture and distribution of air fresheners and toilet rim blocks for domestic use. However, the small size of the market would mean that the overall losses will be small and spread over time, therefore, giving companies time to adapt to the new situation, explore new markets and develop alternative products (if they have not done so already).

Option 4: Weight Restriction

EU-based Manufacturers of 1,4 Dichlorobenzene

No significant impacts to manufacturers of the substance are expected, unless manufacturers of air fresheners and toilet rim blocks believe that the cost of adjusting their production lines is not justified and decide to discontinue the manufacture of products for sale to consumers for use at home. Still, as the consumer markets for these products are small, the consequent impacts on manufacturers of the substance would be accordingly small.

Importers of 1,4 Dichlorobenzene

For the reasons presented above for EU-based manufacturers, no significant impacts would be expected.

EU-based Manufacturers and Suppliers of 1,4 Dichlorobenzene-based Products

We have enquired among a small number of manufacturers of these products as to whether the implementation of a limit on the size of toilet blocks would cause problems or significant additional costs.

Our understanding is that while a restriction imposing specific dimensions on air fresheners and toilet blocks would result in some adjustment costs, a limit on weight would not be accompanied by any real cost:

- for pressing machines with one shaping mould, a cost of €3,500 per machine would arise in order to adapt to new dimension requirements. For larger machines that bear several moulds, costs of up to €15,000 might be required. Stakeholders suggest that, as it is probably only parts of the pressing machine that need to be modified, rather than needing completely new equipment, the impacts would be unlikely to be small; and
- on the other hand, if only a weight limit were to be imposed, manufacturers would have little difficulty in changing the weight if their products, while maintaining their dimensions. A manufacturer selling to private consumers indicated that such changes would not entail any real cost.

Non-EU Manufacturers of 1,4 Dichlorobenzene-based Products

The discussion presented for the EU-based manufacturers above would also apply here.

Professional Users of 1,4 Dichlorobenzene-based Products

No significant impacts on professional users would be likely to arise.

Manufacturers and Suppliers of Alternative Deodorisers

Given that the market for 1,4 dichlorobenzene-based products for use at home across the EU is small, any gains made by manufacturers of alternative products will be very small. Some of these companies may in fact be the same companies that currently supply 1,4 dichlorobenzene-based products to private consumers in the EU.

Option 5: Prohibition of Sales to the Public

EU-based Manufacturers of 1,4 Dichlorobenzene

Our assumption is that a total of 100 (83 + 17) tonnes of air fresheners and toilet rim blocks are used per year by private consumers in the EU. We do not know what percentage of this might actually be sold by EU-based manufacturers of the substance . As discussed in Section 2.4.3, EU-based manufacturers of 1,4 dichlorobenzene are likely to account for less than 50% of the consumption of the substance in these two applications in the EU. Therefore, we could tentatively assume that EU-based manufacturers may account for only part of the 100 tonnes shown above. In the absence of information, we conservatively assume that they account for 25-50% of this tonnage or 25-50 tonnes per year. This would reflect a considerable proportion of their annual sales. The relevant turnover may be calculated to be between €25,000 and €150,000 per year (assuming a wholesale price of €1,000-3,000 per tonne). This lost turnover would be quite small, especially when sales of liquid 1,4 dichlorobenzene to non-EU customers are considered. However, one of the manufacturers has argued that even the loss of the arguably small consumer uses markets for air fresheners and toilet blocks could have wider negative repercussions. These are discussed below. Please note that, for confidentiality reasons and on the request of the company providing this information, we use the terms 'low', 'medium' and 'high' when describing the scale of costs.

- ***Loss of markets***: if the prohibition of sales to private consumers affected the flaking of 1,4 dichlorobenzene in the EU, this would mean that sales for the production of air fresheners and toilet blocks for professional use as well as for unrelated applications (i.e. use as an intermediate) would be lost. If it were not possible to identify alternative markets for the currently flaked quantities of 1,4 dichlorobenzene, manufacturers might need to either lose equivalent 1,2 dichlorobenzene business as well or they would have to incinerate the excess 1,4 dichlorobenzene volumes. The cost of disposal is estimated to be high.
- ***Machinery costs***: under the scenario described above, the loss of the markets for solid 1,4 dichlorobenzene a would result in equipment decommissioning costs of a medium scale (note that the relevant machinery has an intended lifetime of more than 30 years); however, these costs could be several times higher if the global competitiveness of the company was impacted.
- ***Production downtime***: this would depend on the indirect impacts on the competitiveness of the company. It could be fairly low if flaking of 1,4 dichlorobenzene continues but could be very high, if global competitiveness was lost.
- ***Other costs***: other costs that might arise and which have been identified by the manufacturer are:
    - one-off costs for training staff and labelling costs which would be of low magnitude; and
    - ongoing costs such as costs of inputs (i.e. energy) and marketing which could be of low magnitude. However, if global competitiveness were impacted, marketing costs would be estimated to increase by around four-fold.

The above cost estimates are evidently dependent on the size of the EU consumer markets for air fresheners and toilet blocks and on whether those companies manufacturing products for consumer use predominantly purchase the substance from an EU supplier.

Importers of 1,4 Dichlorobenzene

The scale of impacts on those non-EU companies selling the substance to EU customers would depend on the actual size of the market and the percentage of the market that is based on the imported chemical. We assumed above that importers account for 50-75% of the substance used in products sold to EU consumers, i.e. 50-75 tonnes/y. However, this does not sufficiently help us in estimating the impacts on importers. Impacts would depend on:

- the size of the consumer markets and the share that is supported by imports of the substance – the assumptions made in this report are based on information from a few sources only;
- the number of importers and their share of imports – we do not know whether one or more companies have a predominant position in this market (although we have identified one company with a market share larger than the combined market share of EU-based manufacturers); and
- the nature of the business of those manufacturers of 1,4 dichlorobenzene-based air fresheners and toilet blocks that use the imported substance – if these manufacturers of products are seriously impacted, then the importers supplying them would also be seriously impacted

Nevertheless, the available indications are that non-EU markets for 1,4 dichlorobenzene air fresheners and toilet blocks are much more important than the EU one. Therefore, a prohibition of sales to the public in the EU would have a relatively limited impact to importers of the substance.

EU-based Manufacturers and Suppliers of 1,4 Dichlorobenzene-based Products

We have shown earlier that the turnover of the consumer markets for 1,4 dichlorobenzene-based air fresheners and toilet blocks are only €2 million for the former and €0.36 million for the latter. These markets would be lost under this policy option and it is possible that some manufacturers of products might be considerably impacted, if sales to private consumers form a significant proportion of their turnover. We do not know if any of the companies serving the private consumer market have in their portfolio alternative products which they could sell in the place of 1,4 dichlorobenzene-based products. Manufacturing alternatives could reduce the losses that these companies would face.

It is worth discussing here the possible impacts on specific companies which may sell a significant proportion of their production to consumers as opposed to professional users. For these companies, the impacts from this policy option could be considerable. Some specific information on costs has been received by a manufacturer of 1,4 dichlorobenzene-based products. While the information below would relate to the loss of the professional uses market, in the absence of other information, we assume that the costs presented below would apply to individual companies which currently sell a significant tonnage of products to private consumer and which would need to cease the use of 1,4 dichlorobenzene under this policy option.

- ***Impacts on existing investments and materials***: consultation suggests that the key impacts that may arise include:
  - <u>cost of decommissioning existing machinery</u>: the price for a press with a compacting tool is approximately between €80,000 and €250,000 per machine. However, given the long lifetime of these machines, those currently in use could well be old ones, worth only a fraction of their original price. It has been argued that, as these machines do not have a dual use (alternative formulations cannot be manufactured in these presses), the residual investment in these machines for use with 1,4 dichlorobenzene would be lost. With regard to manufacturing alternative products, the manufacturer of the presses could examine the new formulation in question and offer a conversion of the machines. We are not aware of a second-hand market for presses currently used with 1,4 dichlorobenzene;
  - <u>cost of disposing unwanted raw materials</u>: manufacturers stock a certain tonnage of 1,4 dichlorobenzene for use in the months to come. This amount cannot be too high as with time the material becomes compacted and is not sufficiently granular for the presses to operate well. The usual amount stocked would be equivalent to two months' production – this could vary around the year; the same amount sold in winter over two months, could be sufficient for only 20 days over the summer period.

    The estimate of an EU manufacturer is that the cost of disposing existing stock would be the cost of purchase (on average €2,000/tonne) and the cost of disposal which it has been estimated at around €6,000/tonne. Re-selling the material would not be an option as transporting it outside the EU would be costly and it would be difficult to compete with the lower prices of Chinese and Indian manufacturers. It has to be noted however that a restriction would not be introduced overnight and companies would probably have adequate time to use their stock of 1,4 dichlorobenzene before a restriction kicks in. Therefore, we do not believe that a significant cost for disposing unwanted raw materials might arise; and
  - <u>disruption of the investment cycle</u>: an EU manufacturer has suggested that losing the core component of his production would disrupt the investment cycle of the company. The cost of acquiring new machinery, developing the required know-how and starting production of a new formulation could be in the €10,000-100,000 range. The exact figure would evidently depend on the scale of a company's operations.
- ***Capital costs***: consultation suggests that the key impacts that may arise include:
  - <u>cost of new machinery</u>: if alternative formulations would have to be used, new machinery could be required. An EU manufacturer assumes that a minimum of four machines would be required (to ensure that production of different sizes and

forms would be possible) – however this reflects a significant production volume and may not be relevant for all current manufacturers of 1,4 dichlorobenzene-based air fresheners and toilet blocks. At an estimated cost of €85,000 per machine, the total cost could be as high as €340,000. The machines could be supplied by those companies selling machines for pressing 1,4 dichlorobenzene blocks. A manufacturer who intends to produce a modest tonnage of products would not need to acquire four machines and this the associated costs would be lower;

- production downtime: the cost of production downtime has been assumed to be based on a cessation of production activities of at least 20-25 working days. A cost of €1,500 per day has been suggested giving a total minimum cost of €30,000-37,500;
- cost for (new) buildings/facilities: an estimated cost of €15,000 has been suggested in order to meet the latest standards of safety for buildings/productions plants. An EU manufacturer of deodorising products suggests that changes in formulations could result in new legal requirements in relation to health and safety;
- staff training costs: new formulations could mean that training of personnel may be needed. The science of new raw materials, and the hazards associated with their storage, use in the production process and manual handling would require additional training. In addition, training of new products and production processes would be required. Training could be taken internally and the estimated cost per employee has been suggested to be €1,500. An EU manufacturer indicates that he would need to train four members of staff who are currently directly involved in the pressing of 1,4 dichlorobenzene blocks; and
- labelling costs: an EU manufacturer has argued that all labels would have to be changed including those on the packaging but also on the transportation packaging. All product lists and price lists would have to be changed. The manufacturer's estimate of these one-off costs is ca. €15,000.

- ***Operational costs***: consultation suggests that the key impacts that may arise include:
  - costs of new raw materials: 1,4 dichlorobenzene is considered to be a relatively inexpensive chemical and it also accounts for a very high percentage of formulations in the relevant end-products. The raw materials for alternative formulations are allegedly substantially more expensive. For 1,4 dichlorobenzene-based products, the number of components is small and the costs of storing the relevant substances are small. Alternative formulations may contain several ("*20 or so*" has been argued) different components in the formulation. This alone makes the costs substantially higher as one has to have all these different raw materials ready in sufficient quantities. An EU manufacturer assumes the cost of stocking new raw materials to be of the order of €50,000 (again, this will depend on the volumes stocked);
  - costs of other inputs (energy, water): the mixing of components of 1,4 dichlorobenzene-based products is relatively simple and the mixing times are approximately 15 minutes per mix of raw material (using a simple 'recipe' and few different substances). On the other hand, the mixing of formulations with up to 10

different substances can be very time-consuming with mixing times reaching up to 1.5 hours per mix. As these machines are powered by electricity, the electricity costs are higher. It has been estimated that this cost could be ca. €2,000/y. However, when expressed as a cost per block manufactured, the additional cost would be very small (€0.004);

- marketing costs: marketing efforts would aim to explain to customers why 1,4 dichlorobenzene cannot be used any more. An EU manufacturer assumes that the associated costs could reach €20,000 for a marketing campaign for his new products. This will depend on where this marketing campaign takes place and what the sales goals of each company would be; and
- cost of worker protection and health and safety measures: there may be a need for additional protection of workers' health during handling of new materials (for example, safety gloves for protection from chemical agents are not always the same. Certain substances need appropriate gloves, clothes, shoes or breathing apparatus). This has been suggested to be ca. €5,000 – however, this figure is a theoretical one and is not based on any specific additional measure that might be required.

The above discussion suggests that the introduction of a prohibition on sales to the public could have noticeable impacts on specific EU manufacturers of 1,4 dichlorobenzene-based products who would be forced to discontinue production (and presumably elect to move to alternative formulations). We cannot be certain how many companies might find themselves in such a position. If suggestions by an expert are anything to go by, the number of such companies could be relatively small.

A final point that perhaps needs to be made is the fact that many companies which may appear to manufacture 1,4 dichlorobenzene products are in fact selling own-branded products which have been manufactured by another company. The impacts from the restriction on these resellers would significantly less severe.

In Annex 6, we further discuss what the impacts on manufacturers of products could be if a restriction was to be introduced for both professional and consumer uses of 1,4 dichlorobenzene-based air fresheners and toilet blocks.

Non-EU Manufacturers of 1,4 Dichlorobenzene-based Products

We do not have any quantified information on the imports of end-products into the EU for consumer use. As a result, we cannot provide commentary on the likely impacts to this stakeholder group from a prohibition on sales to the public. It is reasonable to expect that some imports of products take place.

Professional Users of 1,4 Dichlorobenzene-based Products

Professional users of 1,4 dichlorobenzene-based products would be impacted only if the prohibition on sales to the public affected the flaking operations of the manufacturers of the substance or if manufacturers of products decided to abandon the manufacture of air fresheners and toilet blocks for professional uses. The latter might occur if a company currently sells its products mainly to consumers and lost a significant proportion of its turnover following the introduction of the prohibition.

We cannot estimate the scale of any impacts from this policy option as it depends on the assumptions made on impacts on other stakeholders and on the actions taken by manufacturers of the substance and of its products.

Manufacturers and Suppliers of Alternative Deodorisers

Given that the market for 1,4 dichlorobenzene-based products for use at home across the EU is small, any gains made by manufacturers of alternative products will be very small. Some of these companies may in fact be the same companies that currently supply 1,4 dichlorobenzene-based products to private consumers in the EU. Even if this policy option had repercussions for the professional uses markets, the 1,4 dichlorobenzene market in the EU is too small in comparison to the overall EU markets for air fresheners and toilet blocks and hence, the benefits to manufacturers of alternatives would be very modest.

Small and Medium Enterprises

A small number of small to medium enterprises (SMEs) are expected to be significantly impacted. This predominantly includes manufacturers of 1,4 dichlorobenzene-based products which could be family businesses that have traditionally manufactured products such as moth balls, insect repellents and deodorisers. These may be using old pressing machines and could have an established position in their national (and possibly EU) market. The scale of impacts will of course depend on whether these companies currently manufacture alternatives or whether they are able to switch to alternative formulations.

Given the strong presence of 1,4 dichlorobenzene-based products in Southern and Eastern EU Member States, it is likely that the SMEs that could be most seriously affected would be located in these countries.

We do not have the information necessary to provide a quantitative analysis of impacts specific to SMEs, although we are aware of one EU-based company selling 1,4 dichlorobenzene-based products to consumers that is an SME; for this company, consumer uses account for a significant percentage of 1,4 dichlorobenzene-related sales, hence a restriction could have significant repercussions. We cannot, however, assume that for the remaining manufacturers of products destined for consumer use, sales to private customers are equally important.

5.2.4 Administrative Burdens on Businesses

Option 1: Business as Usual

No future impacts are envisaged.

Option 4: Weight Restriction

This policy option might somewhat increase the administrative burden on manufacturers of 1,4 dichlorobenzene air fresheners and toilet blocks if they mean that there would be separate requirements for products intended for domestic use as opposed to products intended for professional use.

Option 5: Prohibition of Sales to the Public

No significant impacts expected.

5.2.5 Public Authorities

Option 1: Business as Usual

The existing burden on authorities in relation to the use of 1,4 dichlorobenzene in air fresheners and toilet blocks relates to its classification as a carcinogen category 3 and to any requirements set by central or local government in EU Member States not to use 1,4 dichlorobenzene-based products in establishments such as schools. As discussed in Section A2.5, only Sweden has in place a national restriction on the use of the substance in deodorisers.

Option 4: Weight Restriction

Imposing requirements on the weight of air fresheners and toilet blocks placed on the market for consumer uses only could result in additional monitoring activities on behalf of the authorities and issues may arise with regard to imports of products from non-EU countries. Realistically, however, it would be unlikely that authorities would undertake detailed inspections or monitoring. Potentially, trading standards officers may undertake checks of suppliers of these products to ensure that new legislation is adhered to but the likelihood of this taking place at a large scale is considered to be small. Overall, this policy option could potentially be too complex for the level of consumer exposure control it may be able to achieve; this would be unlikely to be welcome by national enforcing authorities.

Option 5: Prohibition of Sales to the Public

No significant burden on authorities is expected given that the relevant market is small and considering that Member State authorities should already have in place administrative mechanisms for implementing restrictions on chemical substances. It is also worth noting that the additional burden would probably arise for authorities only in certain Member States (Southern and Eastern EU).

5.2.6 Innovation and Research

Option 1: Business as Usual

1,4 dichlorobenzene-products are essentially based on 'old technology'; alternatives are already available on the market and are generally based on different technology (e.g. air fresheners based on gels and aerosols and toilet rim blocks based on surfactants). Given that the consumer markets for 1,4 dichlorobenzene-based products are small and are expected to naturally decline, it is unlikely that the gradual demise of this market would provide sufficient incentive for further innovation and research.

Option 4: Weight Restriction

This policy option sets specific requirements only on the weight of air fresheners and toilet blocks. In this sense, it is unlikely to result in any substantial innovation and development. The pressing technology for the manufacture of these products is generally old and straightforward. As the meeting of the weight requirement of the policy option would be relatively simple, manufacturers may have little incentive to invest in further research on developing more sophisticated products based on 1,4 dichlorobenzene.

Option 5: Prohibition of Sales to the Public

If manufacturers of 1,4 dichlorobenzene-based products would wish to stay on the consumer market, they would need to engage in the development of alternatives. However, if their projected sales would be small, the development of alternatives may not make business sense. Generally, given that the sales of 1,4 dichlorobenzene-based products to the public are small, a prohibition of sale to the public would be unlikely to spur any innovation in the air freshener and toilet block markets. Several alternatives are available and are sold in much larger quantities already.

5.2.7 Consumers and Households

Option 1: Business as Usual

Following the non-registration of 1,4 dichlorobenzene as an active substance under the Biocidal Products Directive, the use of 1,4 dichlorobenzene-based products (predominantly moth balls) at home has greatly reduced[32]. The use of air fresheners and toilet rim blocks is limited and perhaps concentrated mostly in Southern and Eastern EU Member States. Our analysis suggests that the use of 1,4 dichlorobenzene-based products in the EU will gradually diminish and any residual consumer use of these products will accordingly further decline in light of the presence of suitable, competitively-priced alternatives for home use. Such a transition will be gradual and the accompanying cost implications for consumers would be largely insignificant.

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[32] Note that our research suggests that moth repellent products based on 1,4 dichlorobenzene may still be available on the market in the EU.

Option 4: Weight Restriction

It is not expected that the weight limit prescribed under this policy option would significantly affect the effectiveness of the products (i.e. their longevity). The reduction in weight could reduce the retail price of 1,4 dichlorobenzene-based air fresheners and toilet blocks but would also reduce the longevity of the products (hence, consumers might have to replace them more often). We would expect that the overall impact on consumers would be very small.

Option 5: Prohibition of Sales to the Public

As discussed in Section 2 to this impact assessment, we assume that the domestic market for 1,4 dichlorobenzene-based air fresheners has a size of 83 t/y while the domestic market for toilet rim blocks has a size of 17 t/y. We have also shown in Section 2 that a typical 1,4 dichlorobenzene-based air freshener weighs 80 g while a toilet rim block weighs 70 g. Therefore, we can calculate the following:

Table 5.2: Assumptions on Number of Products Sold Annually in the EU

Product	**Size of consumer market (t/y)**	**Weight per unit (g)**	**Number of units sold per year (approx.)**
Air fresheners	83	80	1,000,000
Toilet rim blocks	17	70	240,000

Section A5.5 provides an overview of the costs of alternative products. Considering the suggestion of product manufacturer that 1,4 dichlorobenzene-based air fresheners of a typical size may retail at a cost of €2 per air freshener and €1.50 per toilet rim block, it is evident that there are alternative products that may be either less or more costly than 1,4 dichlorobenzene-based ones.

Table 5.3: Assumed Costs/Savings for EU Consumers from the Use of Alternative Air Fresheners and Toilet Rim Blocks				
Product	**Number of units sold per year**	**Type of alternative product**	**Additional cost of alternative (€/unit)**	**Total additional cost for EU consumers**
Air freshener	1,000,000	Bottom of range aerosol (300 ml)	-€ 1.67	-€ 1,670,000
		Bottom of range gel	-€ 1.57	-€ 1,570,000
		Average aerosol (300 ml)	-€ 0.33	-€ 330,000
		Average gel	-€ 0.07	-€ 70,000
		Average wick in liquid	€ 0.28	€ 280,000
		Average plug-in unit	€ 6.74	€ 6,740,000
		Average automatic aerosol unit	€ 9.85	€ 9,850,000
Toilet rim block	240,000	Bottom of range cistern block	-€ 1.32	-€ 316,800
		Bottom of range solid in cage rim block	-€ 1.27	-€ 304,800
		In-bowl block	-€ 1.19	-€ 285,600
		Average solid in cage rim block	-€ 1.06	-€ 254,400
		Adhesive in-bowl disc	-€ 0.93	-€ 223,200
		Average cistern block	-€ 0.84	-€ 201,600
		Average liquid block	€ 0.11	€ 26,400
		Average solid with gel rim block	€ 0.88	€ 211,200
Note: prices for "average" products have been calculated by adding the prices of the most and least costly products in each category and dividing by two				

Table 5.3 shows our calculations on the range of costs or savings for EU consumers from the use of alternative products at home. To interpret the results of these calculations, please note the following:

- the table presents the relative cost of "bottom of range" products, i.e. products that are the cheapest available on the market – arguably, cost-driven consumers are likely to replace inexpensive 1,4 dichlorobenzene-based products with similarly inexpensive alternative products;
- we also assume that the 'direct' competitors to 1,4 dichlorobenzene-based air fresheners and toilet rim blocks are solid (gel) air fresheners and solid rim blocks and this would be likely to lead consumers to opt for these products following a prohibition on the sale of 1,4 dichlorobenzene-based products in the EU;
- however, we would not expect all consumers to replace an 1,4 dichlorobenzene-based products with the same type of product and therefore, we will not be able to place a single figure on the overall cost of substitution;
- the table does not account for the potential differences in longevity of different products. This is done for simplicity but the issue of longevity should not be disregarded. An aerosol spray will not be used in the same way as a 1,4 dichlorobenzene-based air freshener: it will only be used 'on demand' (while the 1,4 dichlorobenzene-based products is constantly active). This could prolong the lifetime of the alternative making it overall less costly to use. Similarly, the lifetime of a toilet rim block (or even a in-cistern block) will depend on the number of flushes in a household toilet – on the other hand, a 1,4 dichlorobenzene-based block is constantly active and its function is not influenced by the flushing of the toilet (1,4 dichlorobenzene is not water soluble);
- also for simplicity, we disregard the different sizes of products – we assume that the impact of size is largely reflected in the price of different products; and
- we assume that the prices which were collected from a very large retailer (based in the UK but with presence in several EU Member States apply to the whole of the EU.

Overall, we may conclude the following:

- for **air fresheners**, there are more types of alternatives that are on average more costly per unit than types that are on average less costly than 1,4 dichlorobenzene-based air fresheners. There are products that are particularly more expensive than 1,4 dichlorobenzene-based air fresheners but these are very modern, sophisticated products (automatic aerosol or plug-in units), the refills for which subsequently become less costly than the original unit. We believe it would be more realistic to assume that current users of 1,4 dichlorobenzene-based air fresheners will opt for less sophisticated products such as gels, aerosol sprays or wick in liquid products. It is also worth noting that 1,4 dichlorobenzene-based air fresheners may predominantly (but not exclusively) be used in bathrooms. It is far more likely for consumers to use an expensive plug-in air freshener in a bedroom or living room rather than in the bathroom/toilet;

- for these realistic alternative products, some inexpensive ones could result in overall savings for EU consumers (up to a theoretical maximum of ca. €1.67 million when inexpensive aerosol sprays are purchased). For products of somewhat higher quality, the overall cost for EU consumers per year could reach ca. €0.3 million (for wick in liquid products). Evidently, the EU-wide cost associated with replacing 1,4 dichlorobenzene-based products would be modest but not insignificant;
- for **toilet rim blocks**, the majority of alternative products that have been identified are on average less costly than 1,4 dichlorobenzene-based toilet rim blocks. Only some modern sophisticated products (effectively, multi-compartment rim blocks with gel deodorisers accompanied solid blocks) appear to be more costly per unit; and
- given the small assumed number of toilet rim blocks used by private consumers each year, the savings or costs that could be realised for EU consumers from replacing 1,4 dichlorobenzene-based rim blocks with a variety of alternatives would be very low (up to a theoretical maximum of ca. €0.32 million). When the most expensive alternatives are used, the absolute maximum additional cost for consumers would be €0.21 million.

In conclusion, the use of alternative products should not result in considerable additional cost for EU consumers either when air fresheners or toilet rim blocks are considered. This conclusion is based on a simplified comparison of retail costs per unit which does not take into consideration the potential differences in lifetime and deodorising (odour-masking) effectiveness of the different products. It is assumed that in a typical household and with an average level of hygiene, alternative products are generally able to mask the typical malodours that may arise.

It should be noted that prices of 1,4 dichlorobenzene-based products do vary (for instance, depending on weight or depending on brands). We do not have information on whether imported products are less or more costly than products made in the EU. In any case, it is clear that there are alternative products which are less costly than 1,4 dichlorobenzene-based products as well as alternative products that are more costly.

5.2.8 Specific Regions or Sectors

All policy options: indications exist that 1,4 dichlorobenzene-based products are particularly popular in Southern and possibly Eastern EU Member States, where, due to the higher temperatures, public toilets may face a more severe malodour problem. Due to the lack of country-specific information and of data of the destinations of products imported from non-EU countries, we cannot conclusively confirm whether this assertion is correct. Assuming that it is correct, it would mean that impacts could be concentrated on consumers in these Member States and manufacturers and suppliers serving these particular markets.

5.2.9 Third Countries and International Relations

All policy options: no large-scale effect on the trade between the EU and third countries is expected, although Option 5 which introduces a restriction would apply to the relevant products imported from third countries and placed on the EU market. The EU market for these products is generally considered to be small; hence, the impacts on individual non-EU companies will be modest.

5.3 Social Impacts: Assessment of Impacts from Policy Options

5.3.1 Employment and Labour Markets

Option 1: Business as Usual

With regard to Option 1, no significant impacts for stakeholders are expected in the future. The requirements of REACH could force changes in the market, especially for smaller players, but any effects on employment are likely to be very small due to the apparently small size of the market and the time companies will have available for adapting their production to future changes.

Option 4: Weight Restriction

Given the small markets under consideration and the very limited cost implications for manufacturers of air fresheners and toilet blocks from this policy option, employment impacts would be unlikely to be significant.

Option 5: Prohibition of Sales to the Public

Given the limited consumer consumption of air fresheners and toilet rim blocks, the overall impact to EU employment would be small. However, it is possible that for a small number of manufacturers based in or serving the consumer markets in Southern and Eastern EU, the impacts might be more significant and disproportionate in comparison to their competitors across the rest of the EU due to their significant sales to private consumers. For instance, one manufacturer of 1,4 dichlorobenzene-based air fresheners and toilet blocks suggested that a restriction on consumer uses with immediate effect could mean that four employees might have to be laid off.

5.3.2 Standards and Rights Related to Job Quality

All policy options: this impact category is of no relevance to the discussion of restricting the consumer use of 1,4 dichlorobenzene-based air fresheners and toilet blocks. Any benefits to workers' health from a restriction on the substance will be very small, given the small markets under consideration.

5.3.3 Social Inclusion and Protection of Particular Groups

All policy options: the EU RAR has not identified any particular vulnerable groups for which exposure to 1,4 dichlorobenzene may have particularly adverse effects, although it should be reasonable to expect that population groups who spend longer hours at home (older citizens, children, etc.) may be more exposed to 1,4 dichlorobenzene vapours where the relevant products are used.

5.3.4 Public Health and Safety

Option 1: Business as Usual

We cannot provide a monetised estimate of the cost of human health effects arising among consumers through exposure to 1,4 dichlorobenzene vapours at home. The EU RAR, however, has shown that risks to consumers are unacceptable.

We may also estimate the likely number of consumers that may be exposed to vapours of 1,4 dichlorobenzene at home as a result of the use of air fresheners and/or toilet rim blocks that are based on the substance. Table 5.2 shows the estimated number of products used I the EU per year. If we assume that each of these products lasts for ca. one month and that is duly replaced by a similar one once it is depleted, then division of the number of units by 12 would give ca. 833,000 users of air fresheners and 20,000 users of toilet rim blocks in the EU. We could further make an assumption on the average size of a household in the EU. Eurostat data for 2005 on the number of households and the total population in the EU suggest an average household size of 2.54 persons. Therefore, a total of 2.1 million people might be exposed to 1,4 dichlorobenzene through air fresheners and 50,000 might be exposed through toilet rim blocks. Some of these people may be exposed through both types of products. These numbers should not be assumed to represent that number of consumers that are at risk as the level of exposure is dependent on several parameters (for instance, ventilation and temperature).

This however needs to be placed in a more contemporary context, as discussed in Section 2.1.3. Recent developments in the legislative field (new classification, developments with the Biocidal Products Directive, etc.) as well as changes in the market (emergence of applications for liquid 1,4 dichlorobenzene – outside the EU – as the major use of 1,4 dichlorobenzene) have changed the patterns of use of the substance and consequently the scale of consumer exposure at home. Our assumptions on the size of consumer markets further reinforce the view that use of 1,4 dichlorobenzene-based products at home is far less widespread than what was presumably assumed in the EU RAR.

We believe that the use of the substance in air fresheners and toilet rim blocks by consumers in the EU will further decline; therefore, consumer exposure at home will decrease further in the future.

Option 4: Weight Restriction

The aim of this policy is to reduce consumer exposure at home while maintaining the effectiveness of the products in question. We cannot be certain of the degree to which exposure will be reduced, however some reduction should be realised as the size of the typical 1,4 dichlorobenzene-based air fresheners and toilet rim blocks is assumed to be 80 and 70 g respectively. Notably, exposure to 1,4 dichlorobenzene is further influenced by parameters such as ventilation, temperature and room volume, therefore, a weight restriction may not necessarily deliver the required exposure reduction.

Option 5: Prohibition of Sales to the Public

This option will eliminate any possible risks associated with the use of air fresheners and toilet rim blocks at home. This option will not have a material effect to the exposure of the public to 1,4 dichlorobenzene in public toilet rooms. We are unable to monetise the benefits that would accrue from this policy option; however, given the limited usage of the substance at home, any such benefits would be modest across the EU and would be concentrated to households in Southern and Eastern EU Member States.

Annex 5 discusses the human health effects of components of alternative products and concludes that exposure to components of alternative products appear not to pose appreciable risks to human health and the concentrations at which these components are used are normally much lower than the typical concentrations of 1,4 dichlorobenzene in its products. The following box summarises the findings for a selection of key components of alternative products.

Box 5.1: Summary of Human Health Hazards of Selected Components of Alternative Room Air Freshener and Urinal Block Formulations

Fragrances: seven fragrances have been looked at. All seven have potential irritant properties and, with the exception of pin-2(10)-ene, all are potential sensitisers but the available data suggest the fragrances are present at no more than 5% so human exposure to high levels of these substances from these sources is considered highly unlikely.

Surfactants: because of the potentially quite high levels of inclusion and inherent physicochemical properties of surfactants, the risks associated with these substances warrant consideration. In the case of **sodium dodecylbenzene sulphonate**, consumer exposure from all direct and indirect skin contacts as well as from inhalation and from oral route in drinking water and dishware from all consumer sources has been estimated at 4.0 µg/kg bw/day (HERA, 2009a & b) and compared with an established systemic NOAEL of 680 mg/kg/day for the parent chemical class, the linear alkylbenzene sulphonates (LASs) the margin of exposure (MOE) has been estimated to be at least 17,000. The **alcohol ethoxylates (AEs)**, which include the C12-18 ethoxylated alcohols specifically considered here, are also of low concern with regard to human and environmental risks, with PEC:PNEC ratios below 1 (HERA, 2009c). Sodium lauryl ether sulphate has little specific data but belongs to a class of substances the **alcohol ethoxysulphates (AESs)** that have been well characterised and for which aggregate consumer exposure is estimated to be 29 µg/kg bw/day. Compared with the identified critical systemic NOAEL of 75 mg/kg/day, this would suggest a MOE for AESs of 2586 (HERA 2003).

Preservatives: the preservative 1,2-benzotiazoline-3(2H)-one is classified as potentially harmful to humans with any concerns relating to skin and eye irritancy and skin sensitisation. Given that it is included in the alternative products considered in only very small amounts (0.01-0.02%), use in these applications are unlikely to constitute a significant risk.

Dyes: very little information has been identified on the dye CI21095 other than it has very low mammalian acute toxicity.

Complexing agents: citric acid, monohydrate also rapidly dissociates into ions in the presence of water and, given that citric acid plays a vital role as an intermediate in Kreb's cycle metabolism in eukaryotes, its presence in the alternative articles is considered of little human concern (HERA, 2005b).

Solvents: the main routes of human exposure to the solvent ethanol are ingestion (of alcoholic beverages) and inhalation of vapour; dermal absorption is limited. The risk to humans from ethanol has been considered by many authoritative bodies (e.g. ACGIH, 2000; IARC, 1985, 1987, 1988 & Baan *et al*, 2007) and it is the subject of proposals to the EC for reclassification and labelling by the French Institut National de Recherche et de Sécurité pour la Prévention des Accidents du Travail et des Maladies Professionnelles (CEC, 2006). Concerns have been expressed on the risk to humans from occupational or consumer exposures but it has been suggested that there is little basis to suppose exposure at or below current OELs (500 ppm or greater in many EU countries) is associated with an appreciable increase in cancer risk (Bevan *et al*, 2009).

Thickeners: xanthan gum is of low health and environmental concern being generally regarded as safe (Oxford University, 2003b; FDA, 2009) while coconut oil monoethanolamine, although possibly showing irritant potential, is not a sensitiser and has low mammalian toxicity (NOAEL 750 - 1500 mg/kg/day in rats).

Builders: unlike many of the above, the builder sodium carbonate may be present in considerable quantities (>40%) in some alternative articles. However, it is on the 'GRAS' (Generally Recognised As Safe) for food in the USA, has low acute toxicity, is not considered geno- or repro-toxic. Any concerns therefore would focus on irritant (but not sensitisation) responses from contact, but the exposures that would arise from consumer uses are considered too low for such local effects to arise (HERA, 2005).

Anti-caking agents: there is similarly little concern with regard to the anti-caking-agent sodium sulphate. Consumer exposure from use in detergents is estimated at 0.1 mg/kg/day (compared to normal daily intake from all anthropogenic and natural sources of 7.5 mg/kg) suggesting exposures from the applications considered here would be inconsequential.

Stabilisers: benzyl salicylate is widely used in a range of other consumer products with an estimated adult exposure from its use in soaps of 0.45 µg/kg bodyweight/day (Danish Environmental Protection Agency, 2006). The principal human health concern for this substance is its sensitising potential, which available experimental data suggest may be weak. As it is used in only small amounts (<5%) in alternative air freshener and toilet block products, these sources are unlikely to be of concern.

5.4 Environmental Impacts: Assessment of Impacts from Policy Options

5.4.1 Air, Soil, Water Quality and Resources

Option 1: Business as Usual

1,4 dichlorobenzene is a VOC substance that is used in particularly high concentrations in its products. On the other hand, its use should not have a discernible impact on water quality, given its low solubility in water.

Option 4: Weight Restriction

We do not believe that a restriction on the weight of the relevant products would critically change the patterns of atmospheric releases, water losses or water consumption.

Option 5: Prohibition of Sales to the Public

Given the limited use of 1,4 dichlorobenzene-based room air fresheners and toilet rim blocks at home, no significant changes to the baseline are expected. With regard to the potential environmental hazards and risks from alternative air freshener and toilet rim block formulations, the information available for the range of components of alternatives indicates that alternative products should not result in an overall increase to the risks posed to the environment. One of the key drivers of limited impacts is that many of the components of alternative formulations are present at low concentrations, unlike 1,4 dichlorobenzene which is present at concentrations above 98% in air fresheners and toilet rim blocks. It should be noted however that 1,4 dichlorobenzene does not end up in waste water due to its poor water solubility. Alternatives tend to be water-soluble and whilst their components may individually not pose a risk to the aquatic environment, some of these substances will end up in waste water. Also, some components of alternatives may be VOCs with an ozone depletion potential higher than that of 1,4 dichlorobenzene. However, their concentration in alternative formulations is likely to be much lower than the typical concentration of 1,4 dichlorobenzene in its products.

More detail on the comparison of hazard profiles of 1,4 dichlorobenzene and of selected components of alternatives is given in Annex 5. Box 5.2 presents a short summary of the results of the assessment of environmental hazards for the selected components of alternative formulations.

Box 5.2: Summary of Environmental Hazards of Selected Components of Alternative Room Air Freshener and Urinal Block Formulations

Fragrances: while the environmental toxicity data available on the fragrances is limited, only α-hexyl cinnamaldehyde has been suggested as possibly moderately bioaccumulative and of quite high acute toxicity to aquatic species (EPA, 2009b) and four others (citronellol, d-limonene, 2,4-dimethyl-3-cyclohexene-1-carboxaldehyde and pin-2(10)-ene) are classified as dangerous to the aquatic environment. However, most are readily metabolisable in various organisms and, particularly given their low inclusion levels, the uses considered here are considered unlikely to pose a significant risk.

Surfactants: for linear alkylbenzene sulphonates (LASs), a detailed environmental risk characterisation has suggested that PEC:PNEC ratios were below 1 for all environmental compartments (HERA, 2009b). The alcohol ethoxylates (AEs), which include the C12-18 ethoxylated alcohols specifically considered in Annex 6, are also of low concern with regard to environmental risks, with PEC:PNEC ratios below 1 (HERA, 2009c). Sodium lauryl ether sulphate has little specific data but belongs to a class of substances the alcohol ethoxysulphates (AESs) for which environmental risk characterization (PEC:PNEC) ratios are less than 1 (HERA, 2009d).

Preservatives: the preservative 1,2-benzotiazoline-3(2H)-one is classified as potentially harmful to humans and the environment. QSAR calculations have suggested that it is probably aerobically degradable and has low bioaccumulation potential in aquatic organisms (Madson *et al*, 2000) and it was not prioritised by Environment Canada in their Domestic Substances List (Environment Canada, 2007) therefore, given that it is included in the alternative products considered in only very small amounts (0.01-0.02%), use in these applications are unlikely to constitute a significant risk.

Dyes: very little information has been identified on the dye CI21095. Its environmental toxicity has recently been considered by a European expert committee, which concluded that it did not meet the B (or vB) or T criteria but was likely to meet the P (and vP) criteria in order to meet its technical specification. However, it was concluded to be neither PBT nor vPvB (ECB, 2005).

Complexing agents: citric acid, monohydrate also rapidly dissociates into ions in the presence of water and, given that citric acid plays a vital role as an intermediate in Kreb's cycle metabolism in eukaryotes, its presence in the alternative articles is considered of little human or environmental concern (HERA, 2005b).

Solvents: for ethanol, on release into the environment it distributes mainly to air and water and, while stable to hydrolysis, it is readily biodegraded. It has a tropospheric half life of 10-36 hours and is unlikely to bioaccumulate suggesting little cause for concern.

Thickeners: xanthan gum is of low environmental concern being generally regarded as safe (Oxford University, 2003b; FDA, 2009) while coconut oil monoethanolamine, with an estimated log Pow value >4 it might be considered potentially bioaccumulative but is only 'toxic' to 'moderately toxic' to aquatic organisms and is considered unlikely to be considered a PBT. A PNEC of 0.23 µg/L has been estimated for a closely-related substance cocamide DEA which would equate to a MOE of 427.1 based on estimates of its PEC (Danish Environmental Protection Agency, 2006). Given that cocamide DEA appears slightly more toxic than the monoethanolamine, it is likely that the MOE for coconut oil monoethanolamine would also prove adequate.

Builders: sodium carbonate dissociates into its component ions readily in the presence of water. HERA (2005b) has established that its use in detergents poses no significant risk to the aquatic ecosystem.

Anti-caking agents: There is similarly little concern with regard to the anti-caking-agent sodium sulphate, which is widely distributed in nature, occurs in almost all fresh and salt waters, and is a normal constituent of natural foodstuffs. It has low aquatic toxicity and enters the sulphur cycle and so is not considered a major environmental hazard although it has been suggested that local peak concentrations may be greater than the PNEC of 1.9 mg/L and could therefore conceivably damage un-adapted flora and fauna (HERA, 2006).

Stabilisers: benzyl salicylate is widely used in a range of other consumer products. As it is used in only small amounts (<5%) in alternative air freshener and toilet block products, these sources are unlikely to be of concern. However, predicted BCF values are 547.7 - 652.47 (depending on pH) and little ecotoxicity data were identified, so it is not possible to adequately assess the risk posed to the environment at this time.

5.4.2 The Environmental Consequences of Firms and Consumers

All policy options: given the limited use of 1,4 dichlorobenzene-based air fresheners and toilet rim blocks at home, the environmental consequences of consumers should be considered to be low and any policy option taken forward is not expected to change this.

5.4.3 Waste Production/generation/recycling

All policy options: 1,4 dichlorobenzene-based products have packaging which needs to be removed before they are hung on a wall or on the rim of a toilet seat. They also tend to be contained in carton boxes or be hung inside a plastic container or with a wire hook. Similarly, alternative products have packaging and could be contained in a plastic container, a glass bowl (pot pourri) or even be found inside an electrical appliance (for automatic sprayers) which will ideally be refilled and used for a long time. Automatic sprayers may be plugged on the wall or potentially contain batteries.

Overall, it is likely that the use of some alternatives may result in higher waste arisings. However, such waste arisings cannot be considered as significant in a wider context given that:

- the EU consumer market for 1,4 dichlorobenzene-based products is significantly smaller than the overall EU consumer markets for air fresheners and toilet blocks (see Table 2.16); and

- the overall waste arisings in the EU are around 2.9 billion tonnes in 2006, as shown by Eurostat[33]. A recent report for DG Environment (Bio Intelligence Service, 2009) suggests that household waste accounts for ca. 7% of all waste generated in the EU, i.e. 210 million tones per year. A very quick calculation we can make is that, 1.24 million 1,4 dichlorobenzene-based products are sold in the EU each year (see Table 5.2). If these are replaced by an equal number of alternative products and that each alternative product produces, on average, 50 grams of additional waste, then the additional waste arisings would be 1,240,000 x 50 = 62,000,000 grams or 62 tonnes per year. The comparison of this figure to the overall household waste generated suggests that policy options taken with regard to 1,4 dichlorobenzene-based products would have an insignificant effect on the overall waste arisings in the EU.

5.5 Uncertainties and Changes over Time for Policy Options

Option 1: Business as Usual

The key sources of uncertainties in our analysis include:

- the size of the markets for 1,4 dichlorobenzene-based products – our estimates are based on the contributions of a small number of consultees (and associated extrapolations). Input from consultees active in the Southern EU consumer markets has been particularly scant;
- the percentage of the total EU market for these products that are used by private consumers at home;
- the role of imports (and exports) in the functioning and the size of the markets for the substance itself and for 1,4 dichlorobenzene-based products; and
- the future development of the markets for 1,4 dichlorobenzene-based products – we have assumed that these will further decline and that such decline will be speedier for room air fresheners, however, the pace of decline cannot be estimated with accuracy.

Option 4: Weight Restriction

The key sources of uncertainty in our analysis include:

- the same uncertainties described above for Option 1;
- we believe that a 50 g weight limit would still allow air fresheners and toilet rim blocks to be effective in masking malodours but we cannot be sure how much shorter the lifetime of these products would become or how less costly the products would become;

33 Data available here: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasgen&lang=en

- there is uncertainty regarding the level of protection that consumers would be afforded at home from the restriction on weight in comparison to the current situation, especially since exposure is also dependent on temperature, ventilation and room volume.

Option 5: Prohibition of Sales to the Public

The key source of uncertainty in our analysis includes the extent to which air fresheners and toilet rim blocks based on 1,4 dichlorobenzene are used by EU consumers – we have assumed that the relevant consumer markets in the EU are generally small (but could be more prominent in Southern and Eastern EU Member States). Also, the information on the EU RAR does not allow us to monetise the benefits to consumer health that would accrue from a restriction on the substance for consumer uses.

5.6 Obstacles to Compliance

Option 1: Business as Usual

Not relevant for this option.

Option 4: Weight Restriction

No significant obstacles to compliance for EU-based manufacturers of 1,4 dichlorobenzene-based air fresheners and toilet rim blocks could be envisaged. On the other hand, imports of 1,4 dichlorobenzene-based products would be more difficult to control.

Option 5: Prohibition of Sales to the Public

An issue that may arise is the fact that nowadays household products may be sold not only on high street stores or smaller corner shops but also on the Internet. Controlling the products available to consumers through Internet vendors is particularly difficult. For instance, in the course of this study, we identified moth ball products being sold on well-known Internet stores and online auction sites which are promoted as 'traditional moth balls' and could in theory be made of 1,4 dichlorobenzene (or perhaps naphthalene both of which can no longer be used in moth repellents in accordance with the provisions of the Biocidal Products Directive).

6. COMPARING THE OPTIONS

6.1 Comparison of Advantages and Drawbacks of Policy Options

As we have looked at the same policy options for both air fresheners and toilet blocks, we will compare the advantages and drawbacks of policy option for both applications together.

Table 6.1 summarises the key advantages and drawbacks of the three relevant policy options assessed in Section 5.

Table 6.1: Advantages and Drawbacks of Policy Options for 1,4 Dichlorobenzene-based Air Fresheners

Policy Option	Key advantages	Key drawbacks
Option 1: BAU	• Maintenance of status quo • There is a general trend towards replacement of 1,4 dichlorobenzene-based air fresheners and toilet blocks anyway – variety of modern alternatives available, some at a lower cost than 1,4 dichlorobenzene-based air fresheners and toilet blocks • Home use is currently small and more significant, traditional uses (moth balls) have now been discontinued thus reducing exposure of private consumers at home • Avoidance of any adverse effects to EU manufacturers of the substance and of manufacturers of products	• Continued exposure of consumers at home – but should be lower than what it could have been when EU RAR undertaken • Consumer exposure may particularly arise in Southern and Eastern EU Member States where, due to the weather, 1,4 dichlorobenzene-based products may be more popular (but may also sublime faster due to higher temperatures) • No 100% certainty that consumer uses will eventually cease voluntarily
Option 4: Weight restriction	• Relatively easy to implement by manufacturers of products • No significant impacts on manufacturers of the substance would be expected • Could reduce consumer exposure at home as larger products are currently available on the market • 50 g air fresheners and toilet blocks are expected to generally be effective when used at home (i.e. in reasonably small spaces) • No real knock-on effects on the professional users market would arise	• Does not provide a guarantee that exposure or private consumers at home would be adequately controlled as this also depends on temperature, ventilation and room volume • Could create difficulties for manufacturers of products who sell to both professional users and private consumers as they would need to cater for different sizes depending on end-user

Table 6.1: Advantages and Drawbacks of Policy Options for 1,4 Dichlorobenzene-based Air Fresheners		
Policy Option	**Key advantages**	**Key drawbacks**
Option 5: Prohibition of sales to the public	• Would eliminate consumer exposure to 1,4 dichlorobenzene vapour at home • Hazard profile of alternatives appears to be favourable compared to 1,4 dichlorobenzene-based products (mainly due to much lower concentrations of individual ingredients compared to 1,4 dichlorobenzene) • Wide consumer choice of alternatives is available – some alternatives may be less costly than 1,4 dichlorobenzene-based air fresheners and toilet blocks • Alternatives are expected to be effective for the masking of usual malodours at home • The small market size of consumer uses could potentially keep the costs to industry stakeholders low	• Due to limited consumer use, exposure of private consumers at home is limited and consumption is expected to further decline in the future without the need for regulation • Policy option does not address exposure in public toilet rooms where use of 1,4 dichlorobenzene-based products is more likely to continue into the future • Certain manufacturers of air fresheners and toilet blocks could be seriously impacted (including their levels of employment) - the number of companies that may face such costs is likely to be small but impacts may be disproportionately large for companies which serve the Southern and Eastern EU markets • If flaking of the substance in the EU were to be impacted, impacts would spread far beyond those companies selling products to consumers such as manufacturers and importers of the substance, as well as professional users

6.2 Comparison of Effectiveness, Efficiency and Coherence of Policy Options

Table 6.2 summarises the comparison of the selected policy options against the key criteria of effectiveness, efficiency and coherence.

Table 6.2: Advantages and Drawbacks of Policy Options for 1,4 Dichlorobenzene-based Air Fresheners			
Policy Option	**Effectiveness**	**Efficiency**	**Coherence**
Option 1: BAU	• Would not address risks to consumers from the use of 1,4 dichlorobenzene-based air fresheners and toilet blocks at home • Exposure at home, however, has significantly decreased in recent years	No additional resources needed – alternative products are available for private consumers and are gradually replacing 1,4 dichlorobenzene-based products	• Incompatible with results of EU RAR • Not consistent with existing EU legislation with effectively prevents 1,4 dichlorobenzene-based moth balls from being placed on the market (these act in the same manner as air fresheners and toilet blocks)
Option 4: Weight restriction	• Could be effective at reducing exposure where larger products are currently used • But it is not clear what proportion of the consumer markets is represented by products of a weight above 50 g • It is not possible to estimate the extent to which this measure might reduce exposure of consumers	• 50 g air fresheners and toilet blocks would still be effective and no significant impacts for consumers would arise – 1,4 dichlorobenzene-based products might last a shorter period but would also be less costly than before • No significant impacts for manufacturers of the substance, as the relevant markets are small • Cost to manufacturers of air fresheners and toilet rim blocks would be negligible (even if conditions were to be set on the dimensions of the products, a modest cost of €3,000-15,000 per pressing machine would arise) • This policy option might also introduce some unnecessary administrative burden for public authorities by enforcing requirements which are disproportionate to the size and importance of the relevant markets in the EU	• It is not known whether such a size limit may apply to similar products on the market, hence the coherence of this option with existing measures cannot be assessed • It would perhaps introduce an additional complexity which may not be proportionate to the relatively small market for the relevant products in the EU

Table 6.2: Advantages and Drawbacks of Policy Options for 1,4 Dichlorobenzene-based Air Fresheners

Policy Option	Effectiveness	Efficiency	Coherence
Option 5: Prohibition of sales to the public	• Would eliminate consumer risks at home (but would not affect exposure of consumers in public toilet rooms) • The key components of alternative formulations appear to have a favourable hazard profile, partly due to their being used at concentrations much lower than the concentration of 1,4 dichlorobenzene in its own products	We assume that consumer uses account for 83 tonnes of dichlorobenzene-based air fresheners and 17 tonnes of 1,4 dichlorobenzene-based toilet blocks in the EU. Possible impacts: • **manufacturers of the substance**: the loss of this market would represent 12.5% of the estimated sales of substance in the EU with an associated turnover of up to €0.3 million/year. If flaking of the substance became uneconomical, all sales of the substance by EU manufacturers would be impacted also affecting the production of 1,2 dichlorobenzene and the global competitiveness of companies • **manufacturers of products**: the lost turnover for manufacturers of 1,4 dichlorobenzene-based products would be €2 million for air fresheners and €0.36 million for toilet blocks. This however could partly be balanced by new/additional sales of alternative products. For specific companies with a significant portion of their turnover associated with the private consumer markets (in Southern and possibly Eastern Europe), impacts could be more significant and could mainly include (a) costs of decommissioning existing machinery and disruption of a company's investment cycle, (b) costs of new machinery estimated at €80,000 per machine, (c) production downtime estimated at 20-25 days with an assumed cost of just above €30,000, (d) staff training costs, (e) costs of numerous new materials (assumed by one company to be €50,000) and of other inputs (due to the longer production processes required), and (f) marketing costs. Employment in a small number of companies might also be affected by a restriction in the short-term • **private consumers**: alternative products are widely available. The purchase of alternative products could lead to an additional EU-wide cost of: (a) -€1.7 million to €10 million per year for alternative air fresheners – replacement with an average gel product could come at no overall additional cost; (b) -€0.32 million to €0.21 million per year for alternative toilet blocks – replacement with widely available liquid rim blocks could come at minimal overall cost • **professional users**: they would be impacted if flaking of the substance were to be discontinued • **manufacturers of alternatives**: limited benefits envisaged due to the small size of consumer markets. Larger benefits could be possible if flaking of 1,4 dichlorobenzene was impacted, but still very small benefits for individual manufacturers of alternatives might arise. Some of these companies may now sell 1,4 dichlorobenzene-based products • **non-EU manufacturers of 1,2 dichlorobenzene**: if a restriction on consumer uses of 1,4 dichlorobenzene-based air fresheners and toilet rim blocks in the EU resulting in impacts on the EU production of 1,2 dichlorobenzene and adverse effects on the competitiveness of EU manufacturers, it would consequently be expected that their non-EU competitors would benefit. The scale of this benefit cannot be quantified	• Compatible with results of EU RAR and with current EU legislation which prevents the marketing of 1,4 dichlorobenzene-based moth balls • Could result impacts on industry stakeholders disproportionate to the benefits accrued for consumer health

6.3 Preferred Policy Option

Our analysis can be summarised as follows:

- Option 1 is incompatible with the results of the EU RAR as it does not address the conclusion that use of 1,4 dichlorobenzene-based air fresheners and toilet blocks results in unacceptable risks to consumers. However, it is acknowledged that, in recent years, the use of these products has significantly declined and the current consumption by consumers is very modest. As we cannot ascertain the extent to which EU consumers are now adequately protected or not, a precautionary approach should be taken which would mean that this measure must be considered to be inappropriate;
- Option 4 could in theory reduce exposure of consumers at home while imposing a minimal cost on industry stakeholders, essentially manufacturers of air fresheners and toilet rim blocks. However, it is not entirely clear whether a real and sufficient reduction in consumer exposure would materialise. Given the lack of certainty on the extent of consumer health risk reduction that could be achieved, it is not possible to consider this option as appropriate;
- following form the above, Option 5 would be the only measure that could guarantee sufficient reduction in risks to consumers. Given the relatively small size of the EU market of consumer uses of these products and the wide availability of effective and competitively priced alternative products, the impacts on consumers would be limited. Impacts on industry however could potentially be significant. The most favourable scenario would be if only a small number of manufacturers of air fresheners and toilet blocks selling their products predominantly in Southern and Eastern EU Member States were to be affected (potentially seriously). On the other hand, if the loss of the consumer markets affected the viability of the flaking operations of the manufacturers of 1,4 dichlorobenzene, impacts on industry would be much more widespread and severe encompassing manufacturers of products for professional use as well as professional users themselves.

It is clear that only Option 5 can deliver reasonable certainty with regard to controlling exposure of consumers to 1,4 dichlorobenzene at home. However, its implementation could result in costs that might outweigh any benefits to consumer health. It is therefore recommended that such a restriction be introduced in a phased manner to allow for its impacts to be more gradually absorbed. A prolonged implementation would allow manufacturers of products to gradually remove 1,4 dichlorobenzene-based air fresheners and toilet blocks from the consumer market and adjust their production and processes to the new situation (thus also protecting the small number of jobs associated with the production of air fresheners and toilet rim blocks for consumer use). It would also help manufacturers of products located in the Southern and Eastern EU Member States to avoid an immediate severe impact from a restriction which could affect their competitiveness against competitors from other parts of the EU. Moreover, a prolonged implementation could allow the manufacturers of the substance to gradually scale down their flaking operations, prepare for any necessary decommissioning of flaking equipment and identify solutions for the impacts that may arise with regard to global sales of 1,4 dichlorobenzene (including the possibilities for incinerating excess material) and the effects of these changes to their production of the 1,2 dichlorobenzene isomer.

We have received suggestions from the EU-based manufacturers of the substance as well as from a manufacturer of products intended for consumer use at home. Two of these companies indicated that a 12-month period would probably be sufficient for them to adjust the manufacturing processes in order to mitigate the impacts from a restriction. The third company, which believes that impacts from a restriction could be severe, has suggested that 24 months would be required for refocusing their 1,4 dichlorobenzene-based operations.

We would therefore suggest that a 12-24 month delay in implementing a prohibition of sales to consumers be considered.

It should be noted that the suggestions for a delayed implementation of a restriction have been made by only three companies that would be directly affected by such a restriction and which we have identified, i.e. two EU-based manufacturers of 1,4 dichlorobenzene and a manufacturer of air fresheners and toilet rim blocks who sells his products to consumers for use at home. However, this should not be assumed to mean that there are only three companies which might be affected by a restriction. It is certain that there would be other affected companies in the EU that are not known to the study team as these were either not willing to make an input into the study or may not have been identified.

We cannot provide a specific quantified estimate on the impact on companies from a delayed restriction and compare this to the impact from a restriction with immediate effect, as we do not have the necessary information (the suggestions for a delay in implementation were received towards the end of this study). It is clear, however, that these three (and potentially other affected) companies would prefer to have additional time so that they are better prepared for an upcoming restriction, gradually shift production to other products or decommission production machinery. Generally, a delay in implementation might or might not reduce the scale of the impact; it would definitely however, allow costs to be spread over a longer period of time thus reducing the immediate cost pressures on the companies that would be affected.

6.4 Mitigating Measures for SMEs

As discussed in Section 5.2.3, many of the companies affected by the policy options considered are SMEs. SME manufacturers of 1,4 dichlorobenzene-based air fresheners and toilet blocks which are based in Southern and Eastern EU or perhaps serving the consumer markets in these parts of the EU could be particularly and perhaps disproportionately impacted. For instance, we have received information from one such company indicating that 70% of its air freshener and toilet rim block products are sold to private consumers. We believe it would be important to protect the competitiveness of these companies against other EU (and non-EU) manufacturers of such products who do not sell to the consumers. This is particularly important in light of the now limited use of the relevant products which implies that exposure of consumers at home may have considerably decreased in recent years. We have also been advised that previous regulatory interventions on the use of 1,4 dichlorobenzene in moth balls have caused significant adverse effects to many SME producers of moth balls.

Our proposal for a delayed implementation of a prohibition on consumer users would be an appropriate mitigating measure for SMEs that would likely be affected.

7. MONITORING AND EVALUATION

Restrictions upon marketing and use are generally simple and easy to monitor especially compared with policy options that may require users to alter their behaviour in specific ways.

A restriction on the marketing and use of 1,4 dichlorobenzene would be introduced as an amendment to the relevant entry in Annex XVII to the REACH Regulation. This entry was taken over from the relevant Annex to the now repealed Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on marketing and use of certain dangerous substances and preparations. That Directive established a framework to control and limit the risk of certain dangerous substances as such or contained in preparations during specific uses and applications. This legal instrument and its successor (the REACH Regulation) mean that Member States have put in place long-standing mechanisms and have nominated authorities to monitor compliance with the current restrictions. These same structures can be used to monitor compliance with the proposed restriction, which will therefore not create a significant administrative burden.

Although Annex XVII of REACH does not contain any mechanism or indicators for monitoring the progress achieved, a satisfactory level of feedback is obtained through cases registered by the poison centres, recommendations/complaints by the Member States and by industry. The Forum under REACH will be in charge of conducting such monitoring.

8. COMPARISON OF OBJECTIVES AND RESULTS

Table 8.1 presents a comparison between the objectives set out in the Study Specifications and our proposal for this study and the results of our analysis. The Tasks referred to in the table are those described in our proposal of 28 August 2009.

Table 8.1: Objectives of the Study and Results of Analysis

Objective/requirement described in study specification		**Description of result**	**Relevant part(s) of this report**
Task 1	Kick-off meeting	Kick-off meting held in Brussels on 15 October 2009	N/A
Task 2	Current EU markets for 1,4 dichlorobenzene-based toilet blocks and air fresheners	Great efforts were made in obtaining information from EU and non-EU manufacturers of the substance and of the products that contain it. The report has already described the difficulties in obtaining detailed and reliable information, especially with regard to the use of the substance in products intended for use by private consumers at home	Section 2.4
	Use of 1,4 dichlorobenzene in toilet blocks and air fresheners outside the EU	We have attempted to contact the relevant authorities in several non-EU countries. Information collected through consultation and literature review on the relevant markets in Australia, Canada, Japan, New Zealand and the USA is provided in this report	Annex 4
	Existing national restrictions on the use 1,4 dichlorobenzene in toilet blocks and air fresheners in the EU	Information was collected through consultation with national authorities and literature review. Detailed information on EU-wide measures has also been provided	Annex 2, Section A2.5
	Actions by third countries	Information was collected through consultation with national authorities and literature review	Annex 2, Section A2.6
	Alternatives to 1,4 dichlorobenzene in toilet blocks and air fresheners and their health and environmental hazard and risk profiles	Numerous Safety Data Sheets of alternative products have been consulted. Identified 'direct' alternative substances (i.e. fragrances) as well as other structural components and additives which may be present in alternative formulations. For a selected number of alternative substances, tables with a detailed human health and environmental hazard profile has been provided; these are based on extensive literature searches.	Annex 5
Task 3	Initial Consultation	Consultation was conducted throughout the undertaking of this impact assessment; however, very limited information was made available from stakeholders of direct relevance to consumer uses of the relevant products	Section 1.3
Task 4	Interim Report	Submitted to the European Commission on 1 March 2010	N/A

Table 8.1: Objectives of the Study and Results of Analysis

Objective/requirement described in study specification		**Description of result**	**Relevant part(s) of this report**
Task 5	Impact Assessment: A number of different policy options will be considered and evaluated, including at least the options: no action at Community level, voluntary action by industry, and a total ban	We took a holistic view and we considered the greatest possible range of policy options and means of implementation. The analysis of possible options resulted in a shortlist of options which were then assessed against the criteria of effectiveness, practicality and monitorability to identify those options to be taken forward to the impact assessment. These were three: business as usual, a weight restriction, and a prohibition of sales to the public	Section 4 and Section 5.1
	Impact Assessment: The criteria to evaluate each option and to compare them will be based on their effectiveness, efficiency, enforceability, and their coherence with other legislation	The said criteria were duly used in the assessment and comparison of options	Section 5.1 and Section 6
	Impact Assessment: A cost-benefit analysis will be performed for each option taking into account the effects on consumer health due to the inhalation exposure of 1,4 dichlorobenzene	It has not been possible to monetised the benefits to consumer health from the different policy options. Also, due to the limited size of the relevant markets and the reluctance of key stakeholders linked to the use of the relevant products by consumers at home, the assessment of the size of the consumer markets and the evaluation of the potential impacts on stakeholders from different policy options bears a considerable degree of uncertainty. Consultation with some industry stakeholders has helped us formulate a recommendation for regulatory intervention which would mitigate any adverse impacts that might arise for SMEs	Sections, 5.2, 5.3, and 5.4
	Impact Assessment: Social impacts (e.g. employment) and economic impacts will need to be evaluated and a specific analysis will need to be conducted for SMEs, if they would be affected by any of the policy options		
Task 6	Stakeholder Consultation	Consultation was conducted throughout the undertaking of this impact assessment; however, very limited information was made available from stakeholders of direct relevance to consumer uses of the relevant products	Section 1.3
Task 7	Final Reporting: The study should fulfil the requirement of the Commission impact assessment guidelines in terms of its content and format	The format prescribed in the Impact Assessment Guidelines 2009 has been duly followed	N/A
	Final Reporting: Report submission	The Final Report was submitted to the European Commission on 10 May 2010	N/A

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ANNEX 1

LIST OF CONSULTEES

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Name of Organisation	Country
Aarti Industries Limited	IN
Afalin	DE
Alter	CZ
Amity International	UK
Art Analitica	PL
Batleys	UK
Breckland Council	UK
Bunzl CHS	UK
Chaucer	UK
Cleenol Group Ltd	UK
Clorobencenos	MX
DACD	FR
DEB Ltd	UK
Dodge	UK
Dramers SA	PL
Dr Schnell	DE
Dubrava	CZ
Ecolab	BE
Ecoprod	UK
Eurochlor	EU
The European Consumers' Organisation	EU
European Federation of Cleaning Industries	EU
European Public Health Alliance	EU
European Trade Union Confederation	EU
Evans Vanodine International	UK
Formula Chemicals (N.S.W.) Pty Ltd	AU
GDS Produkter	SE
GKI International	CH
Hampshire County Council	UK
Healthmatic	UK
Henkel	DE
Holste	DE
Hygiatec	FR
Industrias Marca	ES

Name of Organisation	Country
Instituto Sindical de Trabajo, Ambiente e Saude	ES
International Association for Soaps, Detergents and Maintenance Products	EU
International Fragrance Association	INTL
Jakota Bohemia	CZ
James Briggs	UK
Jeyes	UK
Jinque	CN
Kinbester Co., Limited	CN
Kirklees Council	UK
KS Productions	CH
Kutch Chemical Industries Limited	IN
Laboratoires Rochex	FR
McBride Western Continental Europe	BE
North Norfolk District Council	UK
Oehme Lorito	DE
Okochem	CZ
ORO Produkte	DE
Pilacouris Trading Co Ltd	CY
Pireka	LV
Polhun	PL
Pro-Ren	DK
Recochem	CA
RE.LE.VI. SpA	IT
Redox	AU
Reinex	DE
Sara Lee	NL
Sky Chemicals	UK
Solutia	BE
Sønderstrup Sæbefabrik	DK
Spontex	FR
Staples Disposables Ltd	UK
Stuber AG	CH
Styl VD	CZ
Tarmann (Tarco)	AT
Tessenderlo BV	IT
Tiger Tim Products	UK

Name of Organisation	Country
Tomil	CZ
UK Cleaning and Support Services Association	UK
UK Cleaning Products Industry Association	UK
Ulrich Natuerlich	DE
Ultra Chemical Works	IN
Vandeputte SA	BE
Vencl	CZ
Villeroy & Boch	DE
Walde	AT
Werner & Mertz GmbH	AT
Winner Group International Ltd.	CN
WWF European Policy Office	EU
Yick Vic	CN
Zakłady Chemiczne Unia	PL

ANNEX 2

EXISTING LEGISLATION AND OTHER MEASURES

ANNEX 2. EXISTING LEGISLATION AND OTHER MEASURES

A2.1 EU-wide Legislation Relating to Human Exposure

A2.1.1 Directive 2000/30/EC – Indicative Occupational Exposure Limits

Commission Directive 2000/39/EC of 8 June 2000 establishes a first list of indicative occupational exposure limit values (OELs) in implementation of Council Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work. Among the substances for which indicative OELs were set was 1,4 dichlorobenzene.

Table A2.1: EU Indicative Occupational Exposure Limit Values for 1,4 Dichlorobenzene

Long-term 8-h TWA		Short-term 15-min STEL	
ppm *	**mg/m^3 ****	**ppm ***	**mg/m^3 ****
20	122	50	306

** parts per million by volume in air (ml/m^3)*
*** milligrams per cubic metre of air at 20 °C and 101.3 KPa*

A2.1.2 Directive 2002/72/EC – Plastic Materials and Articles for Contact with Foodstuffs

Commission Directive 2002/72/EC of 6 August 2002 applies to plastic materials and articles intended to come into contact with foodstuffs. The Directive specifies approved substances, monomers and other starting substances which may be used in the manufacture of plastic materials and articles (Annex II), and additives which may be used in the manufacture of plastic materials and articles (Annex III). This list is being converted into a Community positive list of authorised additives, with all others excluded.

1,4 dichlorobenzene can be found in Annex II under the List of Authorised Monomers and other Starting Substances and is accompanied by a specific migration limit (SML) of 12 mg/kg. Specific migration limits are set for substances for which the toxicological data make it necessary.

A2.1.3 Directive 2003/15/EC & Directive 2005/80/EC – Amendments to the Cosmetics Directive

In its opinion of September 2001 on "Chemical ingredients in cosmetic products classified as carcinogenic, mutagenic or toxic to reproduction according to the chemicals directive 67/548/EEC" SCCNFP/0474/01, final, the SCCNFP (now SCCP, the Scientific Committee on Consumer Products) considered (SCCP, 2005):

"*Substances classified according to Council Directive 67/548/EEC as carcinogens category 3, mutagens category 3, or toxic to reproduction category 3 and substances with similar potentials, must not be intentionally added to cosmetic products unless it can be demonstrated that their levels do not pose a threat to the health of the consumer.*"

Based on this opinion, the Council and the European Parliament Directive 2003/15/EC introduced in the Cosmetics Directive 76/768/EEC a new provision, namely Article 4b.

Article 4b of the Council Directive 76/768/EEC stipulates that "*the use in cosmetic products of substances classified as carcinogenic, mutagenic or toxic for reproduction, of category 1, 2 and 3, under Annex I to Directive 67/548/EEC shall be prohibited…A substance classified in category 3 may be used in cosmetics if the substance has been evaluated by the SCCNFP and found acceptable for use in cosmetic products*".

In order to implement that provision, the Commission, in accordance with Article 8, paragraph 2, of the Directive 76/768/EEC, has consulted the SCCNFP (SCCP). SCCP issued opinions SCCP/0888/05 and SCCP/0913/05 in March and June 2005 which led to a new amendment of the Cosmetics Directive with Directive 2005/80/EC.

Directive 2005/80/EC introduced 1,4 dichlorobenzene to Annex II of the Cosmetics Directive 76/768/EEC with an application date of 22 August 2006 (the date fixed by the Directive as from which Member States shall ensure that cosmetic products which fail to comply with the modifications are not placed on the market) and a withdrawal date of 22 November 2006 (the date fixed by the Directive as from which Member States shall ensure that cosmetic products which fail to comply with the modification are not sold or disposed of to the final consumer)[34].

A2.1.4 Decision 2007/565/EC – Non-inclusion of Biocidal Active Substances

Commission Decision 2007/565/EC concerns the non-inclusion in Annex I, IA or IB to Directive 98/8/EC on the placing of biocidal products on the market. 1,4 dichlorobenzene is among the substances listed in the Annex to the decision with regard to its use as a repellent or attractant. The result of its inclusion is that moth repellents based on 1,4 dichlorobenzene cannot be placed on the market in the EU.

A2.1.5 Regulation (EC) No 1272/2008 – Classification, Labelling and Packaging

The classification of the substance was established by Commission Directive 2004/73/EC of 29 April 2004[35] adapting to technical progress for the 29th time Council Directive 67/548/EEC on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances. Directive 67/548/EEC shall be replaced by Regulation (EC) No 1272/2008.

The table below presents the classification and labelling for the substance with regard to human health effects under both the old and new classification and labelling systems.

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34 Information available from the Cosmetics Ingredients & Substances Database http://ec.europa.eu/enterprise/cosmetics/cosing/index.cfm?fuseaction=search.details&id=29392.

35 OJ L 152, 30.4.2004, corrected by OJ L 216, 16.6.2004, p. 3.

Table A2.2: Overview of EU Human Health Classification and Labelling of 1,4 Dichlorobenzene

C&L System	Classification		Labelling		
67/548/EEC	Xi; R36 Carc. Cat. 3; R40		***Risk phrases***	***Safety phrases***	***Indications of danger***
			36 - 40	2 - 36/37 - 46	Xn
1272/2008	***Hazard class and category code(s)***	***Hazard statement code(s)***	***Pictogram, signal word code(s)***	***Hazard statement code(s)***	
	Carc. 2 Eye Irrit. 2	H351 H319	GHS08 GHS09	H351 H319	

Notes:
R36*: Irritating to eyes;* ***R40****: Limited evidence of a carcinogenic effect;* ***S2****: Keep out of the reach of children;* ***S36/37****: Wear suitable protective clothing and gloves;* ***S46****: If swallowed, seek medical advice immediately and show this container or label;* ***Xi****: Irritant;* ***Xn****: Harmful*
Information on the 67/548/EEC system was taken from the ex-ECB Class-Lab Internet site http://ecb.jrc.ec.europa.eu/classification-labelling/search-classlab/classlab/subDetail.php?indexNum=602-035-00-2&subLang=EN#

A2.2 EU-wide Legislation Relating to Environmental Releases

A2.2.1 Directive 76/464/EEC – The Dangerous Substances Directive

1,4 dichlorobenzene is one of the chemicals identified as being List I compounds under the Dangerous Substances Directive. The Directive requires that Member States take the appropriate steps to eliminate pollution of the waters by the dangerous substances in the families and groups of substances in List I. The Directive was replaced by Directive 2006/11/EC and will be incorporated into the Water Framework Directive 2000/60/EC.

A2.2.2 Directive 96/82/EC – The Seveso II Directive

This Directive is aimed at the prevention of major accidents that involve dangerous substances, and the limitation of their consequences for man and the environment, with a view to ensuring high levels of protection throughout the Community in a consistent and effective manner. 1,4 dichlorobenzene belongs to Main Seveso Category 9i ("*very toxic to aquatic organisms*").

A2.2.3 Directive 2001/81/EC – The National Emission Ceilings Directive

1,4 dichlorobenzene is a volatile organic compound. Directive 2001/81/EC of the European Parliament and the Council on National Emission Ceilings for certain pollutants (NEC Directive) sets upper limits for each Member State for the total emissions in 2010 of the four pollutants responsible for acidification, eutrophication and ground-level ozone pollution (sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia), but leaves it largely to the Member States to decide which measures – on top of Community legislation for specific source categories – to take in order to comply. The NEC Directive has been amended as part of the accession of new Member States. A consolidated NEC Directive for the EU-27 includes the entire Community as of 1 January 2007.

A2.2.4 Regulation 648/2004/EC – The Detergents Regulation

In accordance with Regulation 648/2004/EC on detergents, the following weight percentage ranges:

- less than 5%;
- 5% or over but less than 15%;
- 15% or over but less than 30%; and
- 30% and more

must be used to indicate the content of the 1,4 dichlorobenzene where it is added in a concentration above 0.2% by weight.

A2.2.5 Decision 2004/129/EC – Non-inclusion of Pesticide Active Substances

According to the EU Pesticides database[36], 1,4 dichlorobenzene has been used as a rodenticide, although insecticide, insect repellent and fungicide uses (outside the EU) have been identified in the literature. The database indicates that the substance is not authorised for use in the EU. In accordance with Article 2 of Decision 2004/129/EC which concerns the non-inclusion of certain active substances in Annex I to Council Directive 91/414/EEC and the withdrawal of authorisations for plant protection products containing these substances, Member States had to ensure that authorisations for plant protection products containing 1,4 dichlorobenzene (as well as other active substances listed in Annex I to this Decision) were withdrawn by 31 March 2004 at the latest.

With regard to the relevant Maximum Residue Level for the substance, the default level of 0.01 mg/kg according to Article 18(1)(b) of Regulation (EEC) No 396/2005 applies.

A2.2.6 Regulation (EC) No 1272/2008 – Classification, Labelling and Packaging

The table below presents the classification and labelling for the substance with regard to environmental effects under both the old and new classification and labelling systems.

[36] Available at: http://ec.europa.eu/food/plant/protection/evaluation/database_act_subs_en.htm.

<table>
<tr><th colspan="9">Table A2.3: Overview of EU Environmental Classification and Labelling of 1,4 Dichlorobenzene</th></tr>
<tr><th>C&L System</th><th colspan="2">Classification</th><th colspan="6">Labelling</th></tr>
<tr><td rowspan="2">67/548/EEC</td><td colspan="2" rowspan="2">N; R50-53</td><td colspan="2">Risk phrases</td><td colspan="2">Safety phrases</td><td colspan="2">Indications of danger</td></tr>
<tr><td colspan="2">50/53</td><td colspan="2">60 - 61</td><td colspan="2">N</td></tr>
<tr><td rowspan="2">1272/2008</td><td>Hazard class and category code(s)</td><td>Hazard statement code(s)</td><td colspan="3">Pictogram, signal word code(s)</td><td colspan="3">Hazard statement code(s)</td></tr>
<tr><td>Aquatic Acute 1
Aquatic Chronic 1</td><td>H400
H410</td><td colspan="3">Wng</td><td colspan="3">H410</td></tr>
<tr><td colspan="9">Notes:
R50-53: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment; S60: This material and its container must be disposed of as hazardous waste; S61: Avoid release to the environment. Refer to special instructions/Safety data sheets; N: Dangerous for the environment
Information on the 67/548/EEC system was taken from the ex-ECB Class-Lab Internet site http://ecb.jrc.ec.europa.eu/classification-labelling/search-classlab/classlab/subDetail.php?indexNum=602-035-00-2&subLang=EN#</td></tr>
</table>

A2.3 General Product Safety Directive (2001/95/EC)

This Directive does not specifically apply to 1,4 dichlorobenzene; however, it applies in the absence of specific provisions among the Community regulations governing the safety of products or if sectoral legislation is insufficient.

The Directive imposes a general safety requirement on any product put on the market for consumers or likely to be used by them, including all products that provide a service. A safe product is one which poses no threat or only a reduced threat in accordance with the nature of its use and which is acceptable in view of maintaining a high level of protection for the health and safety of persons.

A product is deemed safe once it conforms to the specific Community provisions governing its safety. In the absence of such provisions, the product must comply with the specific national regulations of the Member State in which it is being marketed or sold, or with the voluntary national standards that transpose the European standards. In the absence of these, the product's compliance is determined according to the following:

- the voluntary national standards which transpose other relevant European standards and the Commission recommendations which set out guidelines on the assessment of product safety;
- the standards of the Member State in which the product is being marketed or sold;
- the codes of good practice as regards health and safety;
- the current state of the art; and
- the consumers' safety expectations.

This Directive applies to the supply of all new and second-hand products to consumers for personal use, whether they were intended for use by consumers or not. It either applies entirely to a product, if no CE marking directives apply, or partially, if CE marking directives do apply to a product. Therefore the General Products Safety Directive applies, at least partially, to all products used by consumers. The Directive contains specific requirements for suppliers including manufacturers, importers, retailers, distributors, those who rework, repair or modify, service providers etc.

A2.4 Other EU-wide Action

A2.4.1 Voluntary Action by Industry

In relation to voluntary action by industry specifically relevant to 1,4 dichlorobenzene, please refer to Section 2.4.4 of the main part of this report.

The Air Fresheners Products Stewardship Programme is an initiative of AISE, the International Association for Soaps, Detergents and Maintenance Products. The programme, implemented from November 2007 onwards, is open to European companies from that industry sector and aims at promoting best practice in the industry through responsible manufacturing, communication and use of air fresheners across Europe, allowing consumers to make the best-informed choices about safe product usage (AISE, 2009).

Any company that produces and places air freshener products on the market in Europe (EU, plus Iceland, Norway and Switzerland) can participate, regardless of whether or not they are members of AISE or one of its national associations. The programme covers the following categories of air fresheners: sprays (including aerosol – mini and pump-sprays), perfumed candles, liquid wick, gel, potpourris, electrical devices, car fresheners, and incense (AISE, 2009).

Companies participating in the AISE Air Fresheners Product Stewardship Programme commit to apply the following, specifically developed, set of rules to their products in the following areas (AISE, 2009):

- **product development/product safety**:
  - *for all products*: companies commit to evaluate their product's ingredients, even, beyond current regulatory requirements in order to ensure that they are safe in use. This will be done by the systematic use of internationally recognised standards, e.g. WHO (World Health Organisation) and IFRA (International Fragrance Association for fragrances);
  - *for combustion products*: where a participating company manufactures and/or places on the market a combustion product with flame, i.e. perfumed candles, it shall, in addition to complying with the Dangerous Preparations Directive and all relevant legislation, adopt the latest relevant CEN (European Committee for Standardization) standards. For products with combustion without flame,

participating companies are required to apply the precautionary principle on the basis of a careful scientific risk assessment which is currently used to assess incense cones and incense sticks that are manufactured and/or placed on the market;

- **product information**:
  - *product labels*: product labels will be clearly visible and key safety messages will be obvious. Where appropriate, clear advice for safe usage of the product including maximum exposure will be made. Furthermore, inhalation abuse warnings on sprays using solvents and propellants will be added where applicable and within local frameworks. Consumers will find the two following sentences on the product labels of participating companies:
    - "*People suffering from perfume sensitivity should be cautious when using this product*"; and
    - "*Air Fresheners do not replace good hygiene practices*".

    Participating companies will refrain from using the absence of banned materials in a product as a marketing claim (e.g. "without CFC").
  - *complementary web information*: in addition to the Dangerous Preparation Directive requirements, all information on the ingredient composition (ingredients plus fragrance allergens exceeding 0.01% by weight) of the product will be made available to consumers using INCI (International Nomenclature of Cosmetic Ingredients) names as per the Detergent Regulation. This will be made available via a corporate website indicated on the product label. In addition, medical information will be made available upon request.
- **product form**: air freshener toy-shape products specifically intended to attract children will not be manufactured and/or be placed on the market; and
- **product communication and advertising**: scenes involving pregnant women, babies or young children activating the product will not be used to advertise the goods. Appropriate use and handling of the product in compliance with product labelling will be demonstrated and all product claims will be substantiated.

The companies committed to the AISE Air Fresheners Stewardship Programme are named on the AISE Internet site as follows (AISE, 2009):

- Lampe Berger;
- McBride;
- Nicols;
- Procter & Gamble;
- Reckitt Benckiser;
- Sara Lee; and
- SC Johnson.

These companies are believed to account for the vast majority of the EU air fresheners market.

A2.4.2 Action by the European Trade Unions Confederation

The European Trade Union Confederation published in 2009 a priority list of chemical substances with the aim of contributing to the practical implementation of REACH, in particular the authorisation procedure by proposing Substances of Very High Concern (SVHC) which from a union's perspective should have priority for inclusion in the Candidate List and potentially in the Authorisation List (ETUC, 2009b).

The chemicals considered as SVHC in the Trade Union Priority List are CMRs category 1, 2 or 3 listed in Annex I of Directive 67/548/EEC, carcinogens classified 1, 2A or 2B by IARC, PBT substances listed in the framework of the OSPAR Convention, known and suspected endocrine disruptors listed in the Community Strategy for Endocrine Disruptors, neurotoxic substances listed by Vela *et al* (2003) and sensitisers listed in the Annex I of Directive 67/548/EEC (ETUC, 2009b).

1,4 dichlorobenzene appears as substance number 95 with an overall score of 17 as a result of its classification as a carcinogen category 3 and as a skin sensitiser (ETUC, 2009b).

A2.5 Relevant Measures in Individual EU Member States

A2.5.1 Regulatory Provisions

The following table summarises the available information on national regulatory measures on 1,4 dichlorobenzene in EU Member States plus Norway and Switzerland. It appears that only Sweden has currently in place a restriction on the marketing and use of the substance in odour masking products. It should be noted that a number of Member State authorities have not responded to the RPA questionnaire.

Table A2.4: Overview of National Legislation on 1,4 Dichlorobenzene in EU/EEA Countries

Country	Regulatory Provisions	Source
AT	No ban or restriction on 1,4 dichlorobenzene according to Austrian law	Austrian Federal Ministry of Environment (2009)
CY	No national legislation on 1,4 dichlorobenzene in Cyprus	Cypriot Department of Labour Inspection (2009)
CZ	No national legislation on 1,4 dichlorobenzene in the Czech Republic	Czech Ministry of Environment (2009)
DK	No national Danish regulation on 1,4 dichlorobenzene in air fresheners or toilet blocks	Danish Environmental Protection Agency (2009)
FI	No national legislation restricting the marketing and use of 1,4 dichlorobenzene in air fresheners or toilet blocks in Finland	Finnish National Supervisory Authority for Welfare and Health (2009)
DE	No national legislation controlling the use of 1,4 dichlorobenzene in air fresheners or toilet blocks in Germany	German Federal Institute for Occupational Safety and Health (2010)

Table A2.4: Overview of National Legislation on 1,4 Dichlorobenzene in EU/EEA Countries		
Country	**Regulatory Provisions**	**Source**
LV	No national legislation or other non-regulatory actions, banning or otherwise controlling the marketing and use of 1,4 dichlorobenzene in air fresheners, toilet blocks or indeed other products Two regulations have been identified by Latvian authorities (Cabinet Regulation No 466 of 2002 and Cabinet Regulation No 184 of 2003) on chemical reporting and biocidal products which may be of relevance to the substance	Latvian Environment, Geology and Meteorology Centre (2009); Latvian Ministry of Health, 2009
LT	No relevant legislation is in place in Lithuania	Lithuanian State Non Food Products Inspectorate (2009)
MT	No specific national restrictions are in place in Malta	Malta Standards Authority (2009)
NL	No national legislation banning or otherwise controlling the marketing and use of 1,4 dichlorobenzene in air fresheners and toilet blocks	RIVM (2009)
NO	No national legislation restricting the marketing and use of 1,4 dichlorobenzene in air fresheners or toilet blocks in Norway	Norwegian Pollution Control Authority (2009)
PL	No national legislation banning or otherwise controlling the marketing and use of 1,4 dichlorobenzene in air fresheners and toilet blocks in Poland	Polish Bureau for Chemical Substances and Preparations (2009)
SK	The only relevant legislative measure impacting on the marketing and use of 1,4 dichlorobenzene in the Slovak Republic is Regulation of the Ministry of Health of the Slovak Republic No 480/2006 Coll. on requirements on quality, acquisition, and transport from the source to the place of treatment and loading, treatment, control of quality, packaging, labelling, and marketing of natural healing water. The Regulation includes a maximum concentration limit for dichlorobenzenes of 0.3 µg/L	Slovakian Trade Inspection (2009)
SI	No national legislation restricting or otherwise controlling the use of 1,4 dichlorobenzene in Slovenia, although the Chemicals Office of the Republic of Slovenia (2009) has mentioned a series of legislative instruments that implement EU legislation and international Conventions (Seveso II Directive, the Rotterdam Convention, etc.)	Chemicals Office of the Republic of Slovenia (2009)
SE	According to the Swedish Chemical Products and Biotechnical Organisms Regulations (KIFS 2008:2, Chapter 5, Section 16; Swedish Chemicals Agency, 2008), chemical products containing 1,4 dichlorobenzene and intended to mask odours may not be may not be offered for sale, transferred or used for and by professional users. According to the EU RAR, these regulations entered into force on 1 January 1990. The Regulations were last amended in 2009 (KIFS 2009:6)	Swedish Chemicals Agency (2009)
CH	As in the EU Detergents Regulation (EC) 648/2004, there is a special labelling for cleaning products containing 1,4 dichlorobenzene in the Swiss Ordinance on Risk Reduction related to the Use of certain particularly dangerous Substances, Preparations and Articles (Ordinance on Risk Reduction related to Chemical Products (ORRChem). No other restriction is in place	Swiss Federal Office of Public Health (2009)

A2.5.2 Green Procurement Initiatives in EU Member States

Some information on Green Procurement initiatives has been received from the Lithuanian and Maltese authorities; however, this does not directly relate to the products at the focus of this study (it rather relates to cleaning products). More specific information has been collected for the UK and is presented below.

After the publication of the Guidance for Responsible Public Procurement of Cleaning Products Handbook SEC(2004) 1050, the trade associations British Association for Chemical Specialities and UK Cleaning Products Industry Association formed a Task Force to provide guidance on environmental aspects of cleaning product ingredients. This guidance lists the major classes of ingredients, as set out in the Detergents Regulation, and others which often appear in tender documents and provides a current scientific assessment and relevant guidance for Green Public Procurement in the UK of cleaning products used in the Industrial and Institutional (I&I) and janitorial markets (BACS, 2006).

The guidance refers to the EU RAR for 1,4 dichlorobenzene and the risks identified for toilet blocks, air fresheners and moth repellents. The guidance indicates that less hazardous alternatives have been developed and this ingredient has been largely substituted and recommends that 1,4 dichlorobenzene-based products should not be used (BACS, 2008).

The guidance for ingredient selection was first published in 2006, prior to which it was reviewed by the UK Government's Advisory Committee on Hazardous Substances. The initiative was subsequently welcomed by the UK Chemicals Stakeholder Forum. The UK Department for Environment, Food and Rural Affairs (Defra) also welcomed this guidance as part of its commitment to support sustainable public procurement in the UK in line with its strategy for promoting sustainable development across Government (BACS, 2008).

A large number of local authorities in the UK have put together procurement guides that make specific mention of 1,4 dichlorobenzene in toilet blocks, air fresheners and insect repellents. Invariably, such guides require that products containing the substance be avoided. A quick Internet search has revealed a considerable number of authorities with such requirements in place on the basis of perceived adverse effect on aquatic plants and marine life as well as a risk of liver and kidney failure, and severe anaemia in humans (Breckland Council, 2009; Hampshire Country Council, 2009; North Norfolk District Council, 2008; Exeter City Council, 2007; Kirklees Council, 2007; South Derbyshire District Council, 2007; Barnsley Metropolitan Borough Council, 2006; Suffolk Country Council, 2005; Bracknell Forest Borough Council, 2004; Coventry City Council, undated; Greenwich Council, undated; Hyndburn Borough Council, undated; London Borough of Hounslow, undated; Staffordshire Moorlands District Council, undated; Torbay Council, undated).

We have attempted to contact these local authorities to enquire the reasoning behind these provisions on 1,4 dichlorobenzene and any impacts to their budgets. A response received from the Kirklees Council suggests that the in-house provider of cleaning services to the various council departments and services, as well as, most but not all the schools, made a decision a few years ago to dispense with the use of urinal blocks. It was considered that urinal blocks were a major contributor to causing blockages in waste pipes and traps and that their usage was usually linked to masking problems of malodour - at the expense usually of endeavouring to identify and resolve the actual source of the malodour, which is the preferred option of the cleaning service (Kirklees, Council, 2010).

Another source indicates that most UK local councils are now controlling the use of urinal blocks containing 1,4 dichlorobenzene in schools (Re-Solv, undated).

A2.5.3 Occupational Exposure Limit Values in EU/EEA Countries

The following table summarises the available information on occupational exposure limits currently applying within the jurisdiction of EU Member States plus Norway and Switzerland.

Table A2.5: Overview of National Occupational Exposure Limit Values for 1,4 Dichlorobenzene

Country	Long-term 8-h TWA		Short-term 15-min STEL		Source
	ppm	mg/m^3	ppm	mg/m^3	
EU	20	122	50	306	Commission Directive 2000/39/EC
AT	20	122	50	306	Arbeitinspektion – Note: particular risk of skin absorption
BE	10	61	50	306	Service public federal Emploi, Travail et Concertation sociale
BG		122		306	MLSP
CY	20	122	50	306	MLSI
CZ		100		200	Gov Portal – Note: penetrates the skin or has a strong irritant effect on skin
DK	10	60			AT
EE	20	122	50	306	Official Gazette – Note: carcinogen
FI	20	120	50	300	STM
FR	0.75	4.5	50	306	INRS
DE	1	6	2	12	TRGS 900 – Note: a risk of foetal harm may not arise if the limits are observed
EL	*75*	*450*	*110*	*675*	Presidential Decree 90/1999
HU		122		306	EMLA
IE	20	122	50	300	HSA
IT	20	122	50	306	D.Lgs.81/08, Allegato XXXVIII
LV	20	122	50	306	Regulation Nr. 325 issued by the Cabinet of Minister (15.05.2007) – Note: skin
LT	20	122	50	306	LRS
LU	20	122	50	306	STI
MT	20	122	50	306	MSP
NL		150		300	SER
PL		90		180	ISIP

Table A2.5: Overview of National Occupational Exposure Limit Values for 1,4 Dichlorobenzene					
Country	**Long-term 8-h TWA**		**Short-term 15-min STEL**		**Source**
	ppm	**mg/m³**	**ppm**	**mg/m³**	
PT	10				NP 1796 - Note: eye irritation; renal injury
RO	20	122	50	306	Hotarare nr. 1.218 (6 Sep 2006)
SI	20	122	50	305	Uradni list - 15-min STEL is 2.5x the 8-h TWA
SK	20	122		306	Zbierka
ES	20	122	50	306	INSHT
SE	10	60	20	120	AV
UK	*25*	*153*	50	306	HSE - Note: skin
IS	10	60	50	306	Reglugerðasafn
NO	*40*	*240*	*60*	300	Arbeidstilsynet
CH	20				SUVA – Notes: possibility of poisoning by percutaneous resorption; biological monitoring
Note: those values which are (considerably) lower than the EU Indicative Occupational Exposure Limits are indicated in grey background. Those less stringent than the EU Indicative Occupational Exposure Limits (for Greece, Norway, and the UK) are indicated in italics					

Communication with the Scientific Committee on Occupational Exposure Limits (SCOEL) indicates that the OEL value set under Commission Directive 2000/39/EC is based on old information and it is possible that it will be revised. We have been advised that the EU RAR points at new studies that were not available at the time of setting the limit and thus SCOEL has to consider whether the new studies have enough weight to revise the earlier recommendation. This is likely to be required as the relevant Monograph by IARC was published in 1999 and classified 1,4 dichlorobenzene as carcinogen 2B[37]. Such a revision may be completed after 2010 (SCOEL, 2010).

A2.6 Relevant Measures in Selected Non-European Countries

A2.6.1 Australia

An assessment of risks from the substance was undertaken by NICNAS in 2000. The risk assessment concluded that, due to intermittent exposure and its relatively low toxicity, the risk to workers engaged in the manufacture of products containing 1,4 dichlorobenzene or in the use of 1,4 dichlorobenzene products would be low (NICNAS, 2000). However, some deficiencies were identified with regard to the provision of exhaust ventilation in areas where 1,4 dichlorobenzene products were re-packaged and with the contents of several Safety Data Sheets (NICNAS, 2000).

[37] It is understood that some very low national OEL values may have indeed resulted from the IARC classification.

Also, the risk to the public from the intended use of 1,4 dichlorobenzene blocks or buttons in the household or public toilets was considered to be low (NICNAS, 2000).

No risks were identified for the environment from the use of 1,4 dichlorobenzene. However, there appeared to be the potential for accumulation of 1,4 dichlorobenzene in sediments. No Australian data existed for this compartment, and levels were recommended for monitoring where possible to determine whether accumulation is a factor. It was noted that use levels of 1,4 dichlorobenzene in Australia had been declining over the previous years, and the trend appeared to be for a continuing decline, which might negate this issue (NICNAS, 2000).

Recommendations for reducing potential occupational health and safety risks for 1,4 dichlorobenzene included the monitoring of airborne 1,4 dichlorobenzene to be undertaken and a review of the then occupational exposure standard for 1,4 dichlorobenzene (75 ppm 8-h TWA) by the Australian National Occupational Health and Safety Commission (NICNAS, 2000). This review appears to have been undertaken. As shown on the Australian Hazardous Substances Information System[38], the occupational exposure standard is now 25 ppm (150 mg/m^3) as an 8-h TWA.

The hazard classification was proposed to be amended to include the following safety phrases: S23 (do not breathe vapour), S24 (avoid contact with skin), S25 (avoid contact with eyes) and S51 (use only in well ventilated areas) (NICNAS, 2000). The currently applicable safety phrases, according to the Australian Hazardous Substances Information System are S2, S36/37, S46, S60 and S61. There is evidently some discrepancy between the 2000 recommendations and the current situation.

We have contacted NICNAS for the purposes of the current study; no information in addition to the above from the 2000 assessment was provided.

A2.6.2 Canada

Environment Canada has undertaken significant work on Volatile Organic Compounds (VOCs) in consumer products in recent years. On 27 September 2006, Environment Canada held a public stakeholder meeting in Toronto, Ontario, to introduce and receive feedback on the discussion document "Environment Canada's Proposed Regulations to Limit Volatile Organic Compound (VOC) Content in Consumer Products (Personal Care, Household, Automotive Aftermarket and Adhesive Products) - Discussion Paper for the Development of Regulations". At the time, stakeholders requested an exemption for 1,4 dichlorobenzene. Environment Canada had responded with the comment that it "*is evaluating how best to manage the risks presented by* (the substance) (Environment Canada, 2008).

Environment Canada published the proposed Volatile Organic Compound (VOC) Concentration Limits for Certain Products Regulations in the Canada Gazette, Part I, on

38 Its searchable database is available at: http://hsis.ascc.gov.au/Default.aspx.

26 April 2008. The proposed Regulations are described in the Canada Gazette (Canada Gazette, 2008). According to these, no person shall manufacture or import any product set out in the schedule of the Regulations if its concentration of volatile organic compounds exceeds the limit set out in the schedule for that product unless dilution of that product is required before it is used, in accordance with the written instructions of the manufacturer, importer or seller, to a concentration equal to or less than that limit and that product is either labelled with or accompanied by those instructions in both official languages. The products that are of particular relevance to the present study are shown in Table A2.6.

The proposed Regulations (and the accompanying Regulatory Impact Analysis Statement) make specific mention to 1,4 dichlorobenzene. They note:

> "*Currently, there is one facility that is manufacturing PDCB air fresheners in Canada. Environment Canada is currently reviewing the impact of including PDCB in the proposed Regulations for that facility. It is expected that the review will be completed prior to finalizing the proposed Regulations; Environment Canada would then be in a position to take a final decision on whether or not to provide an exemption for this substance*".

Table A2.6: Proposed VOC Limits for Selected Consumer Products under the Proposed Canadian VOC Regulations

Item No	Product category	Sub-category	VOC concentration limit
7	Air fresheners, not including cleaning products	Single-phase aerosol, with the liquid contents in a single homogeneous phase and whose container is not required to be shaken before use	30%
		Double-phase aerosol, with the liquid contents in two or more distinct phases and whose product container is required to be shaken before use to ix the phases, producing an emulsion	25%
		Liquid or pump spray	18%
		Solid or semi-solid, a substance or mixture of substances that, either whole or sub-divided, such as the particles comprising a powder, is not capable of visually detectable flow	3%
		Dual-purpose aerosol, for use as a disinfectant and air freshener	60%
31	Toilet or urinal cleaning products	Aerosol	10%
		Non-aerosol	3%

Source: Canada Gazette (2008)

A2.6.3 Japan

According to a Japanese expert (Fukushima, 2009), there is no national (or regional/local) legislation that restricts or otherwise controls the use of 1,4 dichlorobenzene in air fresheners and toilet blocks. 1,4 dichlorobenzene is designated as type II and type III monitoring chemical. For such chemicals, industry has the obligation to report the quantities manufactured and imported in accordance with the Japanese Chemical Substances Control Law (CSCL). Further, the Japanese Ministry of Health, Labour and Welfare has set a guideline value for indoor air for 1,4 dichlorobenzene at 240 µg/m^3 (0.04 ppm) and the Japanese Ministry of Education has established a school environment standard based on above mentioned guideline value by the Ministry of Health, Labour and Welfare.

No non-regulatory initiatives appear to exist in the country; however, the aforementioned government action may have some influence to procurement of local governments and private sector (Fukushima, 2009).

A2.6.4 New Zealand

Room air fresheners and urinal blocks that contain hazardous chemicals are managed under group standards[39]. They can be managed under either a cleaning products group standard (air fresheners) or a water treatment group standard (toilet blocks). These standards set generic controls for the safe use of products but do not set specific controls for 1,4 dichlorobenzene neither do they restrict the import/sale and use of air fresheners or toilet blocks. No non-regulatory initiatives appear to have be taken in New Zealand with regard to 1,4 dichlorobenzene (ERMANZ, 2009).

A2.6.5 United States of America

Regulations on VOCs

Federal Regulations on Volatile Organic Compounds in Consumer Products

In 1998, the US Environmental Protection Agency (US EPA) promulgated the National Volatile Organic Compound Emissions Standards for Consumer Products under the Clean Air Act (CAA). This rule specifies VOC concentration limits for 24 product categories and is applied nationwide to manufacturers, importers and distributors of consumer products manufactured after 10 December 1998 Among the VOC content limits established under the guidelines, the following limits could be found: air fresheners: single-phase: 70%, double-phase: 30%, liquids/pump sprays: 18%, solids/gels: 3% (US EPA, 1998).

Notably, the following consumer products are (among others) exempt from the rule (US EPA, 1998):

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[39] Available at: http://www.ermanz.govt.nz/hs/groupstandards/index.html. A group standard is an approval for a group of hazardous substances under Part 6A of the Hazardous Substances and New Organisms (HSNO) Act 1996. Group standards streamline the transfer of substances notified under the Toxic Substances Act 1979 (NOTS) to the HSNO regime.

- any consumer product manufactured solely for shipment and use outside of the United States; and
- insecticides and air fresheners containing at least 98% 1,4 dichlorobenzene or at least 98% naphthalene.

We have been advised that the US EPA is very close to proposing an amendment of the rule, expected in January of 2010 (we do not have information whether this has indeed been the case). It was anticipated that the exemption on the use of 1,4 dichlorobenzene in air fresheners would remain in the new proposal (US EPA, 2009c).

<u>California Regulations on Volatile Organic Compounds in Consumer Products</u>

California was the first jurisdiction to enact rules for VOC concentration limits for consumer products in an effort to address the smog problem affecting many of its cities. In order to achieve reductions in VOC emissions that would help attain state and federal ambient air quality standards, the California Air Resources Board (CARB) developed rules that prescribed VOC concentration limits for antiperspirants and deodorants (adopted in 1989) and consumer products (adopted in 1991). Since those initial promulgations, CARB has made numerous amendments to the rules. These amendments were required because reductions realised in the initial rules have been overtaken by continuous population and economic growth. The CARB CONS-1 (consumer products regulation) amendments came into effect on 26 June 2004 and 31 December 2006 (Canada Gazette, 2008).

More recently, CARB proposed another set of amendments to the consumer product rules to stakeholders. These amendments include VOC concentration limits for 61 categories and sub-categories of consumer products. Forty of these consumer product categories are currently regulated while the remaining 21 categories have not previously been regulated by CARB. The new limits were effective in 2008 (Canada Gazette, 2008).

The following products are of particular relevance to the present study.

Table A2.7: VOC Limits for Selected Consumer Products under the California CARB Regulations on VOCs in Consumer Products

Product category	Sub-category	VOC standard (and effective date)
Air fresheners, not including cleaning products	Single-phase aerosol	70% (01/01/1993) 30% (01/01/1996)
	Double-phase aerosol	30% (01/01/1993) 25% (31/12/2004)
	Liquid/pump spray	18% (01/01/1993)
	Solid or semi-solid	3% (01/01/1993)
	Dual-purpose air freshener/disinfectant aerosol	60% (01/01/1994)
Toilet/urinal care products	Aerosol	10% (31/12/2006)
	Non-aerosol	3% (31/12/2006)

Source: CARB (2008)

The Regulations forbid, as from 31 December 2005, the sale, supply, offer for sale, or manufacture for use in California any of any solid air fresheners or toilet/urinal care products that contain 1,4 dichlorobenzene, except those products that contain 1,4 dichlorobenzene and were manufactured before 31 December 2005 which could be sold, supplied, or offered for sale until 31 December 2006, so long as the product container or package displayed the date on which the product was manufactured, or a code indicating such date. Until 30 December 2006, the VOC limits specified above did not apply to solid air fresheners containing at least 98% 1,4 dichlorobenzene (CARB, 2008).

Any person who sold or supplied any such product that contained 1,4 dichlorobenzene had to notify the purchaser of the product in writing that the sell-through period for the product would end on 31 December 2006, provided, however, that this notification was given only if both of the following conditions were met (CARB, 2008):

- the product is sold or supplied to a distributor or retailer; and
- the product is sold or supplied on or after 30 June 2006.

<u>Regulations on Other US States on Volatile Organic Compounds in Consumer Products</u>

Numerous new state VOC limitations for cleaning product formulations became effective at the beginning of 2009. In brief, the VOC limitations for cleaning products in Connecticut, Massachusetts and Ohio came into effect for the first time on 1 January 2009. In addition, effective 1 January 2009, the states of Maine, Maryland, Michigan, New Jersey and Pennsylvania impose more aggressive VOC limits for product categories already covered, and in some cases add new product categories to their existing VOC regulations (Balek, 2009).

<u>Ozone Transport Commission</u>

The Ozone Transport Commission (OTC) is a multi-state organisation created under the US Clean Air Act with the responsibility to develop regional solutions to ground-level ozone in the northeast and mid-Atlantic regions of the United States. In 2000, the OTC developed a model rule for consumer products which provides a framework for VOC concentration regulations for states within the OTC region. The OTC Model Rule provides VOC concentration standards for 45 consumer products categories applying to all products manufactured for sale or use within the OTC states after January 2005. Many of the VOC concentration limits in the OTC Model Rule are similar to those present in the CARB rules. In addition, the OTC has indicated that it will incorporate additional CARB CONS-1 limits into the updated model rule to be published on 1 January 2009 (Canada Gazette, 2008).

Regulations on 1,4 Dichlorobenzene in Room Air Fresheners and Urinal Blocks

From 1 January 2009, several US States are moving towards banning the sale of any 1,4 dichlorobenzene products (air fresheners, toilet and urinal products) not manufactured prior to that date. Those products manufactured prior to 01/01/2009 can still be sold through 31 December 2009 in most US States.

The following table summarises the current state-wide restrictions on 1,4 dichlorobenzene.

Table A2.8: Summary of Prohibitions on 1,4 Dichlorobenzene in Individual US States

State	Description of prohibition on sales, supply or offer of sale for 1,4 dichlorobenzene products
California	Any product containing 1,4 dichlorobenzene (urinal blocks, wall blocks, super blocks etc.) is now prohibited
Connecticut	1,4 dichlorobenzene air fresheners and toilet/urinal products manufactured on or after 01/01/2009 are prohibited. No apparent sell through period is listed. Products manufactured on or before 31/12/2008 can be sold. In addition, Connecticut imposes a VOC limitation of 3% on solid air fresheners and non-aerosol toilet/urinal care products. Such products manufactured before the effective date may continue to be sold provided they display the date of manufacture or a code indicating the same
District of Columbia	1,4 dichlorobenzene air fresheners, toilet and urinal products manufactured after 01/01/2009 are prohibited. Those manufactured prior to 01/01/2009 can be sold through 31/12/2009
Maine	1,4 dichlorobenzene air fresheners, toilet and urinal products manufactured after 01/01/2009 are prohibited. Those manufactured prior to 01/01/2009 can be sold through 31/12/2009. Maine also imposes a 3% VOC limitation on solid air fresheners and toilet/urinal care products
Maryland	1,4 dichlorobenzene air fresheners, toilet and urinal products manufactured after 01/01/2009 are prohibited. Those manufactured prior to 01/01/2009 can be sold through 31/12/2009. Maryland also imposes a 3% VOC limitation on solid air fresheners and toilet/urinal care products
Massachusetts	1,4 dichlorobenzene air fresheners, toilet and urinal products manufactured after 01/01/2009 are prohibited. Those manufactured prior to 01/01/2009 can be sold through 31/12/2009. In addition, Massachusetts imposes a 3% VOC limitation on solid air fresheners and toilet/urinal care products
Michigan	1,4 dichlorobenzene air fresheners, toilet and urinal products manufactured after 01/01/2009 are prohibited. Those manufactured prior to 01/01/2009 can be sold through 31/12/2009. Michigan also imposes a 3% VOC limitation on solid air fresheners and toilet/urinal care products
New York	1,4 dichlorobenzene in toilet/urinal products used in NY schools, Erie County, NY Department of Corrections, NYC Fire Houses is prohibited. Current New York State regulations provide an exception from the VOC limitations for air fresheners and insecticides that are comprised of at least 98% 1,4 dichlorobenzene. However, the New York State Department of Environmental Conservation (Department or NYS DEC) is proposing a prohibition on the use of 1,4 dichlorobenzene in the solid air fresheners and toilet/urinal care products categories
Ohio	1,4 dichlorobenzene air fresheners (wall blocks, super blocks etc.) manufactured on or after 01/01/2009 (no other sell-through provision). No regulatory VOC limits for 1,4 dichlorobenzene toilet and urinal care products have been issued

Table A2.8: Summary of Prohibitions on 1,4 Dichlorobenzene in Individual US States	
State	**Description of prohibition on sales, supply or offer of sale for 1,4 dichlorobenzene products**
Pennsylvania	1,4 dichlorobenzene air fresheners and toilet/urinal products manufactured on or after 01/01/2009 are prohibited. No apparent sell through period is listed. Products manufactured on or before 31/12/2008 can be sold. Effective 1 January 2009, Pennsylvania imposes a 3% VOC limitation on toilet/urinal care products
Delaware	*Pending Regulatory Approval* – 1,4 dichlorobenzene air fresheners, toilet and urinal product manufactured on or after 01/01/2009 would be prohibited. It appears there would be an unlimited sell-through for product manufactured on or before 31/12/2008
Indiana	*Pending Regulatory Approval* – 1,4 dichlorobenzene air fresheners, toilet and urinal product manufactured on or after 01/01/2009 would be prohibited. It appears there would be an unlimited sell-through for product manufactured on or before 31/12/2008
New Jersey	*Pending Regulatory Approval* – 1,4 dichlorobenzene air fresheners, toilet and urinal product manufactured on or after 01/01/2009 would be prohibited. Those manufactured prior to 01/01/2009 could be sold through 31/12/2011. New Jersey also imposes a 3% VOC limitation on solid air fresheners and toilet/urinal care products
New Hampshire	Maintaining 1,4 dichlorobenzene exemption - no restrictions proposed
Virginia	Maintaining 1,4 dichlorobenzene exemption - no restrictions proposed
Source: Balek (2009); Lagasse Sweet (2009); NYS DEC (2009)	

Regulations on 1,4 Dichlorobenzene in Moth Repellents

In December 2008, the US EPA published a revised final re-registration eligibility decision allowing the use of 1,4 dichlorobenzene in moth ball products provided that appropriate risk mitigation measures are adopted and labels amended (US EPA, 2008). Based upon a review of available toxicity data which it judged to be sufficient and reliable, the most sensitive NOAEL for all exposure duration scenarios was reaffirmed as 20 ppm in a chronic inhalation study and 55 ppm in a 13-week inhalation study in rats. In relation to consumer exposures, when considering non-cancer endpoints, the US EPA recognised inhalation and dermal exposure when handling moth balls at the time of application as being of possible concern. However, as no appropriate data on handler inhalation exposure under such conditions were available, they only considered exposure via the dermal route for this scenario (using data on naphthalene). The rationale given for not attempting the inhalation exposure estimation was that risks associated with short-term post-application inhalation had been shown to be acceptable and were considered also sufficiently protective for the handler scenario. Since the derived margin of exposure (MOE) for dermal contact was high (33,000 - 224,000), this scenario was not considered of further concern. Consideration was also given to inhalation exposure from use of moth balls in closets and drawers over various periods; all scenarios considered gave MOEs greater than 30 (stated to be the Agency's level of concern, LOC), so it was concluded that no mitigation measures were necessary. The possible risk associated with episodic ingestion of moth balls by children was not considered since the EPA considered that an acute effect endpoint for the oral route had not been identified.

Cancer risk estimates were also derived for consumers handling moth balls during application and for inhalation by individuals living in residences containing such products. These were based on the data for liver tumour effects in mice and used a linear low dose extrapolation model and an assumed exposure period of 50 years during a 70 year lifespan. On this basis, the estimated cancer risk via the dermal route was 4.9 x 10^{-8} to 7.1 x 10^{-9} and that for post-application inhalation was 6.0 x 10^{-5}. Since the US EPA considered the mechanism of tumourogenesis would require sustained mitogenic stimulus and hepatocyte proliferation, consideration was also given to comparing levels at which a response was predicted to occur in 10% of exposed animals with the exposure (0.021 mg/m^3) predicted for homes using these products. The Agency estimated that there would be a 1000-fold margin of safety between the experimental level causing a 10% tumour response in animals at the lowest measurable incidence, and home exposure.

As a result of the review, the US EPA concluded that moth ball products containing 1,4 dichlorobenzene could be reregistered for a variety of uses (including domestic non-food handling applications) provided that additional chamber studies were conducted to establish the maximum air levels that could arise from use of moth balls at the maximum rate specified on the product label, and that enhanced labelling requirements were met (including provision of additional guidance on use of appropriate protective clothing and hygiene practices, and warnings regarding ensuring that product was not accessible to children at any stage during use).

It should be noted that the conclusions reached by the US EPA relate only to the use of 1,4 dichlorobenzene in moth balls. Specifically, the use of this chemical as a toilet deodoriser was not considered and therefore the conclusions reached are not of direct relevance to the current project. Also, no novel hazard information was presented which would suggest a need to reassess conclusions in the EU RAR.

Green Procurement Initiatives

A quick Internet search reveals that local government authorities may have introduced ‘green procurement’ initiatives which exclude the purchase and use of products that contain 1,4 dichlorobenzene. For instance, the City of Seattle recently adopted policies on Environmentally Responsible Purchasing and Chemical Use. Through these policies, environmental criteria are being added to a wide variety of new City contracts, including these environmental specifications for janitorial service contracts. 1,4 dichlorobenzene is found on a list of “*restricted substances that are highly toxic and/or suspected carcinogens*” and as such it shall not be present in a product beyond trace amounts (City of Seattle, 2000).

For the State of Washington, the cleaning products bid criteria of the Department of General Administration, Office of State Procurement specifies that no product shall contain more than trace amounts of 1,4 dichlorobenzene (State of Washington, 2000).

For the State of Vermont, the Environmental, Safety and Occupational Health Criteria for Custodial Products indicate that 1,4 dichlorobenzene is among restricted substances that are highly toxic and/or suspected carcinogens that cannot be present in a product beyond trace amounts (State of Vermont, 2000).

Similarly, the Guidelines and Specifications for the Green Cleaning Schools Act by the State of Illinois Green Governments Coordinating Council requires that, for air fresheners and urinal deodorisers, preference should be given to 1,4 dichlorobenzene-free ones. For air fresheners, it is considered preferable to select a bio-based product applied by staff rather than a solid or automatic device. For urinal deodorisers, more frequent cleaning and, where necessary, biodegradable deodorisers are promoted as alternatives (State of Illinois, 2008). Similar wording can be found in the Green Cleaning Guidelines and Specifications for Schools by the Missouri Department of Elementary and Secondary Education (2009).

A2.6.6 Occupational Exposure Limit Values in non-EU Countries

The following table summarises the available information on occupational exposure limits currently applying within the jurisdiction of selected non-EU countries.

Table A2.9: Overview of National Occupational Exposure Limit Values for 1,4 Dichlorobenzene

Country	Long-term 8-h TWA		Short-term 15-min STEL		Source
	ppm	mg/m^3	ppm	mg/m^3	
Argentina*	10	60			US CDC (2009)
Australia	25	150	50	300	US CDC (2009)
Canada - Québec	50	301	110	660	IRSST (2001)
Colombia*	10	60			US CDC (2009)
Japan	10	60			US CDC (2009)
Jordan*	10	60			US CDC (2009)
Korea	75	450	110	675	US CDC (2009)
Mexico	75	450	110	675	US CDC (2009)
New Zealand	25	153	50	306	US CDC (2009)
Philippines	75	450			US CDC (2009)
Russia	50				US CDC (2009)
Singapore*	10	60			US CDC (2009)
Turkey	75	450			US CDC (2009)
US OSHA PEL	75	450			US OSHA (1999)
US NIOSH REL	1.7**				US OSHA (1999)
US ACGIH TLV	10	60			US OSHA (1999)
US MSHA Standard	75	450			US CDC (2009)
US State of California PEL	10	60	110	675	California DIR (undated)
Vietnam*	10	60			US CDC (2009)

Table A2.9: Overview of National Occupational Exposure Limit Values for 1,4 Dichlorobenzene					
Country	**Long-term 8-h TWA**		**Short-term 15-min STEL**		**Source**
	ppm	**mg/m^3**	**ppm**	**mg/m^3**	
Notes: ** taken from the ACGIH values* *** TWA for up to a 10-hour workday and a 40-hour working week* *OSHA: Occupational Safety and Health Administration* *NIOSH: National Institute for Occupational Safety and Health* *ACGIH: American Conference of Governmental Industrial Hygienists* *MSHA: Mine Safety and Health Administration* *PEL: permissible exposure limit* *REL: recommended exposure limit* *TLV: threshold limit value*					

ANNEX 3

RECENT RESEARCH ON EXPOSURE AND EFFECTS

ANNEX 3. RECENT RESEARCH ON EXPOSURE AND EFFECTS

A3.1 Recent Published Information on 1,4 Dichlorobenzene

A3.1.1 Introduction

Since the publication of the EU RAR (which was based on literature published before or during 2002), several primary papers have reported on the hazard potential of, and exposures to, 1,4 dichlorobenzene. Furthermore, a number of risk assessments have been published including some by authoritative bodies. It is therefore appropriate to seek to document briefly any new scientific evidence that has accrued on the use of 1,4 dichlorobenzene in air fresheners and toilet blocks.

The following information on recently published work is not intended as a systematic reassessment of the risks posed by use of 1,4 dichlorobenzene in room air fresheners and urinal/toilet blocks. Rather, it is undertaken to identify if there are any novel new insights into the hazard or risk profile of this chemical gained during the period 2003 to 2009, which could influence the interpretation of the EU RAR findings in relation to the use of this chemical in the two applications of concern.

The use of 1,4 dichlorobenzene as a moth repellent falls outside the scope of this study since restrictions are covered by Commission Decision 2007/565/EC on the non-inclusion in Annex I, IA of IB of the Directive 98/8/EC on Biocidal Products (Product type 19 - Repellents and attractants) and therefore estimates of risks associated with this particular application will only be mentioned where considered informative or of particular note.

The searches on which this summary is based were conducted to identify primary literature published between 2003 and December 2009 using BIOMED, PUBMED, Google-Scholar and HSDB, and used as search terms the CAS No. for the chemical and its two common names (i.e. 1,4 dichlorobenzene and para-dichlorobenzene). The searches focused on identification of information on human exposure and the mammalian toxicity of 1,4 dichlorobenzene. Also considered were any additional papers suggested as being of relevance by consultees contacted during the course of this study, even where the papers were published outside of the timeframe considered in our search. These were further supplemented by a review of the findings and reference materials cited in any authoritative assessments identified, such as that of ATSDR (2006). All sources identified were considered in respect to any additional information they provided, and to inform on the scientific basis that underlay recent legislative developments in other jurisdictions.

A3.1.2 Recent Published Studies

Effects in Humans Following Exposure to 1,4 Dichlorobenzene

Few recent case reports on the acute effects of 1,4 dichlorobenzene exposure in humans were identified. One related to a child who developed haemolytic anaemia and mild methaemoglobinaemia three days after ingestion of moth balls containing 1,4 dichlorobenzene (Sillert *et al*, 2009). The case of a young woman who concealed her inhalation abuse of moth balls was also discussed by Kong & Schmiesing (2005), who noted that inhalation of moth balls can produce a rapid state of euphoria and general feeling of intoxication. Another case report by Cheong *et al* (2006) reported the development of signs of neurotoxicity (encephalopathy associated with cognitive, pyramidal, extrapyrimidal and cerebellar effects) following rapid withdrawal from chronic ingestion of moth balls containing 1,4 dichlorobenzene. Several studies have, however, reported on the effects of environmental exposure to 1,4 dichlorobenzene on the general human population.

In a study on a panel of 22 children (10-16 years of age) suffering from asthma who lived in Los Angeles and were subject to a mean atmospheric 1,4 dichlorobenzene level of 0.15 (0.05-0.50) ppb (equivalent to approximately 0.9 µg/m^3)[40] over a 3-month study period, Delfino *et al* (2003) failed to establish any statistically significant correlations between severity of respiratory symptoms and atmospheric level (Odds Ratio 1.20; 95% CI 0.86-1.67, for 1 day lag). In contrast, after adjustment for smoking, 1,4 dichlorobenzene was the only volatile organic compound (VOC) pollutant still to show an association with reduced pulmonary function in a study population of 1,338 drawn from the US third National Health and Nutrition Examination Survey (NHANES III; Elliott *et al*, 2006). This cohort, which had a mean 1,4 dichlorobenzene blood level of 38 µg/L, were subject to assessment of forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC), peak expiratory flow rate (PEFR) and maximum mid-expiratory flow rate (MMEFR); all parameters showed a positive correlation with blood level although only FEV1 and MMEFR achieved statistical significance. The authors noted the evidence base suggesting that there was considerable exposure to this substance in US homes and that the 95th percentile blood level in this study was 11.03 µg/L. They also estimated that a blood level of 10 µg/L may correspond to a personal exposure of 102 µg/m^3 or above, and suggested that exposure levels for a proportion of the US population might be above the then proposed chronic duration minimal risk limit in the US (which was based on olfactory epithelium changes in the rat).

A population-based case-control study in Perth, Western Australia conducted in children (6 months to 3 years of age) attending an emergency department who were diagnosed to be asthmatic (Rumchev *et al*, 2004) has been undertaken. Domestic levels for a number of VOCs were assessed for cases within two weeks of the emergency department visit using charcoal sorbent tubes while allergen (house dust mite, Der p I) level was also assessed by a monoclonal antibody capture ELISA (enzyme-linked immunosorbent assay)

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40 Based on a conversion factor of 1 µg/m^3 = 0.166 ppb (Hodgson & Levin, 2003).

and temperature and humidity data was also captured. Similar measures were recorded from a control group of children within the same age range who had never been diagnosed as asthmatic by a doctor drawn from the general population. Comparison of VOC exposure showed that the levels for a number of VOCs were higher in the homes of cases than controls. For dichlorobenzenes, levels of the 1,2 - and 1,4 isomers were approximately twice that of controls. In contrast, for the 1,4 isomer only a slight extension of the exposure range was apparent for cases (0.01; 0.01-123.9 µg/m^3) compared with controls (0.01; 0.01-34.7 µg/m^3).

Although only of limited relevance to the current review because it relates to an occupational exposure scenario, it is noted that Hsiao *et al* (2009) have reported on a small cross-sectional study (46 exposed and 29 non-exposed) workers at insect repellent factories in Taiwan in which they found elevated serum alanine amino transferase (ALT) activities and raised blood white cell counts in exposed workers; these effects were significantly ($p<0.05$) correlated with urinary level of the main metabolite 2,5 dichlorophenol (105.4 µg/L in exposed group). Blood urea nitrogen (BUN) was also raised in exposed workers suggesting that, as well as affecting liver function, kidney function may be affected by high occupational exposure to 1,4 dichlorobenzene.

Reproductive and Developmental Toxicity

In a series of papers, Makita reported on the perinatal toxicity of 1,4 dichlorobenzene in rats. Oral administration to rat dams at 25 ppm (approximately 2 mg/kg) was without obvious adverse consequences to offspring although thymus weight was noted to be elevated in female, but not male, offspring when compared with controls at 6 weeks of age. Co-administration of p,p'-DDE (1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene - a major metabolite of DDT) inhibited the occurrence of this phenomenon (Makita, 2004 and 2005). When mature, the female offspring who had received these chemicals in combination but not alone, also showed a low ovarian weight (Makita, 2008). The toxicological significance of these observations is at present unclear, although it is noted that p,p'-DDE is suspected of being hormonally active (i.e. antiandrogenic; Colburn *et al*, undated) and hence the chemical interactions observed in this study may reflect endocrine-mediated changes.

Genotoxicity and Cancer

Aiso *et al* (2005) have published on the dose-response relationship for the carcinogenicity and chronic toxicity of 1,4 dichlorobenzene in BDF1 mice and F344 rats via the inhalation route, using OECD-based protocol designs. Dose levels were selected on the basis of a 13-week study using the same species/strains in which animals were exposed to 25, 55, 120, 270 or 600 ppm for 6 hours/day, 5 days/week (Aiso *et al*, 2005b). The methodology and findings from the 2-year study bear many similarities to the inhalation carcinogenicity studies from the Japan Bioassay Research Centre (JBRC, 1995) that were reported in detail in the EU RAR. However, the published papers by Aiso and colleagues (who are affiliated to this research centre) make no reference to the JBRC report and there are a number of minor differences in the descriptions of study design and findings in the recent papers compared with the JBRC report as described in the EU RAR. For example, the low exposure level for the JBRC (1995) study is quoted in the EU RAR as 25 ppm while that in Aiso *et al* (2005a) is stated to be 20 ppm. Also, Annex 2 of the EU RAR quotes the incidence of a "*hepatoblastoma-like feature*" as 6/41 females at 300 ppm and in male 2/17, 1/16 and 8/38 at 25, 75 and 300 ppm respectively. In contrast, Aiso *et al* (2005a) quotes incidences of histiocytic sarcoma as 6/41 females at 300 ppm and, in males, as 2/50, 1/50 1/49 and 0/50 at 20, 75 and 300 ppm respectively. Thus, while it is probable that the 2005 papers by Aiso *et al* represent a later publication of the same experiments in a peer-reviewed journal, the identified differences in detail, together with the time difference between the production of the documents, precludes a definitive conclusion being reached. A request for clarification was sought from the author (email to S Aiso, 16 December 2009) but no response was received. In the absence of resolution of this issue, the papers by Aiso *et al* (2005 and 2005b) are presented below in detail.

Effects observed in a 13-week study (Aiso *et al*, 2005b) included: in male mice, reduced growth performance; in male rats, renal (proximal tubular hyaline drop formation which stained positive for $\alpha_{2\mu}$-globulin casts and papillary mineralisation and associated changes in blood profile) and haematological (decreased red blood cell count, haemoglobin concentration, haematocrit and mean corpuscular volume) changes, with associated increase in spleen weight; and in both species, hepatoxicity (increased weight, hypertrophy and increased serum cholesterol in rats and mice, and necrosis and altered blood enzyme profile in mice). The 13-week NOAEL based on liver changes in the mouse and kidney changes in the rat was established as 120 ppm and the authors noted that, while findings in mice were consistent with those of the NTP study (NTP, 1987) considered in the EU RAR, differences in rat hepatotoxic profile were apparent between this and the corresponding NTP study. The authors attributed this to a slightly higher uptake of test substance and first pass metabolism when given via the oral route as used in the NTP study, compared with the inhalation route employed here.

On the basis of the 13-week study, animals were exposed to 20, 75 or 300 ppm for two years to establish the effects of chronic treatment (Aiso *et al*, 2005). In mice, a tendency for lower survival was apparent in treated males, which attained statistical significance at the highest concentration; these males also showed reduced growth performance but not food intake. Significant increases in liver and kidney weights and in incidence of hepatocellular carcinoma and hepatoblastoma (with associated macroscopic changes) were noted in mice exposed to 300 ppm. This group also showed increased incidences of histocytic sarcoma and of hepatocellular adenoma in males and females respectively. A positive trend with dose was apparent for the heptocellular carcinomas while females showed a dose-related increase in bronchoalveolar carcinoma. Other pathological changes noted in mice given the higher doses included nasal gland epithelial metaplasia. In rats, a significant decrease in survival was noted in males exposed to 300 ppm. Both sexes given this dose showed increased liver weight, but kidney weight was elevated in males only. Liver and kidney histopathology comprised hepatocellular centrilobular hypertrophy and renal papillary mineralisation and pelvic hyperplasia, respectively. However, no treatment-related effects on tumour profile were observed in either sex. Eosinophilic globules were seen in the olfactory and respiratory epithelia of treated rats; these showed some evidence of dose-response in terms of severity in females while the olfactory changes observed were associated with a loss of epithelial olfactory cells in high dose females only.

Thus, as emphasised by Aiso *et al* (2005b), their 2-year studies at up to the maximum tolerated dosage (MTD) were valuable in confirming the findings on carcinogenic potential in the oral NTP studies (considered in the EU RAR). The oral NTP study showed increased incidence of hepatocellular adenoma and carcinoma and hepatoblastoma in mice of both sexes given 600 mg/kg/day orally and of hepatocellular adenoma in males only at 300 mg/kg/day. In the study by Aiso *et al*, hepatocellular blastomas were induced in both males and females given 300 ppm by inhalation exposure. These findings emphasise the similarity of response between the oral and inhalation routes particularly when findings are considered in terms of internal dose, and Aiso *et al* estimate that - based on an oral absorption rate of 71% - oral doses of 600 or 300 mg/kg/day approximated to internal intakes of 426 or 213 mg/kg/day, respectively. These can be compared with - assuming a pulmonary absorption of 59% and 6 hour daily exposures to 300 ppm in air - estimated internal doses in excess of 200 mg/kg/day by the inhalation route. The authors suggest that, when expressed in terms of absorbed dose, values of greater than 200 mg/kg/day should be considered as associating with increased risk of liver tumours in mice.

Thus, irrespective of whether the papers by Aiso *et al* represent separate experiments or the same as those reported as JBRC (1995) in the EU Risk Assessment, the findings of Aiso *et al* (2005 and 2005b) do not challenge the conclusions reached in the EU RAR on the carcinogenic potential of 1,4 dichlorobenzene, nor do they impact on the ultimate conclusion reached by the Commission as regards the margin of safety for consumer risk (i.e. the drawing of Conclusion (iii) is supported).

A number of other papers have reported mechanistic investigations that provide some new insights into the mechanism(s) that may underlie the effect of 1,4 dichlorobenzene on the liver and the difference in response seen between rodent species.

Further work published by Gustafson *et al* in 2000 built on work considered in the EU Risk Assessment Report (Gustafson *et al*, 1998). The 2000 paper showed that there was no promotional effect of 1,4 dichlorobenzene on the development of glutathione-S-transferase (GSTP1-1) positive preneoplastic hepatic foci following diethylnitrosamine initiation of rats; this was unlike the response seen with a number of other chlorobenzene compounds known to be positive carcinogens in this species. This lack of effect was also shown to correlate with the absence of induction of CYP1A2 and CYP2B1/2 in these animals, which led the authors to conclude that the extent to which a chlorobenzene induces CYP1A2 or CYP2B1/2 may be a marker of carcinogenic promotional ability, at least in this species.

In a study published in 2003, Ou *et al* reported on the influence of a single dose (at 0.1 mol/kg) of each of a number of chlorobenzenes (including 1,4 dichlorobenzene) on the occurrence and subsequent progression of preneoplastic liver foci in F344 rats that were pre-induced by a single initiating dose of the carcinogen diethylnitrosamine. As such the study design was based on the 'medium-term' bioassay developed by Ito *et al* (1989). Under this method, cell proliferation was promoted by partial hepatectomy one week after dosing with the chlorobenzene and the numbers of glutathione-S-transferase positive foci (an indicator of pre-neoplastic status) assessed between 23 and 56 days after initiation.

Two clonal cell populations were identified as existing within the foci of which cells referred to as B-cells showed a selective growth advantage over either the type A-cells or normal hepatocytes. Furthermore, the growth rate of B cells was closely associated with the measured volume of foci at the end of the study period. This suggests that the B-cells are probably of particular importance for ultimate tumour progression. Interestingly, although time-dependent changes in foci were found to be very similar in the diethylnitrosamine initiated control and the diethylnitrosamine and 1,4 dichlorobenzene treated group, the other chlorobenzenes tested showed higher rates of foci growth (i.e. clear promotional activity).

Chou & Bushel (2009) have reported on a gene expression data analysis based on the Agilent Rat Oligonucleotide Microarray and fluorescent intensity measurement using a microarray scanner of liver samples from F344 rats exposed to substances with varying degrees of hepatotoxicity. Changes in gene profile were examined in animals killed after 6, 24 and 48 hours and cc-biclustering used to analyse the samples into groups according to phenotypic response (in this case, response in serum alanine transaminase (ALT) level). Subsequently hierarchical cluster analysis was used to aid interpretation. The substances tested included 1,4 dichlorobenzene, which was given orally at 15, 150 or 1,500 mg/kg. Liver histopathology indicated that hepatocyte necrosis was low for this chemical (no more than 5%), which was significantly less than seen with several other hepatotoxins investigated. Examination of response patterns for the genes examined suggested 1,4 dichlorobenzene treatment was not associated with any changes suggestive of DNA damage. Therefore, the authors concluded that the hepatic response to 1,4 dichlorobenzene in this species did not involve a genotoxic mechanism.

Muller (2002) in a review suggested that, in the mouse, the formation of hepatic adenoma and carcinoma may be attributed to the formation of substituted hydroquinone metabolites.

Kokel *et al* (2006) reported on the effects of 1,4 dichlorobenzene on the regulation of the genes involved in control of apoptosis in a genomically-characterised model species, the nematode *Caenorhabditis elegans*; these genes are well conserved between the nematode and humans. Effects on apoptosis were assessed by counting the number of cells in the anterior pharynx surviving to adulthood (a specific number of these cells normally undergo apoptosis as a part of normal development) for wild type and mutant strains of *C. elegans*, after exposure to the test substance during developmental stages. In addition, unexposed progeny of exposed nematodes were also examined to ascertain if there were heritable changes in the genomes of exposed organisms that were transmitted to their offspring. It was found that 1,4 dichlorobenzene would suppress apoptosis in both wild-type and mutant nematodes, though the magnitude of effect was greatest in mutants (for which apoptotic mechanisms are already compromised). It also influenced apoptosis rates at several developmental stages and for multiple cell types. Other effects noted with exposure at the levels that caused apoptosis included slow development, reduced brood size and some deaths but survivors appeared anatomically normal and showed no behavioural changes. The authors concluded that inhibition of apoptosis by 1,4 dichlorobenzene was by non-genotoxic mechanisms in *C. elegans*, and suggested that the tumourogenic effects seen in animals may represent non-genotoxic suppression of the apoptosis of latent cancer cells, thereby acting to promote their survival and proliferation.

Other Toxicological Evidence

Versonnen *et al* (2003) have reported on the oestrogenic potential of the various isomers of dichlorobenzene using a yeast screen (YES) assay and a zebrafish vitellogenin model. Although of only limited relevance to mammalian toxicity, it has also been reported that i.p. administration of 1,4 dichlorobenzene to *Carassius auratus* for 30 days caused a significant increase in serum testosterone concentration and hepatic GST activity in the treated carp but did not affect 17β-oestradiol level (Qian Y *et al*, 2004).

A limited potency of 1,4 dichlorobenzene relative to 17β-oestradiol of 2.2×10^{-7} in the YES assay but elevated vitellogenin levels were induced in fish exposed to 1,4 dichlorobenzene at concentrations of 10 mg/L or above suggesting that the substance might possesses endocrine mimicking properties. However, Takahashi *et al* (2007) have reported that 1,4 dichlorobenzene at a dose of 800 mg/kg/day s.c. was consistently associated with reductions in uterine and ovarian weights in rats and mice while doses greater than 400 mg/kg/day inhibited the uterotrophic effect of β-oestradiol in CD-1(ICR) mice when given i.p. Importantly, oestradiol-induced uterotrophy was inhibited in a dose-dependent manner in C57Bl/6N mice (arylhydrocarbon(AH)-responsive) but not in mice of the DBA/2N (AH-non-responsive) strain when 1,4 dichlorobenzene was co-administered at 204-4,000 mg/kg/day. Further experiments found that 1,4 dichlorobenzene did not bind to ERα at up to 10^{-3} M but i.p administration induced ethoxyreorufin-*o*-deethylase in female C57BL/6N mice, suggesting that it may be a weak antioestrogen, possibly operating via an AH-receptor mechanism.

A recent paper by Yan *et al* (2008) has also reported that 1,4 dichlorobenzene may possess the ability to interfere with acetylcholine receptor function, based on findings for a human neuroblastoma cell line. However, no evidence of similar effects occurring *in vivo* has been identified.

Environmental Exposure

As part of a comparative risk assessment of 1,4 dichlorobenzene and alternative fragrance/surfactant-based products, Aronson *et al* (2007) modelled exposure levels for 1,4 dichlorobenzene using a two-zone indoor air model (THERdbASE) drawing on a review of product emission data measurements undertaken to support the modelling of air levels in typical bathrooms and adjacent rooms. After review, it was decided to use one of the lower emission values (1.6 mg/minute) available as this was considered to be more predictive for modelling long-term home exposure levels. The modelled bathroom concentration on this basis was 1.53 mg/m^3 with a value of 0.492 mg/m^3 estimated for the remainder of house. The model did however predict considerable diurnal variation, with a mean bathroom level of 1.8 mg/m^3 in the morning and 3.6 mg/m^3 in the afternoon. Based on the modelled air levels, it was estimated that for a 70 kg adult spending 16 hours per day indoors, daily intakes might be of the order of 7.126 mg/day (0.1018 mg/kg/day).

Since 2002, several studies, mainly relating to USA cohorts, have reported on actual levels of 1,4 dichlorobenzene in outdoor and indoor environments and on the personal exposures and blood levels found in individuals.

Of the studies identified, only one study was identified that related to a European population. In this, ambient levels of 11.4 (maximum 90.4) µg/m^3 were reported for Coruña, Spain based on one-hour samples taken in the winter of 2000 (Fernández-Villarrenga, 2004).

Serrano-Trespalacios *et al* (2004) reported on the relationship between volatile organic compounds (VOCs) as measured by ambient monitoring stations and personal exposures monitored over a year for 90 inhabitants of Mexico City. These authors found lower ambient levels of 1,4 dichlorobenzene, reporting mean ambient, indoor and personal concentrations of 3, 9 and 50 µg/m^3 respectively. The authors noted that for a small number of the VOCs monitored (including 1,4 dichlorobenzene) geometric mean personal exposures were more than twice those for ambient air.

In a small study, levels of chlorobenzenes in three residential buildings in Brisbane, Australia were reported by Djohan *et al* (2007) as part of a wider risk assessment. The median levels of 1,4 dichlorobenzene varied between 0.03-0.34, 0.05-46.7 and 0.15-1.7 µg/m^3 for outdoor air, in toilets and in other rooms respectively, demonstrating that, while ambient levels may be relatively constant, there is considerable variation in concentration within different homes.

With regard to North America, a meta-analysis of data from 13 cross-sectional studies published between 1990 and 2001 on levels of VOCs in new and existing residences and offices was reported by Hodgson & Levin (2003). The overall geometric mean level of 1,4 dichlorobenzene was found to be 0.18 ppb (arithmetic mean = 1.3 ppb and median = 0.08 ppb; equivalent to geometric, median and arithmetic mean values of 1.08, 7.8 and 0.48 µg/m^3 respectively). The 95th percentile value was 0.57 ppb (3.4 µg/m^3) while the maximum values reported across five studies fell between 16 and 50 ppb (96.4 – 301.2 µg/m^3; geometric mean of maximum values = 26 ppb (156.6 µg/m^3)).

In the USA, as part of a study to assess air quality in schools, levels of 1,4 dichlorobenzene were measured in 20 classrooms (13 portable, 7 in main buildings) in seven randomly selected schools from two districts in Los Angeles County, California, USA by Shendell *et al* (2004). Measured levels ranged from not detected to 3.36 µg/m^3 in portable modular classrooms and from not detected to 10 µg/m^3 in classrooms in the main building.

Sax *et al* (2006), as part of the Toxics Exposure Assessment Columbia-Harvard (TEACH) Project, collected personal, indoor home and outdoor (near home) samples for a series of VOCs as well as other common pollutants of ambient air such as $PM_{2.5}$ and particle-bound elements during a series of sampling campaigns between 1999 and 2000. The study population were non-smoking teenagers from The Philip Randolph High School in Harlem New York and the Jefferson High School in central Los Angeles. Pooled median (max - min) values for personal samples, indoor home and outdoor levels were, for the New York cohort, 9.68 (min. 2.05, max. 313), 8.23 (max 1452.0) and 2.24 (max 34.1) µg/m^3 respectively. The corresponding values for the Los Angeles cohort were lower at 5.27 (min. 1.03, max. 341), 6.19 (max. 261) and 1.80 (max. 12.2) µg/m^3 respectively.

Levels of various VOCs were also measured outdoors, indoors (home and school) and with personal samplers for 113 children at two inner city schools in Minneapolis, USA in the year 2000 (Adgate *et al*, 2004). Measurements showed median outdoor, indoor-school, indoor-home and personal sampler levels of 1,4 dichlorobenzene to be 0.1 (10th %ile = 0.0 & 90th %ile = 0.2), 0.5 (0.1-1.1), 0.7 (0.1-344.6) and 1.0 (0.2-167.2) µg/m^3 respectively in winter, and 0.2 (0.1-0.4), 0.5 (0.1-1.1), 0.9 (0.2-429.0) and 1.3 (0.2-87.2) µg/m^3 respectively when sampled in spring. In an associated paper by Sexton *et al* (2005), blood samples were collected during 2000 and 2001 from the same children in the deprived areas of Minneapolis, USA for whom personal air samples reported in Adgate *et al* (2004); activity diaries were also collected. Mean blood levels were found to vary, ranging from 0.12 (10th %ile = 0.04, 90th %ile = 5.50) µg/L in May 2000 to 0.22 (0.05-13.00) µg/L in February 2001. Levels were found to be highest in African-American, Hispanic and Southeast-Asian children than in white or Native Americans.

The study by Elliott *et al* (2006) discussed above in relation to lung function, included the determination of blood levels for a number of VOCs in a US cohort of 953 adults (aged 20-59 years). The median blood level for 1,4 dichlorobenzene was 0.33 µg/L (10th %ile = 0.11 and 90th %ile = 3.89) with highest levels occurring in African-Americans. No information was, however, provided on the corresponding atmospheric levels to which they were exposed although the authors noted evidence suggesting that an ambient level of 10 µg/L would correspond to personal exposures of 102 µg/m^3 or above.

A study by Edelman *et al* (2003) reported on blood levels in US firemen attending the World Trade disaster and found blood 1,4 dichlorobenzene levels of 0.235 µg/L in the exposed group. Of wider relevance however, was the finding of a slightly lower value of 0.165 µg/L in a control group of 47 firefighters who had not attended the incident.

Sax *et al* (2004), as part of the TEACH project discussed above, identified that there were potentially significant indoor sources of 1,4 dichlorobenzene (overall emission rate of 19 mg/hour; equivalent to 0.32 mg/minute). An emission rate of 1.6 mg/minute was used by Aronson *et al* (2007) specifically in relation to 1,4 dichlorobenzene-based toilet blocks. This is slightly higher than the rate reported by Shinohara *et al* (2008) for moth repellent products containing 1,4 dichlorobenzene for which values of 0.0033 g/h (approx. equivalent to 0.055 mg/min) to 0.011 g/h (0.18 mg/min) were found for various products tested.

A study by Yoshida *et al* (2002) that was not included in the EU RAR, reported a close correlation (Pearson correlation coefficient of 0.81) between atmospheric 1,4 dichlorobenzene levels and urinary excretion of 2,5 dichlorophenol in a non-occupationally exposed population living in Osaka, Japan; the median 24-hour atmospheric level was 2.5 ppb (15.05 µg/m^3; maximum value 33.3 ppb, 200.6 µg/m^3) which correlated with a urinary 2,5 dichlorophenol of 0.39 mg/g creatinine (maximum 3.32 mg/g).

Although not addressing health endpoints, a study on 24 volunteers from Japan in which the exposure levels in living room and bedroom air and night time and morning urine samples were compared to assess the extent of correlation (Wang *et al*, 2007); although of limited size, this study found geometric mean living room and bedroom levels of 4.57 (0.7-58.8) and 3.34 (1.0-60.7) µg/m^3 respectively, and night and morning urine levels of 0.023 (0.005-0.082) and 0.027 (0.005-0.107) ng/ml respectively. In particular, bedroom air and morning urine levels of 1,4 dichlorobenzene showed a relatively high correlation (0.84) suggesting that use of morning urine samples in particular may be a useful biomarker of domestic exposure to this substance.

A3.1.3 Contribution of Recent Findings to the Understanding of the Hazard and Exposure Profile of 1,4 Dichlorobenzene

Recently published studies have provided further insight into the hazard profile of 1,4 dichlorobenzene and the levels of exposures faced by populations around the world.

The study by Hsiao *et al* (2009) on workers in Taiwan provides further evidence that high occupational exposure to 1,4 dichlorobenzene may result in liver changes in exposed workers. Of greater relevance is the demonstration of an apparently robust association between relatively low exposure and impairment of lung function in asthmatic children by Elliott *et al* (2006) since this suggests that there may be particularly susceptible sub-groups within a population that are at elevated risk at current environmental exposure levels thus emphasising the need to reduce exposure of the general public to this chemical. A number of other studies (discussed above), particularly in the US, have demonstrated that exposure of the general population remains an issue, particularly for the indoor environment.

Papers on the carcinogenic potential of 1,4 dichlorobenzene have been recently published by Aiso *et al* (2005 and 2005b). Irrespective of whether these constitute separate experiments or the same studies as were identified as JBRC (1995) in the EU RAR, the findings from the studies of Aiso and colleagues do not challenge conclusions reached in the EU RAR on the carcinogenic potential of 1,4 dichlorobenzene nor do they impact on the ultimate conclusion reached by the ESR rapporteur on the margin of safety for consumer risk (i.e. the drawing of Conclusion (iii) is still supported). Furthermore, some recent papers have provided additional evidence on the mechanisms underlying differences in carcinogenic response seen in rats and mice. It has been reported that 1,4 dichlorobenzene may have only a transitory promotional action on preneoplastic liver foci in rats (Ou *et al*, 2003) while Chou & Bushel (2009) have identified the absence of DNA-damage in rats thus providing further insight into the apparent lack of hepatic carcinogenic potential in the rat. Also of note, is the potential inhibitory action of 1,4 dichlorobenzene on apoptosis identified in *C. elegans* by Kokel *et al* (2006), since this provides strong support for the hypothesis that the carcinogenic effect of 1,4 dichlorobenzene in mice may operate through a non-genotoxic mechanism.

Some additional concerns about the hazard profile of 1,4 dichlorobenzene were raised by the studies of Makita (2004, 2005 and 2008) on the perinatal toxicity of 1,4 dichlorobenzene in rats. Also of note are findings that p,p'-DDE (an antiandrogen) appears to inhibit the reprotoxic effects of 1,4 dichlorobenzene while studies by Versonnen *et al* (2003) and Yan *et al* (2008) respectively, suggest the chemical may show hormonal and neuro-receptor activities.

A3.1.4 Recent Risk Assessments

Since the publication of the EU RAR, the US Agency for Toxic Substances and Disease Registry has published a detailed review of several dichlorobenzenes (DCBs) including 1,4 dichlorobenzene (ATSDR, 2006). This considers their hazard profiles, exposures and the risks posed. However, no consideration was given to the ecotoxicological consequences of environmental exposures. In addition to summarising available mammalian toxicity data on DCBs, the report notes that occupational levels of 1,4 dichlorobenzene may be high in factories that make or process 1,4 dichlorobenzene products (5.6 - 748 ppm) while in homes and public restrooms levels appear to be much lower but subject to significant variations (0.291 - 272 ppb; 1.75 – 1,638.55 µg/m^3). Outdoors, levels of 1,4 dichlorobenzene were considered generally low (0.01 - 1 ppb; 0.06-6.02 µg/m^3). It was also estimated that average daily adult intake was approximately 35 µg/person and that this mainly arose from inhalation of vapour from household products.

Although formally termed a toxicology profile, rather than a risk assessment, the ATSDR report presented health-based minimal risk levels (MRLs) for endpoints for which datasets were considered adequate; these are summarised in Table A3.1. The report also noted the opinion of the US Department of Health and Human Services (DHHS) that 1,4 dichlorobenzene can be reasonably anticipated to be a human carcinogen and that, with regard to carcinogenicity, EPA had verified an inhalation reference concentration (RfC) for 1,4 dichlorobenzene of 0.1 ppm (0.8 mg/m^3); this was based on a NOAEL of 75 mg/m^3 for the liver effects in rats and an uncertainty factor of 100.

Table A3.1: Minimal Risk Levels Established for 1,4 Dichlorobenzene – ATSDR (US)

Endpoint	MRL value (ppm)	Basis
Acute inhalation	2.0	NOAEL for irritant effects in workers = 15 ppm, adjusted by uncertainty factor of 10
Intermediate-duration inhalation	0.2	Benchmark dose value BMCL1 = 92.45 ppm, based on liver weight effect in male rats exposed for 15 weeks, adjusted for exposure duration- and physiologically-based species differences and applying an uncertainty factor of 100
Chronic-duration inhalation	0.01	Benchmark dose value BMCL10 = 9.51 ppm, based on nasal lesions in female rats exposed for 104 weeks (from Aiso *et al*, 2005), adjusted for duration- and physiologically-based species differences and applying uncertainty factor of 30 (3 for extrapolating from animals to humans and 10 for human variability)
Intermediate-duration oral	0.07 mg/kg/day	Benchmark dose value BMDL1 = 9.97 mg/kg/day, based on serum alkaline phosphatase (AP) level in female dogs over 6 months, adjusted to give daily exposure equivalent and applying uncertainty factor of 100 (10 for extrapolating from animals to humans and 10 for human variability)

Table A3.1: Minimal Risk Levels Established for 1,4 Dichlorobenzene – ATSDR (US)		
Endpoint	**MRL value (ppm)**	**Basis**
Chronic-duration oral	0.07 mg/kg/day	Benchmark dose value BMDL1 = 10 mg/kg/day, based on serum alkaline phosphatase (AP) level in female dogs over 1 year, adjusted to give daily exposure equivalent and applying uncertainty factor of 100 (10 for extrapolating from animals to humans and 10 for human variability)
Source: information summarised from ATSDR (2006)		

ATSDR (2006) also identified a number of essential or helpful additional data needs that would be required to fully characterise the risk profile of 1,4 dichlorobenzene; those relating to toxicity or exposure issues are summarised below (and relate specifically to 1,4 dichlorobenzene unless otherwise stated):

- **hazard profile**:
  - mechanistic data on non-lethal acute oral exposure effects on hepatic and renal changes in rodents, to provide basis for MRL derivation;
  - no data available on toxicokinetics of DCB isomers in humans and limited experimental data. Experimental information on acute, intermediate and chronic dermal toxicokinetics is needed; if dermal absorption and systemic distribution were demonstrated, appropriate toxicity studies would then be useful. Furthermore, other toxicokinetic data would be useful to quantify route-specific absorption rates and to compare toxicokinetics of isomers across species, particularly to inform on relevance to humans of animal study data on renal toxicity and carcinogenicity in male rats;
  - additional rodent inhalation data to verify that liver weight is the most appropriate endpoint for intermediate inhalation exposure;
  - additional occupational health data on chronic exposure for cancer and non-cancer endpoints;
  - additional information to define mechanistic basis of liver tumours in mice, to inform on relevance to humans;
  - there is no compelling need for additional studies on reproductive toxicity *per se* but post-natal neurobehavioral development is a sensitive end point that requires better characterisation;
  - studies to directly assess the immunotoxic potential in humans and supporting experimental studies would be helpful;
  - additional information on subtle behavioural changes at low exposures is needed to assess neurotoxic potential and dose-response; and
  - epidemiological studies to inform dose-response relationship for hepatic, haematological, and neurological systems, would be useful;

- **exposure issues**:
  - volatilisation, sorption, biodegradation, and bioaccumulation may be competing processes for removal of DCBs from water and additional data on the rates of reaction under various environmental conditions would be useful;
  - information on extent to which absorption can occur by dermal contact with soil or via swimming/bathing/showering would be useful;
  - while food does not appear an important source of human exposure to DCBs, additional data levels in foodstuffs, especially commercially important fish, shellfish, and plants, would be useful to confirm this assumption as would data on bioconcentration of DCBs by commercially important fish, shellfish, and plant species and on biomagnifications, to fully evaluate potential for food chain bioaccumulation and human exposure;
  - it would be valuable to have recent monitoring data on DCBs to estimate current human exposures. In particular, reliable monitoring data on DCB levels in contaminated media at hazardous waste sites and body burdens are needed to inform on the potential risk to populations in vicinity of hazardous waste sites. Additional monitoring data on the occupational exposure of workers to DCBs would also be helpful;
  - additional information on inhalation exposures from use of toilet air fresheners and moth balls containing DCBs would be useful to assess need for further health studies.
  - no exposure or body burden data identified on children; studies to quantify DCBs in amniotic fluid, meconium, cord blood or neonatal blood would be useful in assessing prenatal exposure. Maternal-foetal (including consideration of breast-milk) exposure evaluation would be helpful;
  - although inhalation is the most important exposure pathway in humans, consumption of moth crystals or moth balls by young children may result in exposure, so studies on inhalation and dietary intake are needed; and
  - studies on exposures of janitorial personnel and other occupationally exposed adults would help determine possible accumulation on work clothes and for carry over to their homes.

The World Health Organisation (WHO) has also recently published a Concise International Chemical Assessment Document (CICAD) on the environmental, but not human health, effects of chlorobenzenes other than hexachlorobenzene (WHO, 2004) that included consideration of 1,4 dichlorobenzene. Given that the focus of the current exercise relates specifically to human health, environmental risk findings are not included here for the sake of brevity.

An English-language version of a review originally published in Japanese in 2006 has also been released by the Japanese National Institute of Advanced Industrial Science and Technology (AIST, 2008) which addresses both human and environmental health issues but draws largely on other authoritative sources such as the EU RAR and reviews by the likes of ATSDR, WHO and IARC. A human health reference value is 800 µg/m^3 was derived from a NOAEL of 80 µg/m^3 from a chronic (2 year) inhalation study in mice for which non-neoplastic hepatic changes was taken as the key endpoint, and using an uncertainty factor of 100. The sub-population identified as being at risk were housewives, infants and preschool children, and elderly people in households with high-level 1,4 dichlorobenzene, and it was estimated that approximately 5.4% of the population (2.4% of the total population) would be exposed to levels which exceeded the reference value, indicating the need for actions to reduce indoor air 1,4 dichlorobenzene concentrations for these people.

Several individual research groups have also published on aspects of the human health risks associated with 1,4 dichlorobenzene.

Drawing on measurements of indoor (domestic) and outdoor atmospheric levels of 1,4 dichlorobenzene, Djohan *et al* (2007) estimated cumulative (life-time) exposures for a 70 kg adult using a Monte Carlo probabilistic-based approach for a scenario in which it was assumed that 0.5 hours per day were spent in the toilet, 16 hours in rooms and 0.5 hours outdoors. Probable exposure patterns were compared with health quotient values that had been derived from human equivalent dose-response estimates based on experimental (animal) data for the following body systems: blood; respiratory; eye; liver; urinary system; and nervous system. Under most exposure scenarios, no appreciable public health risk was found. It was only at the predicted very highest exposure (95% value) that risk quotients of greater than unity (ranging from 0.02 to 0.26) were found. Thus, the authors concluded that, for most residents, risk would be low and that a moderate to high probability of any adverse response would only be possible for individuals with pre-existing characteristics rendering them particularly sensitive (e.g. pre-existing metabolic disease, the elderly or those pre-sensitised to this chemical) who also receive exposures at the highest levels predicted for 1,4 dichlorobenzene.

However, in the study to compare cancer risks for non-smoking teenagers in New York and Los Angeles discussed above, Sax *et al* (2006) compared personal exposure measurements with inhalation unit risk factors for the development of cancer from exposure to 1 µg/m^3 of a compound over a 70 year lifetime, to estimate the level of risk faced by the study populations from a number of VOCs and particle-bound metals. In the case of 1,4 dichlorobenzene, based on Californian EPA-derived risk factors, the mean upper-bound excess risk per million population was 458 (median 106; 90th %ile 1,049) and 403 (median 58.0; 90th %ile 1,065) for the New York and Los Angeles study groups respectively. Furthermore, the authors noted that the distribution of risk across the study cohort was not uniform with the highest-risk quartile for this chemical accounting for 65% of the total risk (all compounds considered) in New York and 75% for Los Angeles and the authors stated that exposure was principally attributable to indoor sources, including moth balls and room deodorisers and considered that the use of these products contributed to the increased risk found. The authors also noted that comparison of the findings of this study (based on actual measurements) with predictions based on US EPA model estimates of exposure, suggested that the US EPA model had underestimated exposures and hence risk.

Factors associated with the risk of developing asthma was assessed in a case-control study on young Australian children by Rumchev *et al* (2004) who found that significant risks existing for exposure to a number of VOCs, particularly ethylbenzene and toluene. A small risk (OR 1.04; 95% CI 1.02 to 1.06) was also found when total exposure values for three isomers of dichlorobenzene were considered. However, as noted above, exposures to the 1,2 and 1,3 isomers rather than the 1,4 form, were higher in cases than controls suggesting that the detected association is unlikely to be attributable to the 1,4 isomer.

Aronson *et al* (2007) have reported a comparative risk assessment for the domestic use of a 1,4 dichlorobenzene- and two fragrance/surfactant-based toilet rim block products containing complex mixtures of fragrances (comprising 25 components in one product and 95 in the other; specific substances identified in the alternative products included phenyl ethyl alcohol, camphor, eucalyptol, citronellyl nitrile, linalool, α-pinene and geraniol). Exposure levels estimated using a THERdbASE model based, for 1,4 dichlorobenzene, used published emission rate data on toilet rim products and, for fragrance components in the alternative products, used volatilisation rates derived from Henry's Law constant using conservative assumptions. The THERdbASE model generated state-state exposure estimates for the bathroom and adjacent rooms based upon assumed exposure periods of 16 hours per day spent indoors. Based on a release rate of 1.6 mg 1,4 dichlorobenzene/min, air levels of 1.53 mg/m^3 in the bathroom and 0.492 mg/m^3 in other rooms were estimated which were considered by the author to be similar to actual measured levels from other studies. Estimated daily adult intake of 1,4 dichlorobenzene from this source was estimated at 0.1018 mg/kg/day. In contrast, conservative estimates of air levels arising from use of the alternative products suggested individual fragrance exposures would be at least 100-times lower while the combined exposure for all fragrances were at least one-fold below that of the 1,4 dichlorobenzene-based product. Comparing these exposure levels to available hazard information on each chemical, it was estimated that the toxicity of the fragrances would have to be significantly greater than that of 1,4 dichlorobenzene for the fragrances to represent an overall hazard quotient similar to that posed by 1,4 dichlorobenzene. Indeed, even if it were assumed that each fragrance had hazardous properties equivalent to the most toxic of the fragrances considered, overall hazard quotients for the fragrances were estimated to be 0.1 and 0.2 for each of the two alternative products considered, compared with an estimated hazard quotient value of 3 for the 1,4 dichlorobenzene-based product.

Butterworth *et al* (2007), applying benchmark dose analysis techniques to the combined data set for the inhalation and oral dose carcinogenicity studies considered in the EU RAR (with adjustment for route-specific absorption), established the atmospheric exposure level and oral dose that would associate with a 1% extra risk. Applying an uncertainty factor of 300 to the point of departure thus established, suggested that an atmospheric level of 0.1 ppm (approx. 600 µg/m^3) would equate with a level at which there was unlikely to be any increased lifetime risk of cancer. They contrasted this conclusion with the estimate given by a model that derives a one in one million increased lifetime risk of cancer based on an assumed genotoxic mechanism which suggested a value of 0.00004 ppm. The difference, approximately 2,500-fold, was noted by the authors to be significant. However, it should be noted that even this revised estimate of the 'no lifetime risk of cancer' exposure level is, in some cases, markedly below the atmospheric levels reported or estimated for populations by some of the studies reported above and is comparable with the realistic worst-case for daily continuous exposure value of 850 µg /m^3 (600 -1150 µg/m^3) used in the EU RAR in relation to consumer exposures.

Most recently, McCarthy *et al* (2009) have assessed the risk posed to the general US population by a range of pollutants including 1,4 dichlorobenzene based upon ambient air monitoring data drawn from the US EPA Air Quality System (AQS) for the period 2003 to 2005. Although noting that there was a significant degree of uncertainty with regard to the estimates, the authors reported that comparison of the exposure data with the existing Office of Air Quality Planning and Standard (OAQPS) for chronic cancer health benchmark (0.000011 µg/m^3) for 1,4 dichlorobenzene indicated that a cancer risk level of 10^{-6} was or could potentially be exceeded for 33% or 51% respectively of the locations for which data were available.

A3.1.5 Other Developments

In December 2008, the US EPA published a revised final re-registration eligibility decision allowing the use of 1,4 dichlorobenzene in moth ball products provided that appropriate risk mitigation measures are adopted and labels amended (US EPA, 2008). Based upon a review of available toxicity data which it judged to be sufficient and reliable, the most sensitive NOAEL for all exposure duration scenarios was reaffirmed as 20 ppm in a chronic inhalation study and 55 ppm in a 13-week inhalation study in rats. In relation to consumer exposures, when considering non-cancer endpoints, the US EPA recognised inhalation and dermal exposure when handling moth balls at the time of application as being of possible concern. However, as no appropriate data on handler inhalation exposure under such conditions were available, they only considered exposure via the dermal route for this scenario (using data on naphthalene). The rationale given for not attempting the inhalation exposure estimation was that risks associated with short-term post-application inhalation had been shown to be acceptable and were considered also sufficiently protective for the handler scenario. Since the derived margin of exposure (MOE) for dermal contact was high (33,000 - 224,000), this scenario was not considered of further concern. Consideration was also given to inhalation exposure from use of moth balls in closets and drawers over various periods; all scenarios considered gave MOEs greater than 30 (stated to be the Agency's level of concern, LOC), so it was concluded that no mitigation measures were necessary. The possible risk associated with episodic ingestion of moth balls by children was not considered since the EPA considered that an acute effect endpoint for the oral route had not been identified.

Cancer risk estimates were also derived for consumers handling moth balls during application and for inhalation by individuals living in residences containing such products. These were based on the data for liver tumour effects in mice and used a linear low dose extrapolation model and an assumed exposure period of 50 years during a 70 year lifespan. On this basis, the estimated cancer risk via the dermal route was 4.9×10^{-8} to 7.1×10^{-9} and that for post-application inhalation was 6.0×10^{-5}. Since the US EPA considered the mechanism of tumourogenesis would require sustained mitogenic stimulus and hepatocyte proliferation, consideration was also given to comparing levels at which a response was predicted to occur in 10% of exposed animals with the exposure (0.021

mg/m^3) predicted for homes using these products. The Agency estimated that there would be a 1000-fold margin of safety between the experimental level causing a 10% tumour response in animals at the lowest measurable incidence, and home exposure.

As a result of the review, the US EPA concluded that moth ball products containing 1,4 dichlorobenzene could be reregistered for a variety of uses (including domestic non-food handling applications) provided that additional chamber studies were conducted to establish the maximum air levels that could arise from use of moth balls at the maximum rate specified on the product label, and that enhanced labelling requirements were met (including provision of additional guidance on use of appropriate protective clothing and hygiene practices, and warnings regarding ensuring that product was not accessible to children at any stage during use).

It should be noted that the conclusions reached by the US EPA relate only to the use of 1,4 dichlorobenzene in moth balls. Specifically, the use of this chemical as a toilet deodoriser was not considered and therefore the conclusions reached are not of direct relevance to the current project. Also, no novel hazard information was presented which would suggest a need to reassess conclusions in the EU RAR.

Despite the US EPA decision, it appears that actions are still being progressed at State level within the USA to reduce use of 1,4 dichlorobenzene. For more detail, see discussion in Section A2.6.5 of Annex 2.

A3.2 Documented Accidents and Diseases from Exposure to 1,4 Dichlorobenzene

The RPA questionnaire used in the consultation with Member State Competent Authorities also enquired on accidents/incidence of disease occurring as a result of consumer exposure to 1,4 dichlorobenzene from air fresheners or toilet blocks. The information collected to date is summarised in the following table.

Table A3.2: Information on Accidents and Diseases from Exposure of Consumers to 1,4 Dichlorobenzene from Air Fresheners and Urinal Blocks

Country	Response	Source
Austria	No data	Austrian Federal Ministry of Environment (2009)
Cyprus	One complaint was registered in 2008 for people suffering from dizziness due to exposure to air freshener fumes. The information provided on the SDS of the air freshener stated that it contained a mixture of branch chain aliphatic hydrocarbons 20 to 90% (CAS 64742-47-8 and 64741-65-7). No information was provided on any 1,4 dichlorobenzene content.	Cypriot Department of Labour Inspection (2009)
Estonia	According to the Estonian National Poison Information Centre, no information has been received on possible accidents/incidents of disease in Estonia occurring as a result of consumer exposure to 1,4 dichlorobenzene from air fresheners or toilet blocks.	Estonian Ministry of Social Affairs (2009)

Table A3.2: Information on Accidents and Diseases from Exposure of Consumers to 1,4 Dichlorobenzene from Air Fresheners and Urinal Blocks

Country	Response	Source
Finland	According to the Helsinki Poison Information Centre, there have been: • one case of a 1-year-old tasting a 1,4 dichlorobenzene-containing air freshener in 2008; • two cases related to 1,4 dichlorobenzene in moth balls in 2008 (product was 100% 1,4 dichlorobenzene, no longer on the market); and • six cases of small children tasting 1,4 dichlorobenzene-containing air fresheners in 2007. No allergic reactions have been connected to 1,4 dichlorobenzene (Asthma and Allergy Association).	Finnish National Supervisory Authority for Welfare and Health (2009)
Germany	According to the Poison Information Ordinance (§ 16e of the German Chemicals Act), seven cases of adults in occupational context are known to the German Federal Institute for Risk Assessment (data since 1990): • severity low: three cases with eye exposure, one case with dermal exposure; and • severity medium: three cases with respiratory exposure (short-term impairment of health, no long term consequences). These accidents involved exposure to the pure substance rather than to the products of concern.	German Federal Institute for Occupational Safety and Health (2010)
Ireland	Between 1 January 2004 and 3 November 2009, the National Poisons Information Centre of Ireland (NPICI) had received 17 enquiries about solid/gel air fresheners. Two of these products did not contain 1,4 dichlorobenzene. The ingredients of 14 products were not known/not documented. One product contained 1,4 dichlorobenzene: The enquiry concerned a 1-year-old boy who had ingested some air freshener block. He had gagged and had been short of breath initially but this had settled by the time NPICI was contacted. NPICI received 151 enquiries about toilet blocks (including rim and cistern blocks). 76 of these products did not contain 1,4 dichlorobenzene. The ingredients of 72 products were not known/not documented. Three products contained 1,4 dichlorobenzene: these enquiries concerned ingestion by young children (one three-year old and two one-year olds) and they were all asymptomatic.	Irish Health and Safety Authority (2009)
Latvia	Latvian Competent authorities do not have any statistical information on accident/incidence of disease occurring from 1,4 dichlorobenzene containing air fresheners or toilet blocks.	Latvian Environment, Geology and Meteorology Centre (2009); Latvian Ministry of Health (2009)
Lithuania	No data on incidents with 1,4 dichlorobenzene-containing products observed.	Lithuanian State Non Food Products Inspectorate (2009)

Table A3.2: Information on Accidents and Diseases from Exposure of Consumers to 1,4 Dichlorobenzene from Air Fresheners and Urinal Blocks		
Country	**Response**	**Source**
Netherlands	A search, over the period 2004-2009, of the data base of the National Poisons Information Centre (NVIC) of the Netherlands revealed no accidents or diseases due to exposure to 1,4 dichlorobenzene from air fresheners or toilet blocks.	RIVM (2009)
Norway	During the last couple of years, the National Poisons Information Centre in Norway had 448 enquiries on air fresheners and 43 on toilet blocks. In most cases the involved persons describe intestinal irritation or irritation to the eye. These symptoms are ascribed to other substances in these products. Rash was reported in 3 of the enquiries. The product names for these cases are not available, hence it is not possible to tell whether 1,4 dichlorobenzene was involved.	Norwegian Pollution Control Authority (2009)
Poland	No information is available. There is no national poison centre in Poland; hence it is not possible to obtain such data.	Polish Bureau for Chemical Substances and Preparations (2009)
Slovakia	No data	Slovak Trade Inspection (2009)
Slovenia	The Slovenian authorities have not provided information on incidents occurring in the country although they note the "*offensive smell*" of the relevant products.	Chemicals Office of the Republic of Slovenia (2009)
Switzerland	According to the Swiss poison centre there have been 67 incidences since 1995. The products involved were moth repellents, air-fresheners and toilet blocks. Most of the cases were considered as slightly harmful and have been resolved directly on the phone with some simple measures. In six cases, health professionals were consulted and the poison centre received a feedback (5 humans and 1 dog). Three infants, one adult and one dog ingested orally a small quantity of a 1,4 dichlorobenzene containing product. In one case (an infant) slight mucosa irritation of the lower lip was observed. The breakdown of these cases among the different product types is as follows: • urinal blocks: 10 cases, no feedback on progress; • air fresheners: 4 cases, 1 case with feedback (adult), asymptomatic progress; and • moth repellents/other biocidal products: 53 cases, 5 cases with feedback on progress (including the 3 cases with children, all moth repellents).	Swiss Federal Office of Public Health (2009 & 2010)

ANNEX 4

MARKET INFORMATION FOR SELECTED NON-EUROPEAN COUNTRIES

ANNEX 4. MARKET INFORMATION FOR SELECTED NON-EUROPEAN COUNTRIES

A4.1 Introduction

The following paragraphs summarise the available information collected from literature and consultation on the manufacture, use, imports and exports of 1,4 dichlorobenzene and its key products in Australia, Canada, Japan, New Zealand and the USA.

A4.2 Australia

A4.2.1 Manufacture, Use and Exports of 1,4 Dichlorobenzene

According to data published in 2000 (NICNAS, 2000), up to 1,000 tonnes of 1,4 dichlorobenzene were imported and used annually in Australia. It was primarily used as a deodoriser in toilet blocks, in household toilet bowls and as an air freshener. It had some minor uses in the agricultural and pharmaceutical industries (NICNAS, 2000).

The manufacture of 1,4 dichlorobenzene did not occur in Australia; imports between 1995 and 2000 typically ranged between 500 and 1,000 tonnes per annum. In 1998, five companies imported 1,4 dichlorobenzene into Australia and only one company was identified as an importer of a finished product (a pharmaceutical) containing 1,4 dichlorobenzene. The imported raw material was used in the formulation of air freshener and toilet deodorant blocks and, to a lesser extent, insect repellent blocks and veterinary products (NICNAS, 2000).

A survey of the handling and uses of dichlorobenzenes was undertaken by NICNAS. The survey identified the following areas and sectors of industry in which 1,4 dichlorobenzene is regularly used, mostly as an air freshener/deodoriser and predominantly in toilet facilities:

- State Government (public buildings, police stations, correctional institutions);
- council buildings (public toilet facilities);
- schools (public and private);
- motels/inns/caravan parks/resorts;
- hotels/leagues clubs/service clubs/night clubs;
- sporting clubs and sporting facilities (e.g. bowls clubs);
- industry (company toilets, transport, packaging, automotive and marine sector);
- cleaning industry (associated with cleaning the facilities in the above areas); and
- household use (as an air freshener/deodorant and moth/silverfish repellent).

A small quantity of 1,4 dichlorobenzene products (air freshener and toilet deodorant blocks) for export was identified. The amount of material exported accounted for less than 1% of all raw material imported into Australia (NICNAS, 2000).

A4.2.2 Breakdown of Uses of 1,4 Dichlorobenzene

Toilet blocks were found to account for 85% of 1,4 dichlorobenzene use with a further 13% associated with air fresheners. An estimated 5 tonnes per year (less than 1%) of 1,4 dichlorobenzene were used in the agricultural sector. NICNAS also provides a list of products containing 1,4 dichlorobenzene that were marketed in Australia in 1998/99. At the time, the seventeen named products contained a concentration of 1,4 dichlorobenzene ranging between 97.5% and 100% by weight (NICNAS, 2000).

A4.3 Canada

In 1993, 1,4 dichlorobenzene was produced in and imported into Canada; in the few years before 1993, the amount imported into Canada had increased while domestic production had declined. Approximately 3,500 tonnes per year were used in Canada as an air freshener, as a deodoriser in urinals, and as a moth and bird repellent. This number was not expected to change during the following five years (Environment Canada & Health Canada, 1993).

Quantitative data on use patterns for this substance were only identified for the period 1977 to 1979, when 9.3% of the annual demand was used in the production of deodorant blocks, and 0.7% was used in the production of moth crystals (Environment Canada & Health Canada, 1993). A more recent source presents a list of potential sources of 1,4 dichlorobenzene in wastewater in North America which could give insights to the industries that use the substance. The list is reproduced in Table A4.1.

Table A4.1: Overview of Sectors Potentially Using 1,4 Dichlorobenzene in North America

Chemical manufacturing sub-sectors	**Use of 1,4 dichlorobenzene**
Basic chemical manufacturing	Intermediate/by-product in chemical manufacturing Production of dyes
Resin, synthetic rubber, and artificial synthetic fibres, and filaments manufacturing	Use in production of polyphenylene sulphide resin
Pesticide, fertiliser, and other agricultural chemical manufacturing	Use in pesticide manufacturing
Pharmaceutical and medicine manufacturing	Intermediate in synthesis of pharmaceuticals
Soap, cleaning compound, and toilet preparation manufacturing	Manufacture of air fresheners and urinal deodorisers
Other chemical product and preparation manufacturing	Aerosol can manufacturing; intermediate/by-product in chemical manufacturing
Cleaning and laundry sector	**Use of 1,4 dichlorobenzene**
Dry cleaning and laundry services	Chemicals used in the laundering process Dyes and moth-proofing material washing off in post treatments
Linen and uniform supply	Chemicals used in the laundering process Dyes and moth-proofing material washing off in post treatments during processing

Table A4.1: Overview of Sectors Potentially Using 1,4 Dichlorobenzene in North America	
Chemical manufacturing sub-sectors	**Use of 1,4 dichlorobenzene**
Textiles sector	**Use of 1,4 dichlorobenzene**
Fibre, yarn, thread mills	Insecticidal fumigant against clothing moths, mildew and mould repellent for textiles finishing Dyes Insecticide and fungicide on crops (and so may be present in incoming raw natural materials used by mills) Deodorant for garbage, as a room deodoriser, and in restroom urinal and toilet bowl blocks
Fabric mills	As above
Textile and fabric finishing and fabric coating	As above
Source: XCG Consultants (2006)	

A4.4 Japan

The total quantity of 1,4 dichlorobenzene manufactured and imported in Japan is ca. 40,000 t/y. 30,000 tonnes are used as intermediate for other chemicals and 10,000 tonnes are used in the manufacture of consumer goods, according to the reporting required under the Japanese Chemical Substance Control Law (CSCL) (Fukushima, 2009).

Some 90% of consumer use is in repellent and some 10% is in deodorisers. The latter use may include air fresheners and/or toilet blocks (Fukushima, 2009).

Older information for the years 1997-2002 indicates that the consumption of the substance in the manufacture of deodorisers gradually reduced from 2,100 tonnes in 1997 to 900 tonnes in 2002 (AIST, 2008).

A4.5 New Zealand

Information has been received from the Environmental Risk Management Authority of New Zealand (ERMANZ, 2009). The Authority has indicated that New Zealand does not have a significant chemicals manufacturing industry and, in all likelihood, 1,4 dichlorobenzene is not manufactured in New Zealand. It may be imported for use in the manufacturing of products or it may be imported in finished products. The Authority does not hold any information on the quantities imported.

A4.6 United States of America

A4.6.1 Manufacture of 1,4 Dichlorobenzene

Production of 1,4 dichlorobenzene in the USA rose from approximately 6,800 metric tons in 1981 to approximately 32,600 metric tons in 1993. The production volume of 1,4 dichlorobenzene reported by manufacturers in 1998 and 2002 was in the range of >23,000–45,000 metric tons) (ATSDR, 2006).

1,4 dichlorobenzene was until recently produced by three US companies. Consultation suggests that these companies have now ceased production of chlorobenzenes.

A4.6.2 Imports and Exports of 1,4 Dichlorobenzene

In 1978, about 11 tonnes of 1,4 dichlorobenzene were imported into the USA (HSDB 2005; NTP 1987). Import volumes increased to 3,020 tonnes by 1994 (ATSDR, 2006). In 1990, the USA exported about 25% of its 1,4 dichlorobenzene production volume. Export volumes of the substance were ca. 11,000 tonnes in 1994 (ATSDR, 2006).

Although reported export values for 1,4 dichlorobenzene show that considerable amounts of the substance have been sent to other countries in previous years, the production volumes for the chemical have been consistently higher suggesting that more than half of the amounts produced each year remained in the USA (ATSDR, 2006).

We consulted the Inventory Update Reporting database[41]; this database indicates imports by two US companies[42].

A4.6.3 Use of 1,4 Dichlorobenzene

For the past 20 years, 1,4 dichlorobenzene has been used principally (25-55% of all uses) as a space deodorant for toilets and refuse containers, and as a fumigant for control of moths, moulds and mildews. In recent years, the use of 1,4 dichlorobenzene in the production of polyphenylene sulphide (PPS) resin has increased steadily (25-50% of its total use). 1,4 dichlorobenzene is also used as an intermediate in the production of other chemicals such as 1,2,4 trichlorobenzene (approximately 10%). Minor uses of 1,4 dichlorobenzene include its use in the control of certain tree-boring insects and ants, and in the control of blue mould in tobacco seed beds (ATSDR, 2006).

The US Consumer Specialty Products Association claimed in 2006 that the chemical may still be found in some urinal blocks, moth balls, and hanging deodorisers, but has not been widely used in household products for many years and is not in any air fresheners. In fact, actions by the California Air Resources Board two years ago, which were reportedly supported by the Consumer Specialty Products Association, effectively ended the use of the chemical in virtually all consumer and commercial products at the beginning of 2006 (CSPA, 2006).

Finally, we performed a search in the US Household Products Database[43]. The search suggests that only four household products containing 1,4 dichlorobenzene are available on the consumer market, all of which are moth repellents typically containing >95% of 1,4 dichlorobenzene.

41 Available here: http://www.epa.gov/oppt/iur/.

42 It should be noted that only sites that manufactured (this includes import) more than 25,000 lbs. would have reported to the Inventory Update Reporting database.

43 The entry for 1,4 dichlorobenzene is available here: http://hpd.nlm.nih.gov/cgi-bin/household/brands?tbl=chem&id=1992&query=dichlorobenzene&searchas=TblChemicals.

ANNEX 5

IDENTITY, HAZARDS AND COST OF ALTERNATIVES

ANNEX 5. IDENTITY, HAZARDS AND COST OF ALTERNATIVES

A5.1 Overview of Alternatives to 1,4 Dichlorobenzene-based Air Fresheners

A5.1.1 Changes in the Market

As discussed in the main part of this report, there are two key areas of application for 1,4 dichlorobenzene-based air fresheners: in smaller size as room deodorisers and in larger size as industrial deodorisers in sewers, industrial waste containers and lift shafts. Our focus is the use in rooms of domestic dwellings rather than industrial/professional uses.

In the last decades, air fresheners have become an important consumer goods category appreciated by consumers and present in their daily life. AISE (2007) notes that there are certain social trends underlying the increase in the use of air fresheners. These include:

- **social trends**:
  - smaller homes (allowing odours to spread more easily in homes);
  - increasing migration of populations to large cities (where windows are less frequently open);
  - increased time spent indoor (80% - 90%); and
  - increase in external stress (creating a need for 'relaxation' at home);
- **technological trends**:
  - ability of breakthrough technology to deliver fragrance in closed spaces (e.g. electric/battery diffusers); and
- **scientific knowledge**:
  - research on the relation between perfumes and psychological state (e.g. pleasant odours have a positive impact on consumer's mood).

A5.1.2 Types of Air Freshener Products

There are a number of different types of products available on the market that could be considered to fall under the category of "air fresheners" (as presented in RIVM, 2006):

- **room perfumes in holders**: this is a large group of scented products, comprised of perfumes enclosed by a container, such as a glass disc or plastic flask, from which the scent is released slowly over time. The perfume can be in the form of a water-based or solvent-based liquid, a gel, or a solid soap-like substance. Electric diffusers have been available on the market for several years;
- **fragrant candles and wax**: wax candles made of a fragrant wax, or sole wax. The scent is released by burning the candle or heating the wax;

- **ethereal oils**: fragrant oils that generally need heating before the scent is released fully. Candles or other warm objects such as lamps can heat the oils;
- **fragrant sachets**: bags of textile such as lace or cotton filled with synthetic or natural scented products, such as lavender bags. The sachets can be placed in a room, but usually are placed between clothes and linen;
- **sprays**: many scented products are available in the form of aerosol spray cans or bottles. The product is often dissolved in volatile solvents, although some sprays may be water-based;
- **potpourri**: mix of (dried) flowers, fruits or other material, with natural scent or impregnated with perfume. The mix is placed in an open container; and
- **incense**: cones or sticks of resin-like material that release the scent when burnt.

RIVM also mentions air freshener products that cannot be considered to be potential replacements for 1,4 dichlorobenzene-based products such as:

- **fragrant cardboards**: pieces of cardboard, usually in the form of a leaf or other decorative figure, impregnated with perfume. They are commonly suspended from rear view mirrors in cars (hence cannot be considered as being possible replacements for 1,4 dichlorobenzene-based air fresheners);
- **ironing perfumes**: a liquid perfume to be added to the water container in a steam iron. The scent is released when the appliance is switched on; and
- **vacuum perfumes**: ball of material to be placed in the vacuum cleaner. The scent is released when the appliance is switched on.

It should be noted that the RIVM report also includes toilet rim blocks in this list of air fresheners.

RIVM further explores the location of use and the scent release pattern of different air fresheners. Location is considered to be important in determining exposure (as it affects ventilation and air volume and also because multiple sources of chemicals in scented products can be present in one room). On the other hand, for some products, no specific action is needed to release the scent, such as for fragrant bags, potpourri and room perfumes in holders. Other products may require a specific application, such as use of a spray. The different application types result in different exposure levels, with regard to duration and amount of immediate release. The purpose of some products is to spread a constant pleasant scent in a room (‘constant release pattern’). Other products are used only once or at intervals, releasing relatively high levels of fragrance chemicals with the source of the scent often possibly being switched on and off in-between. It is inherent to sprays that the products are released during a relatively short period of time. Other examples of products in this category are scented candles and incense cones. The purpose of these products is to temporarily spread a pleasant scent, the aim sometimes being that of masking an unpleasant smell (‘peak release pattern’) (RIVM, 2006).

Table A5.1: Location, Application and Scent Release Pattern for Different Air Fresheners			
Product type	**Location of use**	**Application types**	**Scent release pattern**
Room perfume in holders	Living-room, bedroom, kitchen, toilet, garage, car, office, stores	Electric plug, ventilation, no specific action	Constant
Fragrant candles and wax	Living-room, bedroom, stores	Heating, Burning	Peak
Ethereal oils	Living-room, bedroom, sauna, office, stores	Heating	Peak
Fragrant sachets	Living-room, bedroom, kitchen, toilet, garage, car, office, stores	No specific action	Constant
Sprays	Living-room, bedroom, kitchen, toilet, garage, car, sauna, office, stores	Spray on targeted spot, general surfaces, or in air space	Peak
Potpourri	Living-room, bedroom, kitchen, toilet, garage, car, office, stores	No specific action	Constant
Incense	Living-room, bedroom, stores	Burning	Peak
Source: RIVM (2006)			

Discussions with manufacturers of 1,4 dichlorobenzene-based air fresheners and toilet blocks suggest that alternative air fresheners have already made significant inroads into the EU market (as well as elsewhere) and present very competitive solutions compared to 1,4 dichlorobenzene-based air fresheners. A non-EU manufacturer of these products has noted that he would normally specify 1,4 dichlorobenzene-based products only when odour masking is required in an industrial setting (where large 'super blocks' may be used) rather than in small (toilet) rooms.

Apart from chemical alternatives, better ventilation and more frequent cleaning of rooms could also be considered as an alternative to using 1,4 dichlorobenzene-based air fresheners at home.

A5.2 Overview of Alternatives to 1,4 Dichlorobenzene-based Toilet Blocks

Among toilet blocks based on 1,4 dichlorobenzene, urinal blocks (for use by professional users) rather than toilet rim blocks have traditionally found the widest use. In fact, 1,4 dichlorobenzene has traditionally been the substance of choice for urinal blocks. In the 1990s, development of alternative products was under way with surfactants being the key ingredient in the new urinal blocks. A quick research on patents of 1,4 dichlorobenzene-free blocks has revealed proposed alternative compositions being filed as early as 1994 (for instance, see Van Vlahakis *et al* (1994) for a composition based on surfactants, germicide and enzymes). It is likely that replacement of 1,4 dichlorobenzene started earlier in toilet bowl rim blocks[44] and more recently (and is still ongoing) in urinal blocks.

[44] Characteristically, a European patent application filed in 1989 by the UK-based company Bush Boake Allen regarding a new toilet deodoriser (rim block) makes reference to "*allegations of environmental toxicity*

Later additions to urinal blocks were bacteria cultures, which can potentially remove the fats and solids that build up in urinal traps and pipework, causing odours, slow running outlets and flooding.

Hereby, we focus our analysis on alternatives for toilet rim blocks that may be used by private consumers at home. Generally, surfactant-based blocks are the main alternatives to 1,4 dichlorobenzene-based products. Some quick research around the shelves of supermarket retailers would indicate that readily available alternatives may include:

- **in-cistern blocks**: these are placed inside the water tank and are slowly released every time the toilet bowl is flushed. They often contain a dye (normally blue) which dye the flushing water;
- **in-bowl blocks**: these are tables that are deposited in the standing water in the bowl where they offer mostly cleaning action rather than deodorising;
- **solid rim blocks**: these are solid cylinders or cuboids based on surfactants which release small quantities of chemicals with every flush;
- **liquid toilet rim blocks**: these are more modern surfactant-based liquids contained in plastic cages which are released in the toilet bowl with every flush. Some of these products may have two separate compartments, one containing a cleaning liquid with the other containing a deodoriser;
- **solid rim block with deodorising gel**: these are recently developed multi-compartment rim blocks which contain a solid cleaning element accompanied by gel component(s) aimed at deodorising the toilet bowl;
- **toilet discs**: also recently developed, these are gel discs which are deposited inside the toilet bowl (i.e. they do not come inside a container) and gradually release cleaning and deodorising ingredients every time the toilet bowl is flushed. The discs are deposited with an applicator and they are promoted as preventing the development of dirt or germs on and around the cage that toilet rim blocks usually come with.

Other solutions could include:

- use of other air fresheners which would not specifically deodorise the toilet bowl but would mask odours in the entire toilet room (e.g., gels, liquids, aerosols etc);
- more frequent and more thorough cleaning – this may involve the use of liquid or thick liquid chemicals which are squeezed out of bottles and around the toilet bowl, are left for some time and then a manual brush, small mop, or other device is used to scrub the bowl. Products that clean inherently provide deodorising benefits; and
- better ventilation conditions.

problems (which) have made PDCB an undesirable ingredient in such toilet block compositions" (Bush Boake Allen, 1989).

A5.3 Example Compositions of Alternative Air Fresheners and Urinal Blocks

We have looked into the compositions of alternative products. The main source of information has been Safety Data Sheets of products sold in the EU as well as outside the EU. For air fresheners in particular, as there is a variety of products that could in theory be considered as alternative to 1,4 dichlorobenzene-based products, we have opted for examining the composition of sold/gel alternatives only as these products could be considered to be 'direct' alternatives (since 1,4 dichlorobenzene-based products are also solid). Naturally, other options are available (for instance, aerosol sprays) but within the time and budget limitations of this project we were not able to look into all possible options. For toilet rim blocks, our analysis also focuses on 'direct' alternatives, i.e. toilet rim blocks that are intended to be hung on the rim or a household toilet bowl.

Our findings are summarised in the two tables that follow; these list the different substances identified as components of alternatives. These are presented in groups of substances of similar functionality (i.e. fragrances, surfactants, etc.). The two tables have been used in the selection of representative substances to be compared to 1,4 dichlorobenzene in terms of human health and environmental hazards later in this Annex.

Table A5.2: Summary of Encountered Components of Alternative Air Fresheners (Solid/Gel)

*	Name	CAS No	Example conc. %	Key functionality
	Caustic soda	1310-73-2	<0.01	Base
*	Citric acid	77-92-9	<5	Softener
	Polyoxyalkeneamine D400	9046-10-0	0-1	Dispersant, polymer
	Triethylene glycol diamine	929-59-9	0-1	Dispersant, polymer
*	CI 74160	147-14-8	<1	Dye
*	CI 42090	2650-18-2	<1	Dye
	CI 12475	2786-76-7	<1	Dye
*	CI 21095	5468-75-7	<1	Dye
*	Polyethylene glycol sorbitan monooleate	9005-65-6	0.5-1	Emulsifier
*	1,3,4,6,7, 8-hexahydro-4, 6,6,7,8,8-hexamethylindeno [5,6-c]pyran	1222-05-5	<5	Fragrance
*	Pin-2(10)-en	127-91-3	<5	Fragrance
*	OTNE (patchouli ethanone)	54464-57-2	0.1-0.25	Fragrance
*	d-limonene	5989-27-5	<5	Fragrance
*	Linalool	78-70-6		Fragrance
*	Coumarin	91-64-5	<0.1	Fragrance
	Diphenyl ether	101-84-8	<1	Fragrance
	3-p-cumenyl-2-methylpropionaldehyde	103-95-7	<5	Fragrance
	Cinnamyl alcohol	104-54-1	0-0.02	Fragrance
	Citronellol (3, 7-Dimethyl-6-octen-1-ol)	106-22-9	<5	Fragrance
	Geraniol	106-24-1	0.1-1	Fragrance
	Hydroxycitronellal	107-75-5	<0.1	Fragrance

Table A5.2: Summary of Encountered Components of Alternative Air Fresheners (Solid/Gel)				
*	Name	CAS No	Example conc. %	Key functionality
	2-methylundecanal	110-41-8	1-10	Fragrance
	Decanal	112-31-2	1-5	Fragrance
	Dodecanal	112-54-9	<1	Fragrance
	Octanal	124-13-0	1-5	Fragrance
	alpha-isomethylionone	127-51-5	<5	Fragrance
	4-(2,6,6-trimethylcyclohex-1-ene-1-yl-)-but-3-ene-2-one (beta-ionone)	14901-07-6	<0.5	Fragrance
	alpha-cedrene	469-61-4	<0.5	Fragrance
	Citral	5392-40-5	<0.5	Fragrance
	Hexyl 2-hydroxybenzoate	6259-76-3	0.1-0.25	Fragrance
	Allyl(3-methylbutoxy)acetate	67634-00-8	1-5	Fragrance
	3A,4,5,6,7,7A-hexahydro-4,7- methano-1-H-indenyl propionate	68912-13-0	1-5	Fragrance
	bornan-2-one (camphor)	76-22-2	1-5	Fragrance
	Terpineol	8000-41-7	1-5	Fragrance
	Pin-2(3)-ene	80-56-8	<1	Fragrance
	1,1-diethoxy-3,7-dimethyl-2,6-octadiene (citral acid, isomerised)	90480-35-6	1-5	Fragrance
	Orange terpenes	94266-47-4	0.1-0.25	Fragrance
	Eugenol	97-53-0		Fragrance
	Benzyl benzoate	120-51-4	<5	Fragrance, Biocide
*	Benzyl salicylate	118-58-1	<5	Preservative
	Amyl salicylate	2050-08-0	0.1-0.25	Preservative
	Chloromethylisothiazolione	26172-55-4	<5	Preservative
	1,2 Benzotiazoline 3(2H)-one	2634-33-5	0.01 – 0.02	Preservative
	Methylisothiazolinone	2682-20-4	<0.1	Preservative
	1 ,3-Di(hydroxymethyl)-5, 5-dimethyhydantoin	6440-58-0	<2.5	Preservative
	Chloroacetamide	79-07-2	<0.2	Preservative
	Propyl paraben	94-13-3		Preservative
	Methyl paraben	99-76-3		Preservative
*	Propylene glycol	57-55-6	5-15	Solvent, fragrance stabiliser
*	Ethanol	64-17-5	<5	Solvent
	Isoparaffinic hydrocarbon	90622-57-4	1-5	Solvent
*	Peg hydrogenated castor oil	61788-85-0		Surfactant (N)
*	Alcohols, C_{12-18}, ethoxylated	68213-23-0	<5	Surfactant (N) - AE
*	Alcohol C_{11-13} ethoxylated	68439-54-3	1-5	Surfactant (N) - AE
*	Castor oil ethoxylate	61791-12-6	<5	Surfactant (N)
	Fatty alcohol ethoxylate	64425-86-1	1-<5	Surfactant (N) - AE
	Fatty alcohol ethoxylate	68439-45-2	≤2.5	Surfactant (N) - AE

Table A5.2: Summary of Encountered Components of Alternative Air Fresheners (Solid/Gel)				
*****	**Name**	**CAS No**	**Example conc. %**	**Key functionality**
*	Carrageenan	9000--07-1		Thickener
*	Carboxymethylcellulose	9004-32-4	<5	Thickener
*	Xanthan gum	11138-66-2	1-5	Thickener
*	Hydroxycellulose	9004-62-0	<5	Thickener
*	Silica	112945-52-5	<5	Thickener

Source: *RE.LE.VI. (2009); OTL (2009); RE.LE.VI. (2008); Arom (2008); Metsä Tissue (2008); Johnson Diversey (2008); Pro-Ren (2007); Reckitt Benckiser (2007); SC Johnson (2007); SC Johnson (2007b); Kleen Purgatis (2007); BOSTIM Plus (2006); Stadsing (2006); P.H.U. MIXIMPORT (2006); Clean & Green (2006); Sara Lee (2005); Nicols (2005); Clean Trade (2004); Occo (2002); Reckitt Benckiser (2002)*
Note: the asterisk indicates substances that appear in more than one formulation
N: Nonionic surfactant; AE: alcohol ethoxylate

Table A5.3: Summary of Encountered Components of Alternative Toilet Rim Blocks				
*****	**Name**	**CAS No**	**Example conc. %**	**Key functionality**
	Sodium sulphate	7757-82-6	25-50	Anti-caking agent
*	2-Bromo-2-nitropropane-1,3-diol	52-51-7		Antimicrobial
	Dichloroisocyanurate	51580-86-0	10-25	Biocide
	Sodium dichloroisocyanuarate	2893-78-9	15-30	Disinfectant
*	Benzophenone-12	1843-05-6		Preservative
	1 ,2-Benzisothiazol-3 (2H)-one	2634-33-5	<0.1	Preservative
	Phosphorous acid	13598-36-2		Bleaching
*	Calcium carbonate	1317-65-3	10-25	Builder
*	Sodium carbonate	497-19-8	<2.5 and >20	Builder
	Sodium tripolyphosphate	7758-29-4	0.2-2	Builder
	Sodium citrate	6132-04-3		Complexing agent
	(1-hydroxyethylidene) diphosphonic acid	2809-21-4	1-5	Complexing agent
*	Citric acid	5949-29-1	1-<-10	Complexing agent, pH
	Triethylene glycol diamine	929-59-9	<10	Dispersant, polymer
	Sodium chloride	7647-14-5		Filler, viscosity control
	1-dodecanol	112-53-8	<1	Viscosity control (surfactant production)
	Pine oil	8002-09-03	5-15	Fragrance
	Diphenyl ether	101-84-8	<1	Fragrance
	Hexal cinnamal	101-86-0		Fragrance
	Citronellol	106-22-9		Fragrance
	Geraniol	106-24-1		Fragrance
*	Alpha-isomethyl ionone	127-51-5		Fragrance
	Limonene	138-86-3	<1	Fragrance
	Tricyclodecenyl propionate	17511-60-3	<1	Fragrance

Table A5.3: Summary of Encountered Components of Alternative Toilet Rim Blocks				
*****	**Name**	**CAS No**	**Example conc. %**	**Key functionality**
	P-mentha-1,4(8)-diene	586-62-9	<5	Fragrance
*	Limonene	5989-27-5		Fragrance
	Hexyl 2-hydroxybenzoate	6259-76-3	<1	Fragrance
	Hexahydro-4,7-methano-1 h-inden-5(or6)-yl propionate	68912-13-0	<1	Fragrance
*	Linalool	78-70-6		Fragrance
*	Butylphenyl Methylpropional	80-54-6		Fragrance
	Alpha- pinene	80-56-8	<1	Fragrance
	2-tert-Butylcyclohexyl acetate	88-41-5	<1	Fragrance
	Grapefruit essence	90045-43-5	1-5	Fragrance
*	Coumarin	91-64-5		Fragrance
	2-methoxy naphthalene	93-04-9	<1	Fragrance
	Eugenol	97-53-0		Fragrance
	Orange oil	97766-30-8	1-5	Fragrance
*	Dipropylene Glycol	25265-71-8		Fragrance solvent
	Benzyl alcohol	100-51-6		Solvent/Fragrance
	Polyoxyalkyleneamine	9046-10-0	<10	Hardener
	Silica	112926-00-8	<10	Thickener
*	Hydroxyethylcellulose	9004-62-0		Thickener
*	Sodium toluene sulphonate	12068-03-0	5-7	Hydrotrope
*	Titanium dioxide (C.I. 77891)	13463-67-7	<1	Pigment
*	Ethanol	64-17-5	1-5	Solvent
*	Coconut oil monoethanolamine	68140-00-1	1-10	Stabiliser
	N-(2-Hydroxyethyl) dodecamide	142-78-9	10 - < 30	Surfactant
	Laureth-4	5274-68-0		Surfactant
	(C_{10}-C_{16}) Alkyl Alcohol	67762-41-8	<1	Surfactant
	Sodium lauryl sulfate	73296-89-6	10-25	Surfactant
	Polyoxethylene glycol	9004-81-3	2.5-10	Surfactant
	Cocamidopropyl betaine	61789-40-0	<5	Surfactant (A)
*	C_{10-16} alcohol ethoxylated sulfate sodium salts	68585-34-2	10-30	Surfactant (A) - AES
*	Sodium laureth sulfate	68891-38-3		Surfactant (A) - AES
*	Sodium dodecylsulphate	151-21-3	7-25	Surfactant (A) - AS
	Sulphuric acid, mono-C_{12-18}-alkyl esters, sodium salts	68955-19-1	5-10	Surfactant (A) - AS
*	Sodium alkylarylsulphonate	25155-30-0	20-<25	Surfactant (A) - LAS
*	Alkylbenzene sulphonate	68411-30-3	>20	Surfactant (A) - LAS
*	Sodium alkene sulphonate	68439-57-6	10 - < 30	Surfactant (A) - LAS
*	Sodium dodecyl benzene sulphonate	85117-50-6	10-50	Surfactant (A) - LAS
	Fatty alcohol ethoxylate	64425-86-1	5-15	Surfactant (N) - AE
*	Lauryl alcohol, ethoxylated	68439-50-9	1-30	Surfactant (N) - AE
*	Ethoxylated linear alcohol	69011-36-5	2.5-10	Surfactant (N) - AE

Table A5.3: Summary of Encountered Components of Alternative Toilet Rim Blocks				
*****	**Name**	**CAS No**	**Example conc. %**	**Key functionality**
Source: Braeco (2006); Henkel (2004); Henkel (2004b); Kleen Purgatis (2007b); Reinex (2006); Reinex (2006b); SC Johnson (2004); SC Johnson (2004b); Styl (2007); Tomil (2008); Unilever (2009); Unilever (2008); Unilever (2004); Unilever (2004b) *Note: the asterisk indicates substances that appear in more than one formulation* *A: anionic surfactant; N: nonionic surfactant; LAS: linear alkylbenzene sulphonate; AS: alkyl sulphate; AES: alcohol ethoxysulphate*				

A5.4 Hazard Profiles of Substances in Alternative Products

A5.4.1 Introduction

As shown above, alternative products may contain a wide variety of substances. However, given that the role of 1,4 dichlorobenzene is to mask unpleasant odours, fragrances may be considered to be direct replacements to 1,4 dichlorobenzene. Alternative products also tend to contain a number of non-fragrance materials that are incorporated in the articles to fulfil necessary activities such as fillers, anti-caking agents, stabilisers and preservatives (Aronson *et al*, 2007). As such, these other non-fragrance substances may form a significant proportion of any alternative article and can essentially be considered to constitute a part of the alternative to using 1,4 dichlorobenzene in these applications. In many cases, the alternative products also contain a range of other substances with a wider range of activities (including surfactants, enzymes and bleaching agents) while various dyes may also be used to enhance cosmetic appearance although only at very low concentrations (<1%). Although limited, information on currently available alternative products has permitted the identification of a number of non-fragrance substances that appear to find frequent application within alternative air freshener and toilet block products; the available data on the physicochemical and hazardous properties of typical examples of these other substances are therefore also considered below.

A5.4.2 Fragrances

Many of the fragrances available commercially are complex mixtures of anthropogenic and/or naturally occurring substances. According to IFRA (2009b), every fragrance formula is different and may contain between 50 to 200 fragrance materials from a pool of approximately 3,000 available materials. They are made bespoke for every client and specifically for each product. The formulas are confidential business information and rarely disclosed.

Furthermore, their physicochemical and hazard characteristics are frequently poorly characterised and the formulations of individual manufacturers, particularly in the case of ‘naturally derived’ fragrances, may vary in composition (SPEIAC, 2007). The number of fragrances that could potentially be used to replace 1,4 dichlorobenzene in the applications under consideration is large and it is impracticable to systematically review all the potential alternatives. Consideration of the available product information (see Table A5.2 and Table A5.3) has however identified six fragrances that appear to find quite frequent application in alternative products.

Some data are available on the hazard potential of the six alternative fragrances considered although their extent and detail is variable; information is presented in Table A5.4 together with brief details on 1,4 dichlorobenzene to aid comparison.

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances

Property	1,4 DCB	Fragrances and perfumes					
		α-hexyl cinnamaldehyde	Citronellol (3,7-dimethyl-6-octen-1-ol)	Geraniol	Citral	d-Limonene	Pin-2(10)-ene
Example proportion of product	>95%	0.25-0.5%	<5%	0-1%	<0.2%	<0.1%	5%
Identity, Classification and Labelling							
EC Number	203-400-5	202-983-3	203-375-0	203-377-1	226-394-6	227-813-5	204-872-5
CAS Number	106-46-7	101-86-0	106-22-9	106-24-1	5392-40-5	5989-27-5	127-91-3
Chemical formula	$C_6H_4Cl_2$	$C1_5H_{20}O$	$C_{10}H_{20}O$	$C_{10}H_{18}O$	$C_{10}H_{16}O$	$C_{10}H_{16}$	$C_{10}H_{16}$
Ambient state	Crystalline solid	Pale yellow to yellow clear liquid to solid	Colourless to pale yellow clear liquid	Colourless to pale yellow liquid, with an odour of roses	Liquid	Liquid	Colourless clear liquid
Vapour pressure	1.74 mm Hg; 160-170 Pa (2ºC)	0.0002 mm Hg (20°C)	0.02 mm Hg (25°C)	0.03 mmHg	0.091 mmHg; <130Pa (100°C)	2.66644 hPa (25ºC)	2.93 mm Hg (25°C)
Henry's Law constant (atm-m³/mol)	2.41×10^{-3}	1.0×10^{-5} (estimated)		5.9×10^{-5}	2.2×10^{-4}	2.6×10^{-2}	1.6×10^{-1}
Water solubility	81.3 mg/L	Negligible		100 mg/L	590 mg/L (25°C)	Very low	4.89 mg/L (25°C)
Log Kow	3.44	5.3 (measured)	3.217 (estimated)	3.47	3.45	4.57	4.16

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances							
		Fragrances and perfumes					
Property	**1,4 DCB**	**α-hexyl cinnamaldehyde**	**Citronellol (3,7-dimethyl-6-octen-1-ol)**	**Geraniol**	**Citral**	**d-Limonene**	**Pin-2(10)-ene**
Labelling symbols	Xi - irritant; Carc. Cat 3 – may cause concern for humans but available information is not adequate for making a satisfactory assessment; N - dangerous for the environment	Xi - irritant	Xi - irritant; N - dangerous for the environment	Xi -irritant	Xi -irritant	Xi - irritant; N - dangerous for the environment	Xn - harmful; N - dangerous for the environment
Risk phrases	R36 (irritating to eyes); R40 (limited evidence of carcinogenic effect); R50 (very toxic to aquatic organisms); R53 (may cause long-term adverse effects in aquatic environment)	R 38 (irritating to skin); R 43 (may cause sensitisation by skin contact)	R 36/38 (irritating to skin and eyes); R 43 (may cause sensitisation by skin contact); R 51 (toxic to aquatic organisms); R53 (may cause long-term adverse effects in the aquatic environment)	R 36/38 (irritating to skin and eyes); R 41 (risk of serious damage to eyes); R 43 (may cause sensitisation by skin contact)	R38(irritating to skin); R43 (may cause sensitisation by skin contact)	R10 (flammable); R38 (irritating to skin); R43 (may cause sensitisation by skin contact); R50 (very toxic to aquatic organisms); R53 (may cause long-term adverse effects in the aquatic environment)	R10 (flammable); R22 (harmful if swallowed); R36/38 (irritating to skin and eyes); R50(very toxic to aquatic organisms); R53 (may cause long-term adverse effects in the aquatic environment)

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances							
Property	**1,4 DCB**	**Fragrances and perfumes**					
		α-hexyl cinnamaldehyde	**Citronellol (3,7-dimethyl-6-octen-1-ol)**	**Geraniol**	**Citral**	**d-Limonene**	**Pin-2(10)-ene**
Mammalian Toxicity Profile							
Toxico-kinetics	Rapid inhalation and oral absorption; mainly excreted by urine (biphasic with rapid initial clearance)			Readily absorbed by GI tract of rats with subsequent metabolism via 2 hepatic pathways to give metabolites excreted via urine; metabolism may also occur in lung and kidney. Also readily metabolised by rabbits.	Rapidly absorbed from GI tract; Dermal exposures largely lost through extreme volatility but that remaining is fairly well absorbed; Is rapidly metabolised and excreted as metabolites (mainly via urine)	In humans pulmonary uptake is high (approx. 70%); By oral route, excretion of 75-95% and <10% in urine and faeces respectively occurs by 2-3 days in both animals and humans	Absorbed through lungs, skin and GI tract

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances

Property	**1,4 DCB**	**Fragrances and perfumes**					
		α-hexyl cinnamaldehyde	**Citronellol (3,7-dimethyl-6-octen-1-ol)**	**Geraniol**	**Citral**	**d-Limonene**	**Pin-2(10)-ene**
Acute toxicity	Rodent LD_{50} oral >2000 mg/kg; LC_{50} inhalation >5.07 mg/L	Rat LD_{50} oral 3100 mg/kg; 4-hr LD_{50} inhalation >5 mg/L; Mouse LD_{50} oral 2300 mg/kg; Rabbit LD_{50} dermal 3000 mg/kg	Rat LD_{50} oral 3450 mg/kg; Rabbit LD_{50} dermal 2650 mg/kg; Mouse LD_{50} subcutaneous 880 mg/kg	Rodent LD_{50} oral 2100-3600 mg/kg; dermal >5000 mg/kg	Rodent LD_{50} oral 1670 – 6800 mg/kg; dermal >2000 Rabbit LD_{50} dermal 2250 mg/kg	Rat LD_{50} oral 5000 mg/kg; Intraperitoneal 3600 mg/kg; intravenous (male) 125 mg/kg; intravenous (female) 110 mg/kg; subcutaneous (male and female) >20200 mg/kg; Mouse LD_{50} oral 5600-6600 mg/kg; intraperitoneal 1300 mg/kg; subcutaneous >41500 mg/kg; Rabbit LD_{50} dermal (24 hr) >5000 mg/kg	Rat LD_{50} oral >5000 mg/kg; Rabbit LD_{50} dermal (24-hr) >5000 mg/kg; Moderately toxic – probable oral lethal dose in humans = 0.5-5 g/kg
Irritation	Irritant (slight)	Some evidence of irritancy (moderate-severe) in animals but not humans	In humans 6 % solution caused no irritation	Irritant (severe) to skin and eyes	Irritant (mild to severe in various experimental studies and human Patch tests)	Strongly irritant in human Patch tests	Irritant to skin and mucous membranes in animal studies; In mice, inhalation caused sensory irritation and induced sedation and signs of anaesthesia but no pulmonary irritation

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances

Property	1,4 DCB	Fragrances and perfumes					
		α-hexyl cinnamaldehyde	Citronellol (3,7-dimethyl-6-octen-1-ol)	Geraniol	Citral	d-Limonene	Pin-2(10)-ene
Sensitisation	Not considered a sensitiser	LLNA assay EC_3 value = 2372 mg/cm^2; In humans NOEL for HRIPT induction = 23622 mg/cm^2; May cause sensitisation by skin contact	In humans 6 % solution caused no sensitisation	LLNA assay EC_3 value = 3525 mg/cm^2; In humans NOEL for HRIPT induction = 11811 mg/cm^2; May cause sensitisation by skin contact	Sensitising in most Buehler and guinea pig maximisation and open epicutaneous tests and in some human Patch tests LLNA assay EC_3 value = 1414 mg/cm^2; In humans for HRIPT induction NOEL = 1400 mg/cm^2 and LOEL = 3876 mg/cm^2	Studies in animals have shown that chemical must be oxidized in air for sensitisation to occur; Sensitiser in human Patch tests	

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances							
Property	**1,4 DCB**	**Fragrances and perfumes**					
		α-hexyl cinnamaldehyde	**Citronellol (3,7-dimethyl-6-octen-1-ol)**	**Geraniol**	**Citral**	**d-Limonene**	**Pin-2(10)-ene**
Repeat dose toxicity	Renal and hepatic toxin: NOAEL (dog oral) = 10 mg/kg/day. Inhalation also causes pulmonary changes with NOAEL (rat inhalation) = 75 ppm	90 day rat dermal study showed GI tract, liver, kidney, blood and bone marrow changes noted at 250 mg/kg or above; blood and GI effects noted at 125 mg/kg; NOAEL not determined		Rat 16 week oral NOAEL = 10000 ppm diet Rat 28 week oral NOAEL = 1000 ppm diet	Overall rat NOAEL for repeated dose = 200 mg/kg/day (both sexes); effects include morphological changes in nasal cavity and fore-stomach (attributed to irritation)	27 day rat oral caused dose related liver and kidney effects. Kidney effects included α2-microglobulin and chronic nephrosis; 13 week rat oral at up to 2400 mg/kg/day again showed nephropathy in male rats; Dogs given up to 6 ml/kg/d for 6 months suffered vomiting, decreased bodyweight and altered blood chemistry	

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances

Property	1,4 DCB	Fragrances and perfumes					
		α-hexyl cinnamaldehyde	**Citronellol (3,7-dimethyl-6-octen-1-ol)**	**Geraniol**	**Citral**	**d-Limonene**	**Pin-2(10)-ene**
Reproductive and develop-mental toxicity	Limited developmental toxicity: NOAEL (rat oral) = 30 mg/kg/day; NOAEC (rat inhalation) = 211 ppm	In rat 90 day dermal study, NOEL=125 mg/kg; LOEL=250 mg/kg			Rat oral NOAEL for developmental toxicity = 200 mg/kg/day; Inhalation NOAEL for teratogenicity = 68 ppm (423 mg/m^3) in presence of maternal toxicity	Increase in abnormal chick embryos at single dose of 25 μM/embryo; Oral dosing on day 9-15 of gestation in rats caused maternal toxicity and developmental delays at 2869 mg/kg orally; Rabbits given 1000 mg/kg orally showed severe toxicity but 250 mg/kg without effect on dams or foetuses; Oral dosing on day 7-12 of gestation in mice at 2363 mg/kg orally given to mice for 6 days from day 7-12 of gestation caused maternal toxicity and bone abnormalities in foetuses	
Genotoxicity	Not mutagenic	Negative in Ames, micronucleus and sex-linked lethal assays		Negative in Ames test and mammalian chromosomal assay	Negative in Ames and chromosomal aberstion and micronucleaus tests but positive in ister chromatid exchange assay	Negative in Ames, mouse L5178Y/TK, and chromosomal aberration and sister chromatid exchanges assays	Negative in Ames test and in sister chromatid exchange assay in Chinese hamster ovary cells

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances								
Property	**1,4 DCB**	**Fragrances and perfumes**						
		α-hexyl cinnamaldehyde	**Citronellol (3,7-dimethyl-6-octen-1-ol)**	**Geraniol**	**Citral**	**d-Limonene**	**Pin-2(10)-ene**
Cancer	Animal carcinogen (possible threshold mechanism)			Negative in rodent gavage studies	Negative in male rats but equivocal findings for malignant lymphoma in females in one study; another study in same species at higher doses negative; Mouse study negative	Oral rats study at <150 mg/kg/day (males) and 600 mg/kg/day (females) showed dose-related increase in renal tubular hyperplasia and adenoma/ adenocarcinoma in males but no effect in females, or in male and female mice	
Relevant exposure standards	EU: OEL = 122 (8-hour TWA); STEL = 306 mg/m^3				JECFA oral ADI = <0.5 mg/kg	TLV 100 ppm (USA)	

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances							
Property	**1,4 DCB**	**Fragrances and perfumes**					
		α-hexyl cinnamaldehyde	**Citronellol (3,7-dimethyl-6-octen-1-ol)**	**Geraniol**	**Citral**	**d-Limonene**	**Pin-2(10)-ene**
Ecotoxicity Profile							
Log Pow	3.37-3.39	5.33	3.91	3.28 (estimated)	2.8-3.0	4.45 (estimated)	4.16
Environ-mental partitioning at equili-brium	Air: 98.9%; Water: 0.79%; Soil: 0.15%; Sediment: 0.16%				Atmospheric releases partition to: Air 97.7%; Water 1.6%; Soil 0.7%; Sediment 0%; Aquatic releases partition to: Air 1.7%; Water 97.0%; Soil 0%; Sediment1.3%		Expect volatilisation to air from water but may be limited by absorption to suspended solids and sediments
Environ-mental half-life	33 - 50 days (air)				Aqueous – T1/2=9.54 days (pH 4), 230 days (pH 7) and 30.1 days (pH 9)	Soil – approx. 9-20 hrs (experimental); Aqueous volatilisation - river and lake of 1 hr and 5 days respectively (model); Reaction with hydroxyl radicals in air - 2.6 hrs	Vapour-phase degradation by reaction with hydroxyl radicals - half-life about 4.9 hrs; Volatilisation half-lives from river and lake = 3 hrs and 5 days respectively (modelled)
Bio-degradation (k d^{-1})	Surface water 0.046; Sediment 0.002; Soil 0.023	Considered readily biodegradable		Readily biodegradable (86% by 28 days in aerobic conditions; 100% by 15 days in activated sewage)	Readily biodegradable (>90% by 28 days in aerobic conditions; 90-100% by 8 days in activated sludge)	Readily biodegradable (100% by 28 days in aerobic conditions)	Biodegradation may be an important environmental fate in soil (by microorganism)

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances

Property	**1,4 DCB**	**Fragrances and perfumes**					
		α-hexyl cinnamaldehyde	**Citronellol (3,7-dimethyl-6-octen-1-ol)**	**Geraniol**	**Citral**	**d-Limonene**	**Pin-2(10)-ene**
Bio-concentration factor	Fish - 296 (reasonable worst-case)	1,028 (estimated) May have moderate bioaccumulation potential	219 (estimated)	183 (estimated)	151 (estimated)	660 (estimated)	320 (estimated for fish)
Acute toxicity - aquatic	Fish LC_{50} = 1.12- 14.2 mg/L; *Daphnia magna* EC_{50} = 0.7-2.2 mg/L (48 hour); Algae *(Scenedesmus capricornutum* (72-96 hr) EC_{50} = 3.4 mg/L	Fish 96-hr LC_{50} = 2.36 mg/L; *Daphnia* 48-hr LC_{50} = 0.621 mg/L (estimated); Algael 96-hr LC_{50} = 0.896 mg/L (estimated)		Fish (*Brachydanio rerio*) 96-hr LC_{100} = 19.9 mg/L & LC_{0} = 9.8 mg/L	Fish (*Leucuscus idus*) 96 hr LD_{50} = 4.6-10 mg/L; *D. magna* 24 hr EC_{50} = 7-11 mg/L; Algae (*S. subspicatus*) 72 hr EC_{50} = 16 mg/L and 96 hr EC_{50} = 19 mg/L		Fish (*Pimephales promelas*) LC_{50} (96-hr) 0.50 mg/L; *D. magna* LC_{50} (48-hr) 1.25 mg/L; Algae LC_{50} (48-hr) 1.44 mg/L
Acute toxicity - terrestrial							

Table A5.4: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Selected Alternatives - Fragrances

Property	1,4 DCB	Fragrances and perfumes					
		α-hexyl cinnamaldehyde	Citronellol (3,7-dimethyl-6-octen-1-ol)	Geraniol	Citral	d-Limonene	Pin-2(10)-ene
Repeat exposure - aquatic	Fish NOEC = 0.44 mg/L; *D. magna* NOEC (21-28 day) = 0.4-0.22 mg/L; PNEC aquatic = 20 µg/L (based on algael toxicity); PNEC sediment = 900 µg/kg (dw; extrapolated)			30 day exposure of yellow fever mosquito caused 74.4-95.8% egg-hatching inhibition	Aquatic invertebrate EC_{50} (21d repro) = 1.6 mg/L and NOEC of 1.0 mg/L		Fish (*Oncorhynchus mykiss*) LC_{50} (60 day) 930-1400 µg/L
Repeat exposure - terrestrial	Earthworm (2 species, 2 soil types, 14-day) LC_{50} = 96 – 258 mg/kg dry weight; PNEC soil = 96 µg/kg dw						

Source: Aronson et al (2007); Chemical Land21 (2009); Danish Environmental Protection Agency (2006); EC (2009); EC (2009b); IFRA (2009); Japanese Ministry of Foreign Affairs (2001); Oxford University (2003); NTP (2007); IFF (2007); RSC (2009); The Good Scents Company (2009); US EPA (2009 & 2009b); United States National Library of Medicine (2009)

Notes: ADI: Acceptable daily intake; EC_{50}: Effective concentration provoking a response halfway (50%) between baseline and maximum response; EC_3: Effective concentration inducing a 3-fold increase in radiolabelled-thymidine incorporation in lymph node cells of treated compared to control animals; GI: Gastrointestinal; HRIPT: Human repeat insult patch test; LD_{50}: Median lethal dose; LLNA: Local lymph node assay; NOAEC: No observed adverse effect concentration; NOAEL: No observed adverse effect level; NOEL: No observed effect level; OEL: Occupational exposure limit; STEL: Short-term exposure limit; TLV: Threshold-limit value; TWA: Time weighted average

Of the fragrance substances considered, all six are recognised to have potential irritant properties depending upon the route of exposure, as does 1,4 dichlorobenzene. With the exception of **pin-2(10)-ene**, all are also considered as potential sensitisers with **α-hexyl cinnamaldehyde**, **citronellol**, **geraniol**, **citral** and **d-limonene** listed under EU Cosmetics Directive 2003/15/EC Annex III Part 1 with the requirement to indicate the presence of the substance in the list of ingredients when its concentration exceeds 0.001% in leave-on products or 0.01% in rinse-off products. It has, however, been suggested that α-hexyl cinnamaldehyde, geraniol and citral are only weak sensitisers (IFRA, 2009) and pin-2(10)-ene is not listed under Cosmetics Directive 2003/15/EC Annex/Part, Ref # III/1,70 and was not included on the priority list (as foreseen under Council Regulation (EEC) No 793/93) for the evaluation and control of the risks of existing substances. From the available data these fragrances appear to be included at no more than 5% in the alternative products, so the potential for human exposure to high levels of these compounds from the use of the alternative articles will be much less than is the case for 1,4 dichlorobenzene. The available evidence also indicates that the mammalian acute toxic potentials of the six fragrances considered are, in any case, not of particular concern. The possibility of irritant or sensitising effects on the respiratory system occurring from the emissions of various types of air freshener has been considered in detail in a recent review of available evidence by a European expert committee. SCHER (2006), while commenting on the limited data available on the potentially allergenic substances used in these products, noted that the patterns of exposure may vary greatly depending on the nature of the product (i.e. sprays *vs.* slow release gels) and that in many cases the potential for sub-chronic and chronic effects should be considered the endpoints of potential concern rather than any acute effect (including irritancy). Of the fragrances considered here, detailed information on mammalian repeat dose and reproductive toxicity is limited to α-hexyl cinnamaldehyde, geraniol, citral and d-limonene. It is apparent that the repeat dose NOAELs for these four substances are significantly higher than that of 1,4 dichlorobenzene, suggesting that the margin of safety for human health endpoints will be much greater for these substances under foreseeable conditions of use than has been estimated for 1,4 dichlorobenzene. In addition, although evidence of renal tumour induction was reported in male rats given d-limonene, this finding associated with a range of non-neoplastic renal effects that suggest that the renal toxicity of d-limonene probably represents an example of α2-microglobulin-related rat toxicity. As such, this would represent a species- and sex-specific response that is not generally considered of particular relevance to humans. Importantly, studies on the genotoxic potential of all compounds except citronellol are available and raise no concerns with regard to the substances' mutagenic potential.

The environmental toxicity data for the fragrances is somewhat limited. While no specific environmental concerns were identified for α-hexyl cinnamaldehyde, geraniol or citral, the US EPA (2009b) is noted to have suggested that α-hexyl cinnamaldehyde may have moderate bioaccumulation potential and quite high acute toxicity in some aquatic species. The remaining three substances (citronellol, d-limonene and pin-2(10)-ene) are classified as dangerous to the environment and subject to labelling (R51/53, R50/53 or R52/53) because of concerns regarding the aquatic environment. Only d-limonene and pin-2(10)-ene have bioconcentration factors (BCFs) that raise any concern. However, d-limonene has been shown to undergo biodegradation under aerobic conditions (although it is resistant to anaerobic biodegradation) and pin-2(10)ene has a relatively short half-life in several environmental media. Also, both substances are readily metabolised by some organisms suggesting environmental bioconcentration would be of only limited concern, particularly given the low inclusion levels of these substances in the alternative products.

A5.4.3 Other (non-fragrance) Substances

The hazard profiles for selected substances that are frequently used in alternative air freshener and toilet block articles are summarised below; those of surfactants, preservatives and dyes are presented in Table A5.5, those of builders, complexing agents and solvents in Table A5.6, and thickeners, stabilisers and anti-caking agents in Table A5.7.

Table A5.5: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Surfactants, Preservatives, Dyes

Property	**Surfactants**			**Preservatives**		**Dye**
	Sodium dodecylbenzene sulphonate	**Alcohols, C_{12-18}, ethoxylated**	**Sodium lauryl ether sulphate**	**Benzyl salicylate**	**1,2-Benzotiazoline-3(2H)-one**	**CI21095**
Example proportion of product	25-50%	<5%	1-10%	<5%	0.01-0.02%	<1%
Identity, Classification and Labelling						
EC Number	246-680-4	500-201-8	500-234-8	204-262-9	220-120-9	226-789-3
CAS Number	25155-30-0	68213-23-0	68891-38-3	118-58-1	2634-33-5	5468-75-7
Chemical formula	$C_{18}H_{30}O_3S.Na$	Not applicable (generic term is C12-18/EO7)	$CH_3(CH_2)_{10}CH_2(OCH_2CH_2)_2OSO_3Na$	$C_{14}H_{12}O_3$	C_7H_5NOS	$C_{34}H_{30}Cl_2N_6O_4$
Ambient state	White to yellow solid	Liquid paste	Light yellow liquid at 27% and yellow viscous liquid or paste at 68%	Colourless to pale yellow clear oily liquid to solid	Solid	Solid
Vapour pressure	3-17 x 10^{-13}	Low: 0.0011 – 3.3 x 10-6 hPa (25ºC; data for related alcohols)	For related C12-14 substances = 1.2 x E^{-13} to 2.1 x E^{-14} Pa (25ºC)	0.16 hPa (25ºC); 1.33 hPa (45ºC)	0.0000037 hPa (25ºC)	3.68E-25 mm Hg (25°C; estimated)
Henry's Law constant (atm-m³/mol)	6.35 x 10^{-3}					
Water solubility	20 g/100 ml (25°C)	15-35 mg/L (estimated)	For related C12-14 substances = 425 - 41 mg/L Considered soluble:	Slight	1100 mg/L (0.11%; 20ºC) 6000 mg/L (0.60%; 30ºC)	Not considered soluble
Log Kow	3.32 (calculated)	4.63 -7.87 (estimate for C12-18 alcohol ethoxylates); 5.36 - 7.19 (data for related alcohols)	For related C12-14 substances = 0.95 - 19	3.48	0.64 (calculated)	3.62 (estimated)

Table A5.5: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Surfactants, Preservatives, Dyes						
Property	**Surfactants**			**Preservatives**		**Dye**
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Labelling symbols		One MSDS identified indicating - Xn- harmful, Xi - irritant; N - dangerous for the environment		Xi - Irritant	Xn - harmful at >25%; Xi – irritant at <25%; N – dangerous for the environment at >25%	Wassergefahrdungs-klasse (WGK) considers to be weakly water polluting
Risk phrases		One MSDS identified indicating - R22 (harmful if swallowed); R41 (risk of serious damage to eyes); R50 (very toxic to aquatic organisms)		R36 (irritating to eyes); R37 (irritating to respiratory system); R38 (irritating to skin); R43 (may cause sensitisation by skin contact)	Dependent on proportion of article composed of substance: *0.05-<5%:* R43 (may cause sensitisation by skin contact); *5-<10%:* R36 (irritant to eyes); R43 10-<20% R41 (risk of serious damage to eyes); R43 *20-<25%:* R38 (irritant to skin); R41; R43 *>25%:* R22 (harmful if swallowed); R38; R41; R43; R50 (very toxic to aquatic organisms)	

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Mammalian Toxicity Profile						
Toxicokinetics	Related substance considered to be readily absorbed from GI tract (rat - 80-90%) and rapidly eliminated (rats, within 72 hours) mainly via urine with remainder via faeces; absorption through intact skin very poor (0.1-0.6%)	Studies in rats on $C_{12}AE_3$, $C_{12}AE_6$ and $C_{12}AE_{10}$ showed extensive (>75%) GI absorption and metabolism with urinary and biliary excretion; Highest dermal penetration rate = 8.4µg/cm^2 for $C_{12}AE_3$	Related substances readily absorbed from GI-tract. Once absorbed, are extensively metabolised by beta- or omega oxidation and excreted via urine. Those with >7 to 9 EO units are excreted to increasing extent via faeces; Dermal absorption limited		Rapid complete metabolisms; excretion via urine (almost complete clearance by 24-hrs)	
Acute toxicity	Rat LD_{50} oral = 1260 mg/kg Mouse LD_{50} oral = 1330 mg/kg Mouse LD_{50} iv = 105 mg/kg Related substance showed very low inhalation toxicity (not possible to calculate LD_{50} inhalation) and dermal LD_{50} of >1000 mg/kg	Rat LCLo inhalation = 130 mg m^{-3} Related substances Rat LD_{50} oral 600-10,000 mg/kg; Dogs 1650 mg/kg; Monkeys 6700 mg/kg Rat LD_{50} inhalation (4 hr) 1.50 – 20.7 mg/L Rat LD_{50} dermal >2000->5000 mg/kg	Rat LD_{50} oral for C12-14AE2S = >2000 mg/kg and for NaC12-14AE2S = >2500 mg/kg; Rat LD_{50} inhalation (1 hr) for NH_4 C12-14AE3S = >60 mg/L; Rat LD_{50} dermal for NH_4C12-14AE2S = >2000 mg/kg	Rat LD_{50} oral = 2227 mg/kg Rabbit LD_{50} dermal = 14150 mg/kg	Rat LD_{50} oral = 670 - 1450 mg/kg Mouse LD_{50} oral = 1150 mg/kg Rat LD_{50} dermal (24 hr) = >2000 - >5000 mg/kg	Rat LD_{50} oral = >16000 mg/kg

Table A5.5: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Surfactants, Preservatives, Dyes						
Property	**Surfactants**			**Preservatives**		**Dye**
	Sodium dodecylbenzene sulphonate	**Alcohols, C_{12-18}, ethoxylated**	**Sodium lauryl ether sulphate**	**Benzyl salicylate**	**1,2-Benzotiazoline-3(2H)-one**	**CI21095**
Irritation	When tested on rabbit skin and eyes a related substance caused no irritation at up to 2.5%, moderate irritation at 5% (Draize criteria) and was irritating at higher levels. According to the EU criteria, the substance was classified as irritating to skin and also assigned R41	Related substances (undiluted): Slight to sever irritant to rabbit and rat skin; mild to severe irritant to rabbit eye	Experimentally - Skin irritancy: concentration dependent effects seen >70% = moderate to severe skin irritants; 10-30% = mild to moderate irritancy; <1% virtually non-irritant In humans skin irritation potential of aqueous solutions expected to be mild after repeated contact; - Eye irritancy: NH_4C12-14AE2S 9905) and C12-14E2S (28%) are moderate to severe eye irritants; Solutions of <10% are slight to moderate irritants; <1% are virtually non-irritant	Non irritant in Draize or 84/449/EEC B.4 skin test; Very slightly irritant in 48 hr Patch test on humans at 30% solution; Moderately irritant in Draize eye test	Moderate skin irritant in semi-occlusive skin test and severe irritant in 48 hr eye test in rabbits; Negative in human skin test	Not irritant on skin or eye of rabbit

Table A5.5: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Surfactants, Preservatives, Dyes

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Sensitisation	No sensitisation potential was found for related substance in animals or humans	Related substances (C9-C21; E02-21): Weak skin sensitisation noted only for one form (C7-9AE6) in Guinea pig; other forms tested all negative	Most studies in guinea pigs or humans (Patch tests) in related substances are negative	LLNA EC_3 = 725 mg/cm^2; Human RIPT test NOEL = 17717 mg/cm^2 Not sensitising in Patch tests with 30% solution in humans Suggested as only weak sensitiser; No expected sensitisation induction level (NESIL) = 17700 µg/cm^2	Moderate contact sensitiser by Magnusson and Kligman but negative in Beuhler test; LLNA and human repeated patch tests suggest no effect level is approx 500ppm	

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Repeat dose toxicity	Oral dosing of animals with related substance has shown changes in weights of liver, caecum and other organs and minor changes in liver and kidney pathology noted: identified overall NOAEL as 85 mg/kg bw/day (9 month study) and LOAEL as 115 mg/kg bw/day	Numerous oral and limited number dermal studies of 14 - 90 days duration conducted on related substances. Carcinogenicity study data also available. Effects noted include: GI tract (mild gastric irritation), changes in organ weights (e.g. liver, spleen and heart) and for dermal route, skin irritation. Main target organ is liver, where adaptive responses occur. For 90+ days studies NOAELs = 50 - 700 mg/kg/day	Numerous rodent oral studies of up to 2 years duration and a dermal study of up to 91 days conducted on related substances. Effects noted for oral studies include: Non-glandular stomach and liver pathology; Range of organs weight effects (e.g. liver, kidney, heart, adrenal, testes and brain); NOAEL = 250 mg/kg/day; Dermal study showed clear effects.		Rat 28 & 90 day oral studies showed non-glandular stomach lesions (possibly related to irritant/corrosive effect); NOAEL (90 day) = 10 mg/kg/day (equiv to 8.42 mg active)	

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Reproductive and developmental toxicity	Series of multi-generation studies on related substance showed no reproductive effects with NOAEL = 170 mg/kg/day (highest tested); studies also showed effects in foetuses (death and deformities and decrease in pregnancy rate) only at maternal toxic doses: no effects apparent at oral dose of <780 mg/kg/day or dermal dose of <1500 mg/kg/day	Two generation dietary rat studies in $C_{14-15}AE_7$ and $C_{12}AE_6$ gave reproductive NOAELs = >250 mg/kg/day; developmental effects included liver weight changes in presence of maternal toxicity; developmental NOAEL = 50 mg/kg/day	C12AES rat multigeneration feeding study reproductive NOEL = >250 mg/kg/day; Developmental NOAEL = >1000 mg/kg bw/day; NaC12-14AE2S rat multigeneration drink water study developmental NOAEL = >750 mg/kg bw/day		Rat teratogenicity study showed slight foetotoxicity (not teratogenicity) at maternal toxic dose of 100 mg/kg/day; NOAEL = 40 mg/kg/day	
Genotoxicity	Related substance negative in Ames test, recombinant assay on *Bacillus subtilis and Escherichia coli* reverse mutation assay; also negative in mouse micronucleus and cytogenetic bone marrow assays and in mouse dominant lethal assay	Related substances (including $C_{12-14}AE_7$, $C_{13-15}AE_7$, $C_{16-18}AE_{10}$), negative in range of *in vitro* and *in vivo* studies	Related substances negative in range of *in vitro* and *in vivo* studies	Negative in Ames test	Marked cytoxicity in Ames test but some studies show negative response; Negative for mutagenicity but possible clastogen in Chinese hamster ovary cells; Not clastogenic in mice *in vivo;* No induction of UDS in rat hepatocytes *in vivo*	

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Cancer	Limited studies on related substance in rats were negative (mention made of mice studies but no details presented)	Several rodent oral studies available on $C_{12-13}AE_{6.5}$ and $C_{14-15}AE_7$; all negative	Two 2-yr rat oral studies and a mouse dermal study conducted on C12AE3S, and an 18 month mouse dermal study on C16-18AES and other mixed related substances. Although of limited design, all were negative			
Relevant exposure standards				EFSA classification - MSDI = 26 µg/day; No safety concern; CoE category B		
Ecotoxicity Profile						
Log Pow	0.45			4.01	0.4 (20ºC)	9.58 (estimated)
Environmental partitioning at equilibrium		Data on related substances suggest potential transfer from aqueous to suspended solid phases and soil adsorption.				

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Environmental half-life	Related substance degraded rapidly in aerobic conditions (half-life approx. 3 hr in rivers) but not in anaerobic conditions; Also had max. half-life = 1 wk in sludge-amended soil	Readily biodegradable: theoretical oxygen demand (ThOD) 69-86% (estimated); Not expected to be abiotically degradable to appreciable degree				
Biodegradation (k d^{-1})	Related substance was readily biodegradable with: Aqueous primary half-life = 3 hr; Soil primary half-life = 7 days	Estimated half life in river 8 - 12 hrs; Sewage treatment half-life = 1 minute; Readily anaerobically biodegradable (at least 80%)	Ultimately biodegradable via intermediate steps with no recalcitrant metabolites; EUSES estimated degradation range = 87% for C12EO2.7S to 75% for C18EO2.7S; Good anaerobic degradation also expected		QSAR suggests aerobically degradable (has low bioaccumulation potential in aquatic organisms)	Non-biodegradability according to MITI-I (OECD TG 301C) test method; Not considered a PBT or vPvB; likely to be P(and vP)
Bioconcentration factor	For related substance, BCFs about 87 l/kg and 22 l/kg estimated for river water	In fish *(Pimephales promelas)* = <5 - 135.2 (for homologues)		547.7 - 652.47 (depending on pH; calculated)	BCF 13.1 (calculated) QSARs suggests low aquatic bioaccumulation potential	Low potential

Table A5.5: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Surfactants, Preservatives, Dyes						
Property	**Surfactants**			**Preservatives**		**Dye**
	Sodium dodecylbenzene sulphonate	**Alcohols, C_{12-18}, ethoxylated**	**Sodium lauryl ether sulphate**	**Benzyl salicylate**	**1,2-Benzotiazoline-3(2H)-one**	**CI21095**
Acute toxicity - aquatic	Ranges for related substance: Fish (*Pimephales promelas*) LD_{50} = 1.04-39.4 & NOEC = 0.05-14 mg/L; *D. magna* EC_{50} 0.5-16.7 mg/L, NOEC = 0.1-9.8 mg/L	Fish LC_{50} = 0.4 - 100 mg/L (linear forms) and 0.25 – 40 mg/L (branched forms); *Daphnia magna* EC_{50} (48 hr) for C12-15 homolog = 0.14 – 5 mg/L; Algae (various species) for C12-15 liner forms EC_{50} = 0.28 – 50 mg/L	For related C12-14 substances = Fish (various species) LC_{50} = 0.8 to 4.1 mg/L; Invertebrate (*D. magna*) EC/LC_{50} = 0.46 to 1.30 mg/L; Algae (various species) EC_{50} (48 hr) = 0.5 to 50 mg/L		Fish (*Salmos gairdneri* and *Lepomis macrochirus*) LC_{50} (96 hr) 1.6 - 5.9 mg/L; *D. magna* EC*50* (48 hr) = 1.35 mg/L; Algae EC*50* (72 hr) = 0.1 mg/L	Fish (*Oryzias latipes*) LC_{50} (48-hr) = >200 mg/L
Acute toxicity - terrestrial	Most sensitive values for related substance are - Plant EC50 = 167-316 mg/kg dry Soil Fauna EC50 = 41->1000 mg/kg dry Microorganisms = 17->1000 mg/kg dry					

Table A5.5: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Surfactants, Preservatives, Dyes

Property	**Surfactants**			**Preservatives**		**Dye**
	Sodium dodecylbenzene sulphonate	**Alcohols, C_{12-18}, ethoxylated**	**Sodium lauryl ether sulphate**	**Benzyl salicylate**	**1,2-Benzotiazoline-3(2H)-one**	**CI21095**
Repeat exposure - aquatic	Most sensitive values for related substance are for - Aquatic species: Algae (*Microcystis spec.)* population density NOEC = 0.80 mg/L; Fish (*Tilapia mossambica*,) 0.34 mg/L; Sediment species: Worm (*Lumbriculus variegates*) survival, reproduction & growth NOEC = 81 mg/kg/day; Nematode (*Caenorhabditis elegans*) egg production NOEC = 100 mg/kg dry	Algae: 50% reduction in growth between days 2 and 4 at 0.63-4.2 mg/L for C12-C15 homologs EC_{20} Approx 0.00493 -0.000370 mM; *D. magna* calculated EC_{20} = $1.61xE^{+0}$ - $3.55xE^{-02}$ mg/L (calculated for C12-18) NOEC = 0.014-0.16 to 0.008–0.056 (calculated for C12-15) Overall aquatic estimated PNEC = $1.61xE^{-01}$ - $3.55xE^{-03}$ mg/L; Overall sediment estimated PNEC = $3.47xE^{1}$ – $6.54xE^{1}$ mg/L (for C12-18)	No consistent difference in sensitivity between invertebrate and fish species. QSAR developed EC_{20} values = 2.7 - 0.38 mg/L; Generic PNEC aquatic for C12-14 substances in group = 0.27 – 0.038 mg/L			

Table A5.5: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Surfactants, Preservatives, Dyes						
Property	**Surfactants**			**Preservatives**		**Dye**
	Sodium dodecylbenzene sulphonate	**Alcohols, C_{12-18}, ethoxylated**	**Sodium lauryl ether sulphate**	**Benzyl salicylate**	**1,2-Benzotiazoline-3(2H)-one**	**CI21095**
Repeat exposure - terrestrial	Most sensitive values for related substance are for - Soil ecosystem NOEC= >15 mg/kg dry; Biomass NOEC >16->27 mg/kg dry	Overall soil estimated PNEC = 31.04 – 108.35 mg/kg soil (for C12-18)				

Source: Chemid plus (2009); Chemical Land21 (2009b); Dalli (2008); EC (2009 &2009 b); ECB (2005); EFSA (2007); The Good Scent company (2009); HERA (2003, 2004, 2009, 2009b and 2009c); Madson et al (2000); NIOSH (1997); NITE (2002); Oxford University (2003b); RSC (2009); SCCNFP (2004); US National Library of Medicine (2009) and TEX (2008).

Notes: ADI: Acceptable daily intake; EC_{20}: Effective concentration provoking a response 20% between baseline and maximum response; EC_{50}: Effective concentration provoking a response halfway (50%) between baseline and maximum response; EC_3: Effective concentration inducing a 3-fold increase in radiolabelled-thymidine incorporation in lymph node cells of treated compared to control animals; GI: Gastrointestinal; HRIPT: Human repeat insult patch test; LCLo: Lowest concentration anticipated to cause death; LD_{50}: Median lethal dose; LLNA: Local lymph node assay; MSDS Material safety data sheet; MSDI: Maximum survey derived daily intake; NOAEC: No observed adverse effect concentration; NOAEL: No observed adverse effect level; NOEL: No observed effect level; OEL: Occupational exposure limit; PNEC: Predicted no effect concentration; STEL: Short-term exposure limit; TLV: Threshold-limit value; TWA: Time weighted average

Table A5.6: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Builders, Complexing Agents, Solvents			
Property	**Builder**	**Complexing/descaling agent**	**Solvent**
	Sodium carbonate	**Citric acid, monohydrate**	**Ethanol**
Example proportion of product	25-40%	1-5%	<5%
Identity, Classification and Labelling			
EC Number	207-838-8	201-069-1	200-578-6
CAS Number	497-19-8	5949-29-1	64-17-5
Chemical formula	$CH_2O_3.2Na$	$C_6H_8O_7$	C_2H_6O
Ambient state	White crystalline hygroscopic powder	Crystalline solid	Colourless liquid
Vapour pressure	0 (20ºC)		57.3 hPa (20ºC); 280 hPa (280ºC)
Henry's Law constant (atm-m^3/mol)		2.3 x 10^{-7} P am^3/mol	0.000252
Water solubility	71 g/L (0ºC); 217 g/L (20ºC)	Freely soluble; 576–771 g/L (20°C)	High
Log Kow			-0.31
Classification	Xi – irritant; E - explosive	Xi - irritant	F -highly flammable
Labelling	R36 (irritating to eyes)	R37 (irritating to respiratory system); R38 (irritating to skin); R41 (risk of serious damage to eyes)	R11 (highly flammable)
Mammalian Toxicity Profile			
Toxicokinetics	Substance will breakdown on contact with body fluids to constitute ions that are naturally present in organisms		Readily absorbed via oral and inhalation routes; limited dermal uptake; Most absorbed ethanol (90-98 %) is metabolised in liver; 2-10% excreted unchanged via lungs and kidneys
Acute toxicity	Rat LD_{50} oral = 4090 - 5600 mg/kg; Rat LC_{50} inhalation = 2.3 - 5755 mg/L; Mouse LC_{50} inhalation = 1.2 mg/L; Guinea pig LC_{50} inhalation = 0.8 mg/L; Mouse LC_{50}dermal = 117 - 2210 mg/kg	Rat oral LD_{50} = 3000 - 12000 mg/kg; Rat LD_{50} intra peritoneal = 375 mg/kg; RAT LD_{50} subcutaneous = 5500 mg/kg; Mouse oral LD_{50} = 5040 mg/kg; Rabbit oral lethal dose = 7000 mg/kg	Rodent LD_{50} oral = 1780-16710 mg/kg Rodent inhalation LC_{50} (4hr) = 39 - 124.7 mg/L Rodent dermal LDLo = 20000 mg/kg Rodent LD_{50} intraperitoneal = 933 - 6710 mg/kg In humans signs of mild toxicity apparent at blood levels of 5-10 mg/ml

Table A5.6: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Builders, Complexing Agents, Solvents			
Property	**Builder**	**Complexing/descaling agent**	**Solvent**
	Sodium carbonate	**Citric acid, monohydrate**	**Ethanol**
Irritation	Not irritating – moderately irritating to skin of rabbits; Moderately irritating to skin of rats; Not irritating to highly irritating to eyes of rabbits; Irritant to respiratory tract, eyes and skin and may cause vomiting in humans	Slightly irritant to rabbit skin at 500 mg for 24 hr; Permanent eye damage to rabbit eye from 0.5% solution for 30 minutes; Irritant to eyes respiratory system and skin in man	Not to moderate dermal: irritant Irritant to eyes
Sensitisation		Low sensitising potential; some reports of possible sensitisation in humans	Not sensitising
Repeat dose toxicity	Rat 3.5 month inhalation study at up to 2% showed only reduced weight gain and slight lung pathology at 0.07 mg/L; NOAEL = 0.01-0.02 mg/L	Main target is reversible changes in blood profile and metal absorption/excretion characteristics; Rat NOAEL = 1200 mg/kg/day	Main target of repeat exposure in humans and animals is liver, with initial steatosis and inflammatory changes, progressing to cirrhosis and potentially cancer; Long term alcohol abuse also associated with effects in GI tract, nervous system and testes; Rat chronic drinking water study showed reduced bodyweight, thyroid hyperplasia and peripheral nerve damage at 3% w/w while 4 week rat oral study showed hepatic changes at 10000 and 20000 mg/kg/day; 90 day inhalation study in rats, guinea pigs, rabbits, dogs and monkeys at 86 mg/m^3 (46 ppm) showed no effect
Reproductive and developmental toxicity	Mouse fertility study – TDLo = 84,800 mg/kg; Developmental studies in rats at up to 245 mg/kg, mice at 3.4 - 340 mg/kg and rabbit at 176 mg/kg showed no effects; Effects (not specified) noted only mice given intra-uterine dose of 84 mg/kg	Not a reproductive or developmental toxin; Rat reproductive NOAEL = 2500 mg/kg/day	Long-term high level exposure results in testicular atrophy in humans; Established human foetotoxin and developmental toxin (including teratogenic effects) Rats given 22-27 mg/ml for 3-4 wks showed reduced reproductive performance; Rat 6 week inhalation study at 18.8 and 30 mg/L (10,000 and 16000 ppm) - negative

Table A5.6: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Builders, Complexing Agents, Solvents

Property	**Builder**	**Complexing/descaling agent**	**Solvent**
	Sodium carbonate	**Citric acid, monohydrate**	**Ethanol**
Genotoxicity	Negative for primary DNA damage in *Escherichia coli*; Ames test on sodium bicarbonate and sodium sesquicarbonate negative	Not mutagenic *in vitro* or *in vivo* assays	Positive for mutagenicity and clastogenicity in *in vitro* (only with metabolic activation) and *in vivo* studies
Cancer	No data	Not carcinogenic	Established human and animal carcinogen operating via both genotoxic and non-genotoxic mechanisms (respective importance in eliciting effects uncertain)
Relevant exposure standards	UK OES 10 mg/m^3 (8-hr TLV)		NL: MAC 1000 mg/m^3; DE: MAK 1000 mg/m^3 or 2000 mg/m^3 (60 min), 1900 mg/m^3, 3800 mg/m^3 (1 hr, 3 times), 4000 mg/m^3 (15 min, 4 times); UK: OES 1900-1920 mg/m^3 (8hr); US TLV: 1000-1880 mg/m^3; NO: 950 mg/m^3; FR: VME 1900-9500 mg/m^3
Ecotoxicity Profile			
Log Pow	ca. 0 (not applicable for an inorganic compound which dissociates)	-1.72 (20°C)	-0.32
Environmental partitioning at equilibrium	Sodium and carbonate ions do not adsorb significantly to sediment	Equilibrium state: 99.99% water; <0.01% soil; <0.01% sediment; <0.01% air	Distributes mainly to air and water (57% air, 34% water, 9% soil)
Environmental half-life		Atmospheric = 2.3 days	Tropospheric half-life = 10 - 36 hrs
Biodegradation (k d^{-1})	Dissociates in water to sodium and carbonate ions	Readily biodegradable - 97% (CO2 evolution); Used as metabolite in Krebs cycle by all eukaryotic cells; Dissociates readily in water into the citrate anion and representative cations	Stable to hydrolysis but readily biodegradable; 45-74% after 5 days
Bioconcentration factor			logBCF = 0.5

Table A5.6: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Builders, Complexing Agents, Solvents			
Property	**Builder**	**Complexing/descaling agent**	**Solvent**
	Sodium carbonate	**Citric acid, monohydrate**	**Ethanol**
Acute toxicity - aquatic	Fish (various species) LC_{50} = 167 - 1200 mg/L; NOEC = 550 mg/L. Invertebrate (*D. Magna)* EC_{50} = 151 - 565 mg/L; (*Culex sp*.) EC_{50} = 600 Algae (various sp.) EC_{50} (120hr) = 137-1050 mg/L	Fish (various species) LD 50 (96 hr) = 440-1516 mg/L; Invertebrate (various species) EC0 = 73-1206 mg/L	Extensive – e.g. Fish (various) - LC_{50} (96 hr) = 8140-14200 mg/L; Invertebrates - *D. magna* LC_{50} (48 hr) = 9268-14221 mg/L EC_{50} (24 hr) = 10000 mg/L; *Artemia Salina* LC_{50} (24hr) = 1833 mg/L) Algae (*Chlorella vulgaris)* EC_{50} (96h) = 1000 mg/L; Microorganism EC_{50} = 1450-6500 mg/L
Acute toxicity - terrestrial			Worms: LC_{50} (48 hr) = 0.1-1 mg/cm^2 filter paper
Repeat exposure - aquatic	Fish (various sp.) LC_{100} (5 day) = 68-110 mg/L; Invertebrate (*D. magna)* EC_{50} *(*immobilisation at4 days) = 228-297 mg/L	Fish (*Carassius auratus*) LC0 = 625 mg/L; LC_{100} = 849 mg/L; Invertebrate (*D. magna*) EC_0 = 80 mg/L; EC_{100} = 120 mg/L; Algae (*Scenedesmus quadricauda*) EC_0 (7 days) = 640 mg/L	Fish (various sp) EC_{50} = 14-26 mg/L; LC_{50} = 454 mg/L; Invertebrate - *(D. magna)* EC_{50} = 14-26 mg/L; *(Cerodaphnia sp)* 10 day reproduction NOEC = 9.6 mg/L
Repeat exposure - terrestrial			

Source: ACGIH (2000); Albano (2000); Baan et al (2007); Basketter et al (2004); EC (2006); Chemical Land21 (2009e); Cohen-Kerem & Koren (2003); EC (2009b); Ethanol HPV Challenge Consortium (2001); Gossel & Bricker (1994); HERA (2002, 2005 and 2005b); HSE (2000); IARC (1985, 1987, 1988); Kane et al (1980); Kruhoffer (1983); Lester and Greenberg (1951); Mahan & Myers (1987); Nelson et al (1985, 1985b, 1988); Oxford University (2005 and b); Pendlington et al (2001); Rivier & Vale (1983); Simpson et al (2004); Steiner et al (1997); Swiss Agency for the Environment, Forests and Landscape (2004); Turcotte et al (2005); US EPA (2005)

Notes: ACGIH: American Conference of Industrial Hygienists; DE: Germany; ED_o/LD_o: Highest dose causing no effect/deaths; EDL_O/LDL_O: Lowest dose causing effect/deaths; ED_{50}/LD_{50}: Median effective/lethal dose; ED_{100}/LD_{100}: Dose causing effect/deaths in all organisms; FR: France; NL: Netherlands; NO: Norway; NOEL/LOEL: No/lowest observed effect level; N/LOAEL: No/lowest observed adverse effect level; MAK: Maximale Arbeitsplatz-Konzentration; TLV: Threshold-limit value; VME: Valeur Moyenne d'Exposition; UK: United Kingdom; USA: United Sates of America

Table A5.7: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Thickeners, Anti-caking Agents, Stabilisers			
Property	**Thickener**	**Anti-caking agent**	**Stabiliser**
	Xanthan gum	**Sodium sulphate**	**Coconut oil monoethanolamine**
Example proportion of product	1-5%	25-50%	5-10%
Identity, Classification and Labelling			
EC Number	234-394-2	231-820-9	268-770-2
CAS Number	11138-66-2	7757-82-6	68140-00-1
Chemical formula	$(C_{35}H_{49}O_{29})_n$	$H_2O_4S.2Na$	$C_{17}H_{35}NO_2$
Ambient state	Off-white free flowing powder	White powder or crystals	Pale yellow solid
Vapour pressure		1E-06 Pa (25ºC)	
Henry's Law constant (atm-m^3/mol)			
Water solubility	Soluble	1.61 x E^{05} mg/L (20ºC)	1.40 mg/L
Log Kow		10^{-3}	
Labelling symbols		German KBwS : generally not water polluting	Fatty acid monoethanolamides: Xi – irritant German KBwS: water polluting
Risk phrases			Fatty acid monoethanolamides: R41 (risk of serious damage to eyes)
Mammalian Toxicity Profile			
Toxicokinetics	No significant absorption via oral or dermal route; Approximately 98% of oral intake eliminated via faeces unchanged and of that absorbed 15% of radio-labelled material is metabolised to CO_2 within 100 hours		
Acute toxicity	Rat LD_{50} oral = >1000 mg/kg (max. dose feasible)	Rat LD_{50} oral = 60000 - >10000 mg/kg; Mouse LD_{50} oral = 193 - 6346 mg/kg; Acute effects in humans limited to diarrhoea after single dose >300 mg/kg	Rat LD_{50} oral = >3125 - >5000 mg/kg Mouse LD_{50} oral = 3125 - >10000 mg/kg

Table A5.7: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Thickeners, Anti-caking Agents, Stabilisers			
Property	**Thickener**	**Anti-caking agent**	**Stabiliser**
	Xanthan gum	**Sodium sulphate**	**Coconut oil monoethanolamine**
Irritation	Skin irritation in rabbit noted with 5% aqueous suspension; No skin irritation in rats at <2% solution; No eye irritation in rabbit with 1 % solution		No to moderate irritant in rabbit and mouse dermal tests; No to slight irritation in rabbit eye tests
Sensitisation	Negative in Guinea pig and rabbit sensitisation studies and in epidemiological investigations of exposed workers		Negative in Guinea pig maximisation tests
Repeat dose toxicity	Rat dietary studies showed increased small intestine dry weight (but not stomach, ceacum or large intestine) at >2000 mg/kg/day; Well tolerated (minor clinical pathology and GI-tract disturbance) in dogs at 2000 mg/kg/day for 12 weeks, and at 1000 mg/kg in rats and dogs for 2 years	Extensive data - Rat 6 week feeding study no effect at <2% diet; Rat inhalation studies - 3 day - no effect at 10 mg/m^3; 3 month - pulmonary changes and, hepatic and spermatocyte effects at 1 mg/m^3; NOEL = 0.1 mg/m^3; No adverse findings in human epidemiology studies; Overall repeated dose NOAEL (for rats) considered = 320 mg/kg/day	None-dose related changes in forestomach in rat repeat dose oral studies; NOAEL 750-1500 mg/kg/day
Reproductive and developmental toxicity	Rat multi-generation study showed no effects at <500 mg/kg/day	Foetal toxicity in mice given 14 g/kg (gestation days 8-12); Negative in mouse drinking water study at up to 5000 ppm	
Genotoxicity		Negative in Ames and Escherichia coli assays	Negative in Ames tests
Cancer		Rat dietary study no effect at <630 mg/kg/day	No data (note some concerns regarding potential for nitrosamine contamination)
Relevant exposure standards	German MAK: 6 mg/m^3 US TLV: 10 mg/m^3 OSHA, 5 mg/m^3 TWA ACGIH, 3 mg/m^3 TWA	German MAK 6 mg/m^3 UK OEL 10 mg/m^3 (inhalable)	
Ecotoxicity Profile			
Log Pow			3.89 -4.71 (calculated)
Environmental partitioning at equilibrium			
Environmental half-life			

Table A5.7: Comparison of Hazard Profiles of 1,4 Dichlorobenzene and Substances used in Alternative Products – Thickeners, Anti-caking Agents, Stabilisers

Property	**Thickener**	**Anti-caking agent**	**Stabiliser**
	Xanthan gum	**Sodium sulphate**	**Coconut oil monoethanolamine**
Biodegradation ($k\ d^{-1}$)		Not biodegradable; Undergoes abiotic hydrolysis – COD = <3 mg/g; No bioaccumulation anticipated	Readily biodegradable: 55 - 82% after 30 days aerobic (activated sewage plant effluent); Also undergoes anaerobic biodegradation (79% in 42 days)
Bioconcentration factor		2.5 l.kg (earthworm) 13 l.kg (fish)	
Acute toxicity - aquatic	Past the US EPA (California) mysid shrimp toxicity test	Extensive data – e.g. Fish (*Gambusia affinis*) LD_{50} - 24-hr = 5400 mg/L 96-hr = 120 mg/L Fish (*Morone saxatilis*) LD_{50}- 24-hr = 650-1100 mg/L 48-hr = 320-1100 mg/L Crustacea (*Artemia salina*) EC_0 100-hr = 24 mg/L; 4-day = deaths at 5.4 - 7.8 mg/L; *(D magna)* EC_{50} 96 hr = 630 mg/L; Overall low acute toxicity to fish, daphnia and algae; LC_{50}/EC_{50} generally values far >1000 mg/L	Fish LD_{50}: *Brachydanio rerio*, 96-hr = 28.5 – 90 mg/L; *Leuciscus idus*, 48-hr = 13.5 – 20.7 mg/L; Crustacea EC_{50} *Crangon crangon* 48 hr = >100 mg/L *D magna* 24-hr = 10 - 135 mg/L; Algae EC_{50} (*Scenedesmus subspicatus*) (96-hr) = 0.76-1.1 mg/L –based on possibly contaminated material; values of 16.6-17.8 mg/l reported for algae in recent studies on pure substance
Acute toxicity - terrestrial			
Repeat exposure - aquatic		Extensive data – e.g. Fish (*Gambusia affinis*) LD_{50} 6-day = 2200 - 3200 mg/L; Algae (*Chlorella pyrenoidosa*) EC_{100} 8-day = 57700 mg/L; (*Nitscheria linearis*) EC_{50} (5-day) = 1900 mg/L	
Repeat exposure - terrestrial			

Source: Burdock Group Consultants (2006); Chemical Land21 (2009c and 2009d); EC (2009 and 2009b); US FDA (2009); The Good Scents Company (2009); HERA (2006); Madson et al (2000); and MILLC (1998).
Notes: ACGIH: American Conference of Industrial Hygienists; COD: Chemical oxygen demand; LD_{50}: Median lethal dose; MAK: Maximale Arbeitsplatz-Konzentration (German); OSHA: Occupational Safety and Health Administration (USA); TLV: Threshold-limit value

Because of the potentially quite high levels of inclusion and inherent physicochemical properties of surfactants, their potential risks warrant consideration. **Sodium dodecylbenzene sulphonate** has not been subject to classification or labelling requirements. Although only very limited hazard data are available specifically on this substance, considerable information exists for the class of substances linear alkylbenzene sulphonates (LAS). Indeed, a 'read-across' approach was adopted for LAS in the research project 'Human and Environmental Risk Assessment on ingredients of household cleaning products' (HERA). In this, the extent of consumer exposure from all direct and indirect skin contacts as well as from inhalation and from oral route in drinking water and dishware from all consumer sources was estimated to be 4.0 µg/kg bw/day (HERA, 2009; HERA, 2009b). When compared with the established systemic NOAEL of 680 mg/kg/day for LAS, the margin of exposure (MOE) was of the order of at least 17,000. It is, therefore, reasonable to conclude that use of sodium dodecylbenzene sulphonate in the two applications under consideration here should not raise safety concerns for consumers. HERA (2009b) noted that the surface-active properties of surfactants limit the extent to which bioconcentration can be predicted based on Kow. However, a bioconcentration factor (BCF) for LAS in river waters was estimated to be approximately 87 l/kg for the commercial mixture (C11.6 alkyl chain length) and 22 l/kg for the linear (C10.8 alkyl chain length) form. Particularly given the estimated exposures and the biodegradation which would occur, these BCFs were not considered of concern. This opinion is supported by a detailed environmental risk characterisation on LAS which suggested that the PEC:PNEC ration was below 1 for all environmental compartments, thus confirming that the environmental risk is low (HERA, 2009b).

There is also little information on **C_{12-18} ethoxylated alcohols** (sometimes termed polyethylene glycol ethers of C_{12}-C_{18} alcohols or $C_{12-18}EO_7$). However, the alcohol ethoxylates (AEs) together constitute a major class of non-ionic surfactants that are widely used in laundry detergents and, less so, in household cleaners, institutional and industrial cleaners, cosmetics, and agriculture and in textiles, paper, oil and other process industries. The aggregate consumer exposure to AEs is conservatively estimated to be a maximum of 6.48 µg/kg bw/day (HERA, 2009c). AEs are not considered sensitisers and, while irritant in undiluted form, dilute solutions are not considered to hold any appreciable risk of irritancy. Data on acute mammalian toxicity of the C_{12-18} class of AEs suggest they are only slightly to moderately toxic. Repeat exposure is also well tolerated by mammals (lowest recorded NOAEL for AEs is 50 mg/kg/day based on hepatic changes that are probably adaptive in nature; HERA, 2009c). There is also no evidence suggesting carcinogenic or genotoxic potential or of developmental toxicity in the absence of the maternal toxicity. The ecotoxic potential of AEs is also limited. Available data suggest there may be an optimal structural combination of ethoxylate and alkyl chain lengths at or around $C_{14}EO_7$ at which BCF would be maximal. However, measured BCFs for this form are well below a critical limit of 5,000. Environment Canada was cited in HERA (2009c) to have concluded that, as a group, AEs were not bioaccumulative. Overall, the risk to the environment from AEs (including ethoxylated C_{12-18} alcohols) was estimated to be low, with PEC:PNEC ratios below 1 (e.g. 0.023 - 0.041 for surface waters; HERA, 2009c).

Sodium lauryl ether sulphate (also termed alcohols, $C_{12\text{-}14}$, ethoxylated, sulphates, sodium salts and α-sulpho-ω-hydroxy-poly(oxy-1,2-ethanediyl) is not included in Annex I of Directive 67/548/EEC or Annex I of Regulation (EC) No 689/2008 but is included in the NLP (No-Longer Polymers) list (NLP No. 500-234-8; EC, 2009a). This substance, for which little specific data was identified, belongs to the alcohol ethoxysulphates (AESs) which are currently undergoing consideration within the HERA project. AESs are generally marketed as mixtures rather than pure substances and find application in a wide range of consumer uses. Preliminary assessments are available on human health (draft only) and environmental risk (HERA, 2003 and 2004 respectively). AESs show low acute mammalian toxicity and, while neat AESs are irritant to skin and eyes, this effect diminishes at lower concentrations. The group does not show contact sensitisation and has low repeat dose toxicity. AESs are not considered mutagenic, genotoxic or carcinogenic and are not reproductive or developmental toxicants. The aggregate consumer exposure to these substances has been estimated at 29 µg/kg bw/day. Compared with the identified critical systemic NOAEL of 75 mg/kg/day, this gives a MOE for humans of 2586 (HERA, 2003). Consideration of the ecotoxicity profile and predicted environmental concentrations also gives risk characterisation (PEC:PNEC) ratios less than 1 (HERA, 2004) suggesting the AESs as a group are not of environmental concern.

In addition to use in alternative air fresheners and toilet blocks, **benzyl salicylate** is widely used both as a perfume and as a preservative in consumer products (e.g. soaps and perfume products) where its presence must be indicated in the list of ingredients referred when present at levels above 0.001% for leave-on products and 0.01% in rinse-off products. It is also used in foodstuff as a flavouring (EC, 2009b; EC, 2009 and Danish Environmental Protection Agency, 2006). The estimated adult exposure from its use in soaps is estimated at 0.45 µg/kg bodyweight/day (Danish Environmental Protection Agency, 2006). Data on this substance are limited; no data was identified on repeat dose toxicity but it is not particularly acutely toxic and no genotoxicity has been identified. The principal concern for this substance is its sensitising potential which available experimental data suggest may be weak. In any case, since preservatives such as benzyl salicylate (which is also used as a fragrance) are used only in small amounts (<5%) in the alternative air freshener and toilet block products considered here, this source is unlikely to be of concern. Predicted BCF values are 547.7 - 652.47 (depending on pH) but little ecotoxicity data were identified so it is not possible to assess the nature of any risk that might be posed to the environment at this time.

The other preservative considered, **1,2-benzotiazoline-3(2H)-one**, is classified as potentially harmful to humans and the environment. Concerns for humans relate to skin and eye irritancy and skin sensitisation. By the oral route, it is rapidly metabolised and eliminated and shows only limited mammalian acute toxic potential. A repeat dose oral NOAEL equivalent to 8.42 mg of pure chemical was identified and foetotoxicity was only elicited at a maternally toxic dose of 40 mg/kg/day. Although no data was identified on carcinogenicity, it was negative in *in vitro* and *in vivo* mutagenicity assays suggesting it is probably of low concern. 1,2-Benzotiazoline-3(2H)-one shows, however, significant ecotoxic potential, particularly in algae (EC_{50} (72 hr) of 0.1 mg/L). QSAR calculations have suggested that it is probably aerobically degradable and has low bioaccumulation potential in aquatic organisms (Madson *et al*, 2000). This substance was not prioritised by

Environment Canada in their Domestic Substances List (Environment Canada, 2007) therefore, given that it is included in the alternative products considered in only very small amounts (0.01-0.02%), use in these applications is unlikely to constitute a significant environmental concern.

Very little information was identified on the **dye CI21095** (i.e. 2,2'-[(3,3'-dichloro[1,1'-biphenyl]-4,4'-diyl)bis(azo)]bis[N-(2-methylphenyl)-3-oxobutyramide, also known by a number of synonyms including C.I. Pigment Yellow 14) other than it has very low mammalian acute toxicity and may be a weak water pollutant. Its environmental toxicity has recently been considered by a European expert committee, which concluded that it did not meet the B (or vB) or T criteria but was likely to meet the P (and vP) criteria in order to meet its technical specification. However, it was concluded to be neither a PBT nor vPvB (ECB, 2005).

Of the substances summarised in Table A5.6, the builder **sodium carbonate** is used in considerable quantities (>40%) in some of the alternative articles under consideration. However, it is on the 'GRAS' (Generally Recognised As Safe) for food in the USA, has low acute toxicity, is not considered geno- or reprotoxic, and the responses to repeated inhalation exposure of rats was limited to local responses in the respiratory tract which are not unexpected given the alkaline nature of the substance. Concerns regarding possible adverse effects arising from human exposure are therefore limited to irritant (but not sensitisation) responses arising from contact. However, the exposures estimated to possibly arise from consumer uses are too low for such local effects to arise (HERA, 2005). Sodium carbonate will dissociate into its component ions readily in the presence of water, with the carbonate ion thus formed undergoing further reaction with water to form hydroxide and bicarbonate ions which exist in equilibrium with carbon dioxide in the water. HERA (2005) estimated that, for use in detergents, the $PEC_{regional\ added}$ and PEC_{local} added were 1.7 and 5.7 mg/L respectively. Because the substance breaks down into constitute ions which then establish equilibrium levels in the water bodies they enter, it is not possible to establish a PNEC for the parent substance. However, in the light of the ecotoxicity profile of sodium carbonate and its component ions, HERA concluded that this source would not have an adverse effect on the aquatic ecosystem.

Citric acid, monohydrate, a complexing agent with descaling action, will also rapidly dissociate into ions in the presence of water. Citric acid plays a vital role as an intermediate in Kreb's cycle metabolism in eukaryotes. It has low acute and repeat dose toxicity (rat repeat dose NOAEL = 1,200mg/kg/day) and is not suspected to have any carcinogenic, mutagenic, reprotoxic or teratogenic potential. Although an irritant at high levels, its sensitising potential is low. Citric acid also has a very low aquatic toxicity and is readily biodegradable. Based on EC_{50} values of 825 – 1750 mg/L, a highly conservative PNEC of 0.8 mg/l has been proposed. Comparison to the worst-case estimate (based on maximum European production levels with 20% going to wide dispersive uses) of river levels of citric acid of approximately 0.04 mg/L, demonstrated that this substance does not pose an environmental risk (HERA, 2005b).

The main routes of human exposure to the solvent **ethanol** are ingestion (of alcoholic beverages) and inhalation of vapour; dermal absorption is limited. It is rapidly and extensively absorbed through the GI-tract while 60% and 1% are absorbed via inhalation and dermal routes respectively (Beskitt & Sun, 1997; Pendlington *et al*, 2001, Kruhoffer, 1983). Most ethanol (90-98%) undergoes hepatic metabolism (Albano, 2000) but 2-10% is excreted unchanged via the lungs and kidneys (Gossel & Bricker, 1994). Its acute toxicity is limited and the main target organ of repeated exposure is the liver. Inhalation exposure may cause slight irritancy at >10 mg/m^3 (>5.3 ppm) and it is an ocular irritant but not a sensitiser by any route (EC, 2006). The risk to humans has been considered by many authoritative bodies (e.g. ACGIH, 2000; IARC, 1985, 1987, 1988; & Baan *et al*, 2007) and it has been the subject of proposals to the EC for reclassification and labelling by the French Institut National de Recherche et de Sécurité pour la Prévention des Accidents du Travail et des Maladies Professionnelles (EC, 2006), the principal concern being its status as an established human and animal carcinogen and mutagen (alcoholic beverages are tumourogenic for the oral cavity, pharynx, larynx, oesophagus, liver, colorectum and female breast; IARC, 1988 & Baan *et al*, 2007). Studies in rats also suggest possible effects on the endocrine system (Steiner *et al*, 1997; Emanuele *et al*, 2001) and oral ethanol consumption (as alcoholic beverage) may be the most common human teratogen (Cohen-Kerem & Koren, 2003). Concerns have been expressed about the potential risks to human health of occupational or consumer exposures (i.e. from sources other than alcoholic beverages) but it has been suggested that there is little basis to suppose exposure at or below the current OEL (500 ppm or greater in many EU countries) would be associated with an appreciable increase in cancer risk (Bevan *et al*, 2009). Releases into the environment will distribute mainly to air and water and, while stable to hydrolysis, it will readily biodegrade and is unlikely to bioaccumulate. It is not persistent, having a tropospheric half-life of 10-36 hours. The most sensitive species identified are algae *Chlorella vulgaris* (96hr EC_{50} = 1,000 mg/L) and the invertebrate *Artemia Salina* (24hr LC_{50} = 1833 mg/L) and the lowest reported repeat dose NOEC is for invertebrates (9.6 mg/L for 10 day reproduction; Czech Republic, 2004).

Of the remaining substances (see Table A5.7), **xanthan gum** is of low health and environmental concern being generally regarded as safe (Oxford University, 2003b; US FDA, 2009). It is a high molecular polysaccharide produced by fermentation of carbohydrates with *Xanthomonas campestris* and is soluble in water but not in organic solvents. In addition to the uses considered here, it has a wide range of environmental applications including as a rheology control agent in aqueous systems and is also used widely in the food industry. The daily intake from dietary and pharmaceutical sources has been estimated at 884 mg/person/day in the US (Burdock Group Consultants, 2006).

The anti-caking-agent **sodium sulphate** is widely distributed in nature, occurs in almost all fresh and salt waters and is a normal constituent of natural foodstuffs. It has low mammalian acute and repeat dose toxicity (tentative rat NOAEL = 320 mg/kg/day) and is not suspected of being a mutagenic, carcinogenic, reprotoxic or teratogenic agent. Furthermore, human experience suggests it is not a sensitising agent. Consumer exposure from use in detergents have been are estimated at 0.1 mg/kg/day (compared to normal daily intake from all anthropogenic and natural sources of 7.5 mg/kg) suggesting exposures from the applications considered here would be inconsequential. It has low aquatic toxicity and enters the sulphur cycle and so is not considered a major environmental hazard although it has been suggested that local peak concentrations (at greater than the PNEC of 1.9 mg/L) could conceivably damage un-adapted flora and fauna (HERA, 2006).

Coconut oil monoethanolamine (also known as Cocamide MEA) is a non-ionic surfactant and foam stabiliser that, although possibly showing irritant potential, does not appear to be a sensitiser. While concerns have been expressed as to consequences of contamination with nitrosamines, the pure compound has tested negative in Ames assays. No information is available on its reproductive toxicity. However, it has low acute and repeat dose mammalian toxicity (NOAEL 750-1500 mg/kg/day in rats). It is 'toxic' to 'moderately toxic' to aquatic organisms (EC/LC_{50} values range between 24 to >100 mg/L), with the lowest EC_{50} value identified (26 mg/L) occurring in algae. Given the estimated log Pow value above 4, the substance might be considered potentially bioaccumulative but in the light of its limited toxicity it would be unlikely to be considered PBT. A PNEC of 0.23 µg/L has been estimated for the closely-related substance Cocamide DEA, which would equate to a MOE of 427.1 based on estimates of its PEC (Danish Environmental Protection Agency, 2006). Given that Cocamide DEA is slightly more toxic than the monoethanolamine, it is likely that the MOE for coconut oil monoethanolamine would also prove to be adequate

Finally, with regard to the release of VOC compounds, a manufacturer of air fresheners and toilet blocks notes that 1,4 dichlorobenzene has a low Maximum Incremental Reactivity (MIR) value of 0.2 and does not contribute significantly to low-level ozone formation. Other common formulating chemicals (e.g. ethanol) have much higher MIR values and are known to be more photo-reactive which increases their likelihood to partake in reactions producing low-level ozone. However, these chemicals could be present in alternative formulations at concentrations much lower than the typical concentrations of 1,4 dichlorobenzene in its products.

A5.5 Relative Cost of Alternatives Products

We have collected information on the cost of alternatives to 1,4 dichlorobenzene-based air fresheners and toilet rim blocks from a leading UK-based retailer who is also active in other EU member States. The relevant details are provided in the two tables that follow. Where products contained more than two units, the cost was divided by the number of units to calculate the retail cost per unit. The tables also indicate the cost of refills for products that may use them.

Table A5.8: Overview of the Cost of Alternative Air Freshener Products

Type of air freshener alternative	Price range per unit
Aerosol	€0.32 - €3.50 per 300 ml
Automatic aerosol refill	€2.28 - €4.05
Automatic aerosol unit	€7.41 - €16.29
Gel	€0.43 - €3.42
Manual spray refill	€2.85

Table A5.8: Overview of the Cost of Alternative Air Freshener Products	
Type of air freshener alternative	**Price range per unit**
Manual spray unit	€3.50 - €6.84
Plug-in refill	€4.08 - €5.09
Plug-in unit	€6.99 - €10.49
Pot pourri	€3.42
Scented oil	€1.14 - €7.98
Wick in liquid	€1.93 - €2.62
Source: prices for products available from a leading supermarket in the UK as of 20 April 2010; used an exchange rate of £1 = €1.14	

Table A5.9: Overview of the Cost of Alternative Toilet Block Products	
Type of toilet block alternative	**Price range per unit**
Adhesive in-bowl disc	€0.57
Cistern block	€0.18 - €1.14
In-bowl block	€0.31
Liquid	€1.48 - €1.74
Liquid - refill	€1.12 - €1.14
Solid in cage rim block	€0.23 - €1.12
Solid with gel rim block	€2.05 - €2.71
Source: prices for products available from a leading supermarket in the UK as of 20 April 2010; used an exchange rate of £1 = €1.14	

The table for air fresheners indicates a wide range of products with a rather diverse cost which may exceed €16 for an automatic aerosol unit, although the refills that would subsequently be bought would be far less costly. On the other hand, a smaller range of alternative toilet deodoriser products are shown in the second table; while their prices vary, the price differences are not as extreme as in the case of air fresheners.

With regard to 1,4 dichlorobenzene-based air fresheners and toilet rim blocks, consultation with an EU-based manufacturer of such products indicates that the typical price per unit for 1,4 dichlorobenzene-based air freshener and toilet rim block is €2 and €1.50 for products weighing 80 g and 70 g respectively.

ANNEX 6

PROFESSIONAL USES OF 1,4 DICHLOROBENZENE-BASED PRODUCTS AND THEORETICAL IMPACTS FROM AN EU-WIDE RESTRICTION

ANNEX 6. PROFESSIONAL USES OF 1,4 DICHLOROBENZENE-BASED PRODUCTS AND THEORETICAL IMPACTS FROM AN EU-WIDE RESTRICTION

A6.1 Introduction

During the preparation of this impact assessment, consultation with industry stakeholders consistently suggested that the use of 1,4 dichlorobenzene-based products in a professional setting (for instance, by janitorial/cleaning staff) is far more important than use by private consumers at home. In particular, 1,4 dichlorobenzene-based urinal blocks still find significant use in public toilets, especially when heavy ‘traffic’ is expected or when the frequency of cleaning is low. In such circumstances, malodour can be intense and 1,4 dichlorobenzene performs very well at masking unwanted odours at a low cost.

In this Annex, we discuss the usage of 1,4 dichlorobenzene-based urinal blocks (and to a lesser extent air fresheners) by professional users. We further examine the technical and cost advantages and drawbacks of alternative urinal block products and we also provide a short analysis of the likely impacts from an EU-wide restriction that would theoretically affect both consumer and professional uses of 1,4 dichlorobenzene-based products. It should be remembered that an EU-based manufacturer of the substance has argued that consumer uses account for 30-40% or more of the overall EU market for the relevant products; hence a restriction on consumer uses would have such a detrimental effect that would result in a de facto restriction on all uses of these products. Whilst we do not subscribe to this theory, we hereby provide an analysis of the likely costs and benefits from such a restriction.

A6.2 Market Share of 1,4 Dichlorobenzene-based Urinals

A6.2.1 Urinal Types and Functionality

The World of Urinals in Figures

According to US sources, there are currently around 53.7 flushed urinals installed around the world (Falcon Waterfree Technologies, 2010). These flush an estimated 2 trillion gallons or ca. 10 trillion litres of fresh water into the sewer each year (Green P, 2010).

At the national level, two estimates are available in the open literature:

- in the US, there is an estimated 7.8 million urinals, 65% of which exceed the maximum allowable flush volume set by US federal standards - while the current federal standard for commercial urinals is 1.0 gallon per flush (ca. 4.5 litres per flush), some older urinals use as much as five times that amount; and
- in the UK, there are approximately 1.55 million installed urinals, each using an average of 6 to 10 litres to flush (Construction Resources, 2010).

Due to the lack of more detailed information, we may assume that the UK population in 2010 was around 12.4% of the total EU population[45], therefore, the number of flushed urinals across the EU is ca. 12.5 million. This figure does not include waterless urinals; however, the market for these products still appears to be rather small (see description of waterless urinals further below).

Urinal Technologies

Urinal technology has evolved over time and as such a variety of urinal systems may be found around the world. The word 'urinal' is used to signify the individual ceramic bowls fixed to the wall as well as multi-person urinal troughs (often made of stainless steel) or simply a wall with drainage and flushing, automatic or manual. Troughs tend to be less common nowadays.

On the basis of water flushing patterns, the types of urinals available on a global scale include:

- **manual flushing urinals**: these usually have a lever or button, which the user will ideally push after having used the urinal (there is no guarantee that the user will do so, however, possibly for hygiene reasons);
- **timed flushing urinals**: flushing could be programmed to take place at regular intervals. In older types of urinals, groups of urinals are flushed simultaneously, which could mean that urinal bowls that have not been used by visitors may also be flushed at the same time. Other systems may include switches linked to the light switch or the toilet room door which allow for the flushing to take place only when the lights are on (so flushing does not take place during the night) or when a certain number of visitors enters the toilet room;
- **automatic flushing urinals**: this is a more modern system where active or passive infrared sensors activate the flushing after a urinal has been used or when someone stands in front of the urinal and then moves away. It is possible with some systems that simply with visitors passing by, flushing is activated even when the urinal has not been used – to avoid this, the infrared sensor may be adjusted to trigger the flushing only after the presence of a visitor has been detected for several seconds. Automatic flushing can be retrofitted to manual and timed systems; and
- **waterless urinals**: this is a fairly recent development where urinals do not operate with flushing. There are three main types of waterless urinals namely, microbiological, barrier and valve systems (Gentworks, undated):
    - in microbiological systems, urine comes into contact with a block, often housed within a dome inserted into the urinal waste outlet. The block contains a number of active ingredients, including surfactants, but the most important of these is the microbial spores. Once taken down into the trap with the urine, the spores

45 Population data from Eurostat available here: http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&language=en&pcode=tps00001&tableSelection=1&footnotes=yes&labeling=labels&plugin=1.

become active 'good' bacteria that feed upon the urine and then multiply. By breaking down the urine, the 'good' bacteria prevent the build-up of sludge and crystals that are a major contributing cause to blockages. They also generate an environment hostile to the 'bad' bacteria that cause odours. Appropriate cleaning chemicals must be used and simple but regular maintenance is required;

- for barrier systems, urine and debris passes through an oil-based barrier fluid which forms the seal to prevent odours reaching the toilet room. In some systems, the barrier fluid is contained within a replaceable cartridge that also captures debris that would otherwise fall into the waste pipes. Cartridges typically need to be replaced every 2 to 5 months, depending on usage. The barrier fluid can be swiftly degraded if the incorrect cleaning chemicals are used. Otherwise, barrier systems work well, although they can be expensive to run for busy washrooms; and
- in valve systems, urine passes through a one-way 'plastic' valve that, when closed, prevents odours from being emitted into the toilet room. A system available on the market has a siphon based on a hydrostatic float and uses two odour traps. The first is the siphon itself (like a conventional siphon), which always has a content of urine rather than standing water found in the trap of a water flush urinal. The hydrostatic float has a patented odour seal which prevents odour from escaping from the waste system. These generally require some regular maintenance to clear urine crystals and debris and it is evidently important not to allow the valve to become stuck open. Valve systems work well if properly maintained and are available to retrofit for most types of standard urinal bowls. Some models include a scented or microbiological block to complement the valve.

Finally, a most recent development appears to be a waterless urinal system that includes a low-watt on-line fan in the vent pipe. This runs constantly, causing airflow at the bowls to remove malodours. The fan is claimed to use a very small amount of electricity – about 3W – and is expected to last more than three years (Airflush, 2010).

There have been mixed views among consultees on whether regular flushing is the norm. From one hand, some sources argue that regular flushing of urinals is not common:

- a manufacturer of urinals has suggested that regular flushing is not very common in the EU; and
- a manufacturer of urinal blocks has indicated that 'traditional' regular flushing urinals (the ones which flush every few minutes and perhaps often several of them flush simultaneously) are no longer popular due to their high water consumption and perhaps account for less than 15% of all urinals. Modern controlled-flushing urinals are suggested to be very popular in Northern European countries and may account for 60-70% of all urinals. Finally, waterless urinals have come into fashion in the last five or so years and are assumed to account for no more than 5% of the urinal market. Consultees from the UK and Germany, have suggested that, in their countries at least, waterless urinals tend to be installed in motorway stations to reduce water consumption. The number of waterless urinals has stopped growing and may currently be somewhat decreasing (at least in Germany) due to perceived problems

with odours and pipe blockages. A manufacturer of urinals has noted that there was some sort of a 'gold rush' when waterless urinals first appeared in the market, but since users have realised that they might also cause problems, the number of waterless urinals being installed each year has largely stabilised.

On the other hand, other sources suggest that regular flushing of urinal bowls is still common in the EU:

- a supplier of waterless systems has indicated that frequent flushing urinals are very prevalent;
- Stay Fresh Systems (2010) indicates that, in the UK at least, the average flush rate for a urinal is once every 15-20 minutes;
- the Environment Agency for England and Wales (2009) also suggests that many urinal installations do not have controls and so flush continuously, and often at a higher rate than specified by the UK Water Supply (Water Fittings) Regulations 1999. For an office with a 40-hour working week this means that 76% of the flushing occurs when the building is unoccupied. Under the Water Fittings Regulations, urinals should use no more than 7.5 litres per bowl per hour (10 litres for a single bowl) and should have a device fitted to prevent flushing when the building is not being used. In practice, flow rates are rarely measured and will drift with time, or are deliberately increased in a (usually vain) attempt to solve odour problems; and
- another well-known manufacturer of urinals who sells his products across the EU has also indicated that regular flush urinals are the most common types present in the EU today.

Conclusion: we tentatively conclude that only 30% of flushed urinals in the EU are 'traditional' high-flush urinal bowls and troughs.

We have further confirmed that urinals which operate with standing water are indeed present in the EU. According to an EU manufacturer of urinals, standing water is used to avoid odour nuisance coming out of the drain pipe (presumably in a way similar to how a regular toilet bowl at home operates). The presence of this type of urinals is limited; two manufacturers of urinal blocks estimate that >90% of urinals in the EU do not operate with standing water.

A6.2.2 Market Share of 1,4 Dichlorobenzene-based Urinal Blocks

An important consideration for the discussion presented throughout this Annex is the number or percentage of EU urinal bowls that may actually be deodorised with 1,4 dichlorobenzene-based urinal blocks at present. We do not have specific information on this so our estimates are based on information from three sources:

- **calculations based on historical consumption data**: we can make some assumptions on the basis of the consumption tonnage date presented in Section 2 of the main report. In 1994, 1,268 tonnes of 1,4 dichlorobenzene were sold for EU-based manufacture of toilet blocks. In 2008, the figure was 400 tonnes. If we assume that these figures refer exclusively to urinal blocks (rather than rim blocks), the reduction in sales between 1994 and 2008 was 68-84% (please note that this may in fact be an underestimate of the reduction that occurred between 1994 and 2008 as the above data compare consumption in the EU-12 in 1994 and in the EU-27 in 2008). If we use data on EU-based production as a proxy and assume that, in 1994, 1,4 dichlorobenzene-based urinal blocks represented 100% of the urinal block market, then in 2008, the share of 1,4 dichlorobenzene-based urinal locks would not exceed 30% and could be well lower, at 15%[46];

- **calculations based on current consumption data**: the extrapolation from data provided by authorities in some EU member States (see Section 2.4.7 of the main report) indicates that 980 tonnes of 1,4 dichlorobenzene-based toilet blocks were consumed in the EU in 2009. We cannot be certain whether this estimate is compatible with the estimated 17 t/y of toilet rim blocks being used by consumers at home. In the absence of better information, we assume that the difference between the two figures (980 - 17 = 963 tonnes) will be the tonnage of toilet blocks used by professional uses in the EU. We do not know what proportion of this tonnage are urinal blocks and what proportion are toilet rim blocks. Since these products have the same functionality and urinal blocks are much more widely used than toilet rim blocks, we assume, for simplicity, that the entire 963 tonnes are urinal blocks. We also assume that the typical size of 1,4 dichlorobenzene-based urinal blocks in the EU is ca. 80 g with an assumed lifetime of 21 days. Therefore, those 963 tonnes are equivalent to ca. 12,000,000 urinal blocks of an 80 g size. With a lifetime of 21 days, each urinal will need around 17 of these blocks over 365 days (= 365/21). Therefore, the number of urinals treated over a whole year with 1,4 dichlorobenzene-based urinal blocks is 12,000,000/17 = ca. 710,000. This represents around 6% of the total number of flushed EU urinals (see discussion in Section A6.2.1 above); and
- **consultation with a UK supplier of urinal blocks**: we have discussed this issue with a large company based in the UK which used to manufacture and supply 1,4 dichlorobenzene-based urinal blocks but following the classification of the substance as a carcinogen category 3, it discontinued its production. The company now supplies alternative products. The company has advised us that 1,4 dichlorobenzene still accounts for 20-25% of the UK urinal blocks market. However, in the last 10 years, the entire urinal blocks market diminished in size by 25-30%, mainly due to the introduction of controlled flushing and a growing market share of waterless urinals.

Overall, in the assessment of impacts we will use the following assumptions:

- 1,4 dichlorobenzene-based urinal blocks account for 15-30% of the EU urinal block market; and
- 1,4 dichlorobenzene-based urinal blocks are used in ca. 6% (or ca. 710,000) of flushed urinals in the EU.

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46 Please note that the above calculation does not take into account present EU expansion since 1994, it assumes a constant market for all urinal blocks and does not take account of trade with non-EU countries.

Box A6.1: Information on the Market Share of 1,4 Dichlorobenzene-based Urinal Blocks in the US

Some information is available for the US in the form of estimates from stakeholders. Before the introduction of restriction on the use of the substance in several US States, it is estimated that 1,4 dichlorobenzene urinal blocks accounted for around 65-70% of all urinal blocks sold. At present, the urinal block business is expected to be split about 50%-50% between 1,4 dichlorobenzene-based and 1,4 dichlorobenzene-free blocks. Products such as a new consumable urinal screen have also made inroads in the US.

The manufacturer has given the example of a downstream supplier of his products in a US State where a restriction on 1,4 dichlorobenzene is not in place. The split in the sales of the supplier in 2009 were 30% 1,4 dichlorobenzene-based blocks, 40% alternative blocks, 25% consumable urinal screens and 5% vinyl screens. The supplier estimates that 15 years ago, that breakdown was probably 65% 1,4 dichlorobenzene-based blocks, 30% alternative blocks and 5% vinyl urinal screens. The supplier further estimated that, just prior to consumable urinal screens being introduced to the market, the split was about 35% 1,4 dichlorobenzene-based blocks, 50% alternative blocks and 5% vinyl urinal screens. So, in his opinion, there has already been a customer shift to 1,4 dichlorobenzene-free technologies, even in the absence of regulatory intervention.

A6.3 The Problems of Odours and Blockages in Urinal Bowls

A6.3.1 Overview of Odour Problems

It is useful to set out the key sources of odour in toilet rooms because while it may seem to relate to the functioning of urinals, this may not always be the case. The key sources of odour can be identified as follows (Gentworks, 2010b):

- **inadequate cleaning**: this is common and could be a combination of cleaning personnel doing a poor job or using inappropriate cleaning products, and visitors accidentally causing urine to splash onto the floor and the surrounding area, soaking into the grout work. Cleaning personnel may not always have the time, training or diligence to do a good job;
- **inadequate flushing**: unless the urinal is a waterless one, flushing is required for the urinal to receive enough flush water. When groups of four or five urinals are being flushed off one cistern, the end urinals may not receive enough water, if the horizontal sparge pipes are not truly horizontal or are scaled up. Even in groups of two urinals, debris in the downpipe and sparges can prevent adequate flush volume reaching both urinals;
- **waste pipes venting to the toilet room**: intense malodour may be the result of a broken pipe. Information received from a manufacturer of urinal blocks suggests that urine itself is relatively odourless, but bacteria present in the urinal environment degrade components of the urine to produce strongly smelling molecules, resulting in the characteristic ammonia-like odour. Uric scale, formed by insoluble compounds in the urine, forms unsightly deposits on the bowl. This scale accumulates in the pipework, causing slow flow, and in extreme cases urinals can block and overflow. There are two types of living organisms that may cause odours emanating from drain pipes (Stay Fresh Systems, 2010):
  - **biofilm**: biofilm is a translucent living organism deposited by the urine and is the primary contributor to smell. It is very resilient towards cleaning chemicals and if

left unchecked, biofilm will develop to a point where it causes the 'traditional' urinal smell; and

- **bacteria**: in a conventional urinal system, bacteria accumulate in the salt sludge and limescale deposits;

- **broken one-way valve**: another common reason is that a valve attached to the urinal waste has malfunctioned. Many waste pipes have one-way valves fitted to stop a flush from sucking the water out of the traps, exposing the unpleasant air in the waste pipes to the toilet room environment;
- **poorly configured pipework**: for example, it is not a good idea to plumb an overflow pipe from a WC cistern into a urinal waste. The smells will come up from the waste, into the cistern and out into the toilet room;
- **very heavy usage**: high traffic in a toilet room may cause unpleasant smells, at least in the short term. Fine particles of urine are sprayed into the air and the only real solution to this is to change the air in the toilet room. Failing this, then an air freshener might help to disguise the odour; and
- **hot toilet room**: if the room is very warm, odour causing bacteria multiply more quickly.

A6.3.2 Blockage Problems

With specific regard to blockages, there appear to be two main causes of blockage (Stay Fresh Systems, 2010):

- **uric acid salt sludge**: the uric acid salt sludge is a non-soluble substance that builds up in the pipe-work below the waste outlet. The formation of uric scale (also known as "urine stone") is the result of the reaction between uric acid and the salts that are naturally present in potable water (calcium, magnesium, etc. in hard water – sodium in softened water). Uric acid is a semi-solid compound resulting from the body's breakdown of purine. It is normally present in urine in small amounts although this varies significantly with different levels of health. The reaction with the salts contained in potable water produces urates (calcium urate, magnesium urate, sodium urate, etc.[47]); and
- **limescale**: limescale is a common problem brought about by hard water. The limescale collects and hardens in the pipe-work until they become choked, preventing the fluids from passing through.

Toilet rooms with naturally 'soft' or artificially softened water (i.e. little limescale content) are likely to experience fewer problems with blockages than those with hard water. When static in the waste pipes, urine and limescale combine to coat the pipework with a hard scale. Over time, layer upon layer is added until the pipe blocks. The coating also

47 Sources: Mosby's Medical Dictionary, 8th edition, 2009; The American Heritage Medical Dictionary, 2007, 2004

provides an ideal medium for the development of odour causing bacteria (Gentworks, undated).

A6.3.3 The Role of Flushing in Odour Control and Pipe Blockage Prevention

The role of flushing in odour control and pipe blockage prevention is linked to the performance of deodorising products, such as urinal blocks and requires particular attention. The points below discuss the potential for malodour and pipe blockage under different urinal operating conditions:

- **frequent flushing**: a standard urinal that is not flushed regularly will soon develop unpleasant odour and will eventually block up. By contrast, a urinal that is flushed every few minutes (the typical time required for the cistern to fill) is less likely to smell or block. However, an unregulated urinal costs a lot to run, is bad for the environment and may contravene water regulations, for instance the UK Water Fittings Regulations (Gentworks, undated). The Environment Agency for England and Wales notes that, in practice, flow rates are rarely measured and will drift with time, or are deliberately increased in a usually vain attempt to solve odour problems (Environment Agency, 2009). It is important to note that standard urinals may not actually flush the trap in the way that a toilet bowl is flushed but instead just dilute the urine without removing solids such as hair, scale and cigarette ends. As a result, even regularly flushed urinals tend to block and in hard-water areas tough scale (insoluble in water) will build up quickly in traps and pipes (Green Building Store, 2010);
- **infrequent flushing**: a reduction in the frequency and quantity of water passing through the waste pipes often leads to problems with odours and blockages. Using a small amount of water (for example, one-litre low flush urinal) will increase the build up of urine scale formed from the reaction of uric acid with water: the salts of uric acid are slightly soluble in water so reducing the flush rate of urinals will actually increase the rate of deposition due to there being less water available to dissolve and flush them away, whilst water is still present to initiate the creation of the salts. If the urine concentration is higher as a result of reduced flushing, uric scale will develop faster and will not be flushed away resulting in blocked waste pipes and a maintenance issue. Reducing flush frequency without serious negative consequences is achievable but it is necessary to find the right balance between reducing expenditure on water and increasing expenditure on maintenance. A rule of thumb is that a standard urinal should be flushed through within 20 minutes of use. This can be easily achieved with a flush controller incorporating a usage sensor. However, urinals with flush controllers tend to block more frequently than those that are flushed every few minutes (Gentworks, undated); and
- **no flushing**: as the name suggests, waterless urinals work without using any water other than for routine cleaning. Due to the absence of water, in waterless urinals, instead of hard scale, untreated and static urine eventually forms a soft sludge. In addition, hair and other debris inevitably enter the wastepipes and attract fats in urine. This can also cause blockages and foul odours, but is reportedly considerably easier to combat than the combination of urine and limescale (Gentworks, undated). Some waterless urinal systems seek to avoid the problems of sludge build-up by trying to

ensure the urine flows quickly through the urinal waste pipes to the main drain, often referred to as 'the stack'. To achieve this, very good plumbing is required to ensure the appropriate gradient towards the stack. Waterless urinals using the 'barrier method' often employ a cartridge that collects debris so that there is less chance of a blockage forming within the waste pipes. The most popular waterless urinal systems use microbiology to treat urine as soon as it enters the waste pipes, breaking it down into constituent parts so that it is less likely to form sludge. However, whilst the microbes are very good at treating urine, they are not so successful at dealing with hair and other debris. So even in waterless systems, some form of manual flushing is often recommended; it is recommended that the traps be sluiced at least once per week (Environment Agency, 2009).

The following box provides additional detail on the functionality, advantages and drawbacks of waterless urinals.

Box A6.2: History, Advantages and Disadvantages of Waterless Urinals

History of Waterless Urinals

Literature suggests that many people dislike waterless urinals or have had bad experiences with them, especially with regard to odour. Gentworks (2008) summarises some potential reasons for some people's dislike towards this technology (which is also shared by a manufacturer of 1,4 dichlorobenzene-based urinal blocks we have contacted):

- old systems were unreliable and tended to let odours from the urinal waste pipes vent into the room;
- users were given bad advice, for instance, they were asked to put some device or chemical compound in the urinal bowl and just turn the water off – this did not work;
- zero flushing highlighted poor pipework installations, such as pipes that are running uphill, have multiple right angled connections and inadequate rodding access so they have never been maintained properly. In addition, some vents and overflows are incorrectly connected into the urinal waste pipes and floor drains are inherently smelly. Whether or not urinals are to be converted to waterless, such issues should be resolved to avoid problems with blockages and odours. Converting to waterless can solve some such problems but exacerbate others;
- waterless urinals require careful and systematic maintenance action. It is vital to follow the correct maintenance regime for the type of waterless urinal used. For microbiological systems, this includes weekly dosing with compatible chemicals. Use of drain clearing acids will 'kill' the enzyme producing microbes and disable the system; or
- incorrect cleaning, for instance cleaning with strong acids, alkalis or bleach will destroy the 'good' bacteria in microbiological systems and degrade the gel in barrier systems. Even valve systems can cease to operate correctly due to a strong cleaning chemical affecting the flexibility of the valve.

The following table summarises the advantages and drawbacks of waterless urinals as presented in the open literature.

Table A6.1: Advantages and Disadvantages of Waterless Urinals	
Advantages of waterless urinals	**Disadvantages of waterless urinals**
• Maximum water savings, typically 20% to 30% of total site water consumption • reduced water and sewage charges • reduced incidence of blockages if properly installed and maintained • no need to maintain cistern, flushpipes and flush controllers • no floods to cause damage • immunity to frost • eliminate vandal-prone plumbing and avoid flooding when bowls block due to sabotage • lower installation cost	• Unfamiliar concept • bad experiences from the past - any odour or blockage will be assumed to be due to waterless operation whereas odour or blockage in conventional urinals is not attributed to the technology • the cost of consumables may exceed the cost of the water saved • the environmental cost of consumables may outweigh the environmental benefit of reduced water use (chemicals, waste to landfill, plastics) • simple but essential weekly maintenance - a maintenance contract could make them uneconomic for smaller installations • standard urinal problems such as leakage and splashing, which lead to odour, are not addressed by most designs • need to assess legionella risk then, if necessary, drain and cap existing flush pipes
Source: Green Building Store (2010); Environment Agency (2009); Gentworks (2008)	

Some waterless systems are supplied as a complete unit, while others can be retrofitted to standard bowls and troughs. A key point that needs to be made is that, although waterless technology is a very promising one and can lead to significant savings in water resources and costs of waster supplies and sewage removal, it may not be the most appropriate option in every case. Correct installation and careful maintenance (including replacement of cartridges which comes at a certain cost) is necessary for waterless urinals to be able to deliver the promised benefits. In this context, retrofitting waterless urinals (i.e. replacing existing flushed water urinals with waterless ones) may prove particularly difficult as the old pipework may not be suitable for waterless systems[48].

In conclusion, there is no perfect urinal system that would remove the risk of blockage. While frequent flushing may remove debris and urine from the system, it still leads to uric scale formation and limescale deposits. On the other hand, waterless urinals might avoid uric scale formation and limescale deposits but may not deal well with debris and may need more frequent maintenance to ensure smooth operation.

48 This issue was highlighted in a recent report presented by the US network CNN – in the California EPA headquarters building, 56 waterless urinals were installed two years after the building opened its doors. Despite claims of odourless operation, malodours were present in the toilet rooms (associated with, among others, urine spillages). The waterless urinals were subsequently replaced with low flushing ones and the problems were traced to the original plumbing of the building rather than the waterless technology. See relevant video at: http://cnn.com/video/?/video/us/2010/02/24/waterless.urinals.replaced.kxtv.

A6.4 Technical and Performance Comparison of Alternatives

A6.4.1 Range of Possible Alternatives

Alternatives to 1,4 dichlorobenzene-based urinal blocks essentially include surfactant-based blocks. In recent times, new types of urinal blocks contain bacteria cultures which can in theory remove the fats and solids that build up in urinal traps and pipework, causing odours, slow running outlets and flooding. These products are promoted as being able to reduce organic matter, biologically preventing the build-up of waste and scale in pipework. However, they do need to rely on additional fragrance in order to create the desired pleasant atmosphere in the toilet room.

Other deodorising solutions might include:

- use of a combination of plastic (normally vinyl) urinal screens (to prevent debris going down the drain) and selection of a different form of air freshener (like gels, liquids, aerosols etc.). Some of the plastic screens are infused with fragrance; it is suggested that the fragrance usually dissipates quickly and the use of a urinal block is recommended to keep bathrooms smelling fresh (Monster Janitorial, 2009);
- use of modern urinal screens which are infused with fragrance and gradually shrink during use. These products are marketed as releasing ten times more fragrance than vinyl urinal screens and they also contain bacteria that clean the urinal and eliminate odours whilst lasting longer than standard plastic screens. Such products are unlikely to be currently available in the EU but are currently promoted (even for use in waterless urinals) in the US (Fresh Products, 2008);
- plastic urinal screens with in-built blocks made with surfactants, occasionally also containing bacterial cultures;
- automatic deodoriser dispensing systems – these may include sophisticated automatic dispensing systems used in high-traffic public or commercial toilet rooms, and products for portable toilets and urinals. The automatic dispensing systems may include an external container and liquid-product delivery tube, either to the bowl of the toilet or urinal, or into plumbing that provides flush water. The most advanced systems use infrared sensors for ‘touchless’ automatic flushing and product dispensing, as toilet/urinal users depart. Automatic flushing devices help alleviate odours from the fixtures caused by otherwise ‘no-flush’ users (CARB, 2004);
- more frequent and more thorough cleaning – this may involve the use of liquid or thick liquid chemicals which are squeezed out of bottles and around the urinal bowl, are left for some time and then a manual brush, small mop, or other device is used to scrub the bowl. The last step is to drain the contents of the bowl by rinsing the urinal. Products that clean inherently provide deodorising benefits; and
- better ventilation conditions.

A6.4.2 Odour Masking Properties of Alternative Urinal Blocks

1,4 dichlorobenzene-based blocks are marketed and sold as cost-effective deodorisers. Their mechanism of action is a simple aromatic vapour release (it is a sublimating solid) and they are considered to be effective at masking unpleasant odours. Since the vapour density of 1,4 dichlorobenzene is greater than air (and apparently than the majority of malodour gases[49]), it may prevent unpleasant odour gases from being released from drain pipes. 1,4 dichlorobenzene-based deodorisers do not prevent the formation of unpleasant odours; they simply mask odours. The additional fragrance that is added to 1,4 dichlorobenzene-based products is simply there to make the odour of the product more pleasant as the smell of pure 1,4 dichlorobenzene is a moth ball-like one and is very strong (which is to be expected given that the substance may constitute almost the entirety of the end-product).

On the other hand, alternative blocks 'attack' the source of the malodour rather than try to mask it or prevent it from being released. Surfactant-based products aim at cleaning the bowl and drain pipes to prevent the accumulation of deposits, which may lead to the development of unpleasant odours and contain fragrances to mask malodours in the toilet room. Modern alternatives may also contain bacterial cultures to actively prevent the action of 'bad' micro-organisms which are believed to be behind the development of unpleasant odours; the 'good' micro-organisms develop a biofilm, produce active enzymes and decompose organic materials which cause bad odours in the drain (Pro-Ren, 2007).

Box A6.3: Biological Action of Certain Alternative Urinal Blocks

A supplier of microbial urinal blocks describes the action of microbial cultures as follows (Ecoprod, undated):

the product contains spores; spores are the sleepy state of microorganisms and are therefore stable for a very long period of time. When the product is in contact with water and with a food source like urine for instance, spores are going to germinate and grow as microorganisms. They are able to use more and more organics as food and avoid bad odours emanating from these organics. More than just an odour control, microorganisms are also able to break down uric acid and avoid uric scale build-up. When there is no food source available, microorganisms revert to a spore form again, or go further along the drain line to find other food sources or simply are not able to survive and then die. The spores cover the organic areas: urine, protein, fat, cellulose, and hydrates.

Alternative products contain fragrance to enhance their deodorising effect. However, manufacturers of 1,4 dichlorobenzene-based blocks have argued that alternatives do not release sufficient amounts of fragrance of sufficient strength to ensure that malodours are masked, especially in toilet rooms with high traffic. As will be explained later in this Annex, alternative products are water-soluble (1,4 dichlorobenzene ones are not), hence, in high-traffic toilet rooms, alternative urinal blocks could be spent very quickly if flushing is very frequent. Moreover, due to their poorer odour masking capabilities, alternative products may not be as effective in masking malodours not coming from the drain pipes

[49] The vapour density of 1,4 dichlorobenzene is 5.08 (when air's is assumed to be 1) – see here: http://www.nmenv.state.nm.us/aqb/projects/openburn/CAchemfacts/1-4dichl.pdf.

(for instance, malodours associated with urine spillages and the general cleanliness of the toilet room).

A manufacturer of 1,4 dichlorobenzene-based urinal blocks suggests that, in the industrial and institutional industry, 'positive' air freshening is more important than simply removing malodours; positive air freshening is noticeable to customers and unconsciously related to a facility being 'clean'. The manufacturer argues that simply eliminating malodours does not have the same impact on a consumer considering a facility as being 'clean' because no positive scent can be noticed.

Another particular issue that may arise during the use of bacteria-based alternatives is that they often need to be used alongside suitable bacteria-based cleaning products (marketed as 'biological' cleaning products). The reason for this is that the 'good' biofilm developed in the urinal bowl and the drain pipes needs to be preserved for the bacteria to be able to prevent the development of malodours. Certain cleaning chemicals (quaternary ammonium compounds[50], bleaches, acids, alkalis, disinfectants, etc.) kill the bacteria that provide much of the malodour removal properties and the malodour prevention is dramatically reduced. The use of the appropriate cleaning products is not only a matter of cost but also a matter of educating the cleaning and janitorial staff to avoid those products that may damage the 'friendly' bacteria cultures.

A6.4.3 Scent and Product Variety of Alternative Urinal Blocks

Alternative blocks may come in a large variety of forms – and this may be something that users could value. On the other hand, 1,4 dichlorobenzene-based products do not look particularly modern. More importantly perhaps, the odour of 1,4 dichlorobenzene is very strong and dominates other fragrances; alternatives, on the other hand, could in theory provide a great variety of scents (citrus, pine, etc.).

More importantly, not everyone likes the odour of 1,4 dichlorobenzene. For instance, ETUC has advised us of a janitorial company in Spain whose members of staff complained about the strong smell of the 1,4 dichlorobenzene-based products which they had to use (ETUC, 2009). Manufacturers of 1,4 dichlorobenzene-based products agree that their products have an intense, moth ball-like odour which may not appeal to everyone and which perhaps is more familiar to older persons. Nevertheless, a pleasant fragrance may have little positive impact if a product is not capable of effectively masking malodours.

[50] Some alternatives based on bacterial cultures claim to be resistant to quaternary ammonium compounds but admit that bleach, strong acid and alkali cleaners must be avoided.

A6.4.4 Water Solubility, Block Integrity and Pipe Blockages using Alternative Urinal Blocks

Impact of Water Solubility

1,4 dichlorobenzene-based urinal blocks are generally not water-soluble. Therefore, they may continue being effective even when urinals are flushed very regularly (for instance, in high traffic toilet rooms[51]) or when there is standing water in the urinal, as long as the block is exposed to air. The fact that 1,4 dichlorobenzene-based urinal blocks are not water-soluble also means that the likelihood of water-soluble components which may pose hazards to the aquatic environment being flushed down the drainage system is reduced.

However, we have been advised of at least one product being sold in the EU which is based on 1,4 dichlorobenzene and a soluble crystalline filler. When such products are used, flushing may dissolve the filler; this could create 'gaps' in the structure of the block and could result in the block breaking into pieces.

We further understand that efforts have been and are being made to develop composite products that may contain 1,4 dichlorobenzene and components such as surfactants, binders and gelling agents. Some of these components could be introduced into the product to moderate the solubility of surfactants and binders so that the solubility of the product in water is controlled. These products could be promising but the initial efforts to develop them have shown issues with stability and longevity.

On the other hand, alternative urinal blocks are essentially water-soluble and indeed they require water to act inside the drain pipe: with each flush, a small portion of the product is released and goes through the drain where it provides its cleansing (and indirectly) deodorising action. However, where flushing is frequent, too much of the product may be dispensed with each flush and the resultant deodorising action may only last for a limited period.

A manufacturer of both 1,4 dichlorobenzene-based and 1,4 dichlorobenzene-free products has noted the presence in his portfolio of a 1,4 dichlorobenzene-free urinal block designed to last around 1,000 "flushes" or ideally for about a month (see also discussion on product longevity in Section A6.5.1). This would mean around 33 flushes per day. It is not uncommon, however, that a high-traffic facility will receive a much larger number of visitors. The manufacturer has spoken of a customer's facility with one of the toilet rooms having been fitted with four urinals and one toilet bowl. In 90 minutes, on a Thursday between 9.00 am and 10.30 am, there were 134 counted visits to the restroom, which would likely result in 20-30 flushes to each urinal in that time frame. He further asserts that it is likely that a urinal in a high-traffic facility will be flushed in excess of 100 times per day. Under such circumstances, water-soluble urinal blocks may not perform as well as 1,4 dichlorobenzene-based ones.

51 Examples of high-traffic scenarios might include shopping centres, theme parks, train/bus stations, airports, etc.

Block Integrity

As already discussed, 1,4 dichlorobenzene-based urinal blocks gradually sublime and this leads to the diminishing of the size of the block until it completely disappears. Manufacturers of these products do not agree that their blocks may break into pieces – to ensure this, the components are compacted under great force at the manufacture stage (under the pressure of 2-6 tons, we have been advised). The use of plastic urinal screens with deodorising block enclosures has also been suggested as potentially reducing the risks of the block breaking up. However, breaking of the blocks could be witnessed when the block contains water-soluble fillers.

For alternative urinal blocks, breaking of the blocks is indeed a key consideration at the formulation stage as the blocks need to be able to withstand frequent exposure to water and dissolve in a controlled manner without breaking up into small lumps (Unger Surfactants, 2009). The urinal blocks should not be grainy, should not get dry or gelatinous, should not swell or get mushy and they need to it needs to look good during use by simply gradually reducing in size. To achieve this, the composition is very important – essentially the use of an appropriate surfactant (Unger Surfactants, 2009).

Our research suggests that this problem of disintegrating blocks may indeed occur with products and at least one manufacturer of alternatives recognised that his products may sometimes flake. To avoid flaking, users need to be offered advice and be instructed to adopt a low water usage strategy and to avoid immersing the blocks in water. The use of plastic boxes-enclosures is a possible solution to consider.

Potential for Pipe Blockages

There are two theoretical possibilities for a pipe blockage associated with the use of a urinal block:

- the presence of a block may contribute to the development of deposits in the drain pipes; or
- the block may disintegrate and fall inside the drain pipe.

The use of 1,4 dichlorobenzene-based urinal blocks may lead to pipe blockages. This is due to the fact that 1,4 dichlorobenzene-based urinal blocks only deodorise and have no cleaning or descaling functionality. They rely on high flushing frequency for water to remove urine and debris but even this cannot prevent the formation of uric scale and limescale deposits in the pipes and potentially the blocking of the pipe, as shown in Section A6.3.2.

On the other hand, alternative urinal blocks based on surfactants and potentially on bacterial spores display cleaning capability as well as descaling action, when they containing suitable descaling components. However, these products ideally need to be used in a low-flushing frequency environment and, as shown in Section A6.3.3, such urinals may tend to block more often than regularly flushed ones.

Modern waterless urinals stand a better chance of staying blockage-free but they do require very good installation and regular maintenance.

Of interest is communication with the Kirklees Council, a local authority in the UK. The Council has suggested that a decision was made to discontinue the use of urinal blocks as these were a major contributor to causing blockages in waste pipes and traps and that their usage was usually linked to masking problems of malodour - at the expense usually of endeavouring to identify and resolve the actual source of the malodour, which is the preferred option (Kirklees Council, 2010).

With regard to the possibility of urinal blocks falling into the drain pipe and causing blockages, this has been suggested in literature of manufactures of alternative urinal blocks. Allegedly, when the block sufficiently reduces in size, it may fall through the grating into the urinal trap where it can neither dissolve nor sublime and as a result it may cause a blockage (Bio-Productions, undated).

This argument has been countered by manufacturers of 1,4 dichlorobenzene-based products. Under normal circumstances, 1,4 dichlorobenzene based products will typically be used alongside a plastic urinal screen which prevents the block (when its size is reduced) from falling inside the drain pipe. Such a screen is also useful for preventing the clogging of the drains by cigarettes, chewing gum and other debris. It has been claimed that any blocking of drains when 1,4 dichlorobenzene-based products are used might occur when blocks that contain water-soluble components (e.g. common salt) are used; in these cases, the water-soluble component is lost in the flushing water and there is a greater likelihood for the block to lose its structural integrity, break up and allow its pieces to fall inside the drain. As the substance is not water-soluble, it is possible that a blockage may occur. It is argued, however, that pipe blockages are more likely to occur due to the build-up of uric scale rather than pieces of the block falling inside the drain.

Blocks based on surfactants dissolve in water and cannot normally cause blockages even if they fall inside the drain pipe.

A6.4.5 Cleaning and Descaling Action of Alternative Urinal Blocks

1,4 dichlorobenzene-based blocks comprise almost 100% 1,4 dichlorobenzene which may have some deodorising (and insecticide) effect but does not contribute to the cleanliness of the urinal. This could be considered to be a key drawback; however, these products are not supplied as cleaning products[52], therefore they do not directly compete with surfactant-based blocks. Also, 1,4 dichlorobenzene-based products are chemically and physically stable to most aqueous/surfactant cleaners and are not degraded by general cleaning[53].

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52 A manufacturer of alternatives has suggested, however, that many users of 1,4 dichlorobenzene-based urinal blocks have traditionally been under the false impression that these products actually display cleaning action.

53 Some products based on 1,4 dichlorobenzene may also contain bacteria spores to display cleaning action (see Fresh Products, 2007b); however these do not appear to be present (at least in noticeable quantities) on the EU

On the other hand, modern urinal block formulations contain surfactants that offer cleaning action. They may also contain bleaching agents for stain removal and whitening (Wonderflush, 2009). Bacteria-based products may also ensure that apart from uric scale, calcium salts (limescale) are also removed[54]. Other components of these blocks may include peroxy salts which may act as anti-bacterial agents (Safe Flush, 2009) or water-softening agents (Bio-Productions, undated). A manufacturer of 1,4 dichlorobenzene-based urinal blocks argues, however, that a urinal block sitting in the bowl provides limited cleaning action anyway and cannot clean the upper part of the urinal. Therefore, other cleaning products need to be used anyway. As discussed earlier, the use of special cleaning products is particularly important when bacteria-based blocks are used.

A6.4.6 Production Process of Different Deodorising Products

A urinal block manufacturer has noted that most toilet blocks are pressed into their final form under a pressure of 2-6 tons. Allegedly, not all raw materials can be effectively pressed into blocks/tablets.

1,4 dichlorobenzene-free toilet blocks contain several ingredients and this makes pressing more difficult. Manufacturers of 1,4 dichlorobenzene-based urinal blocks have argued that most non-1,4 dichlorobenzene materials lack the required integral strength in the block and simply break into pieces if the 1,4 dichlorobenzene block manufacturing process is attempted.

Alternative products are typically manufactured by heated extrusion or melt-and-pour methods. The processing and handling of alternative blocks is a significantly lengthier and more costly operation, unless a manufacturer invests in specialised automated equipment.

A6.4.7 Conclusions

Our analysis of the technical characteristics of different urinal blocks shows that 1,4 dichlorobenzene-based and 1,4 dichlorobenzene-free products are distinctly different in formula and function.

1,4 dichlorobenzene-based products appear to have an intense odour (not necessarily appreciated by everyone) and very good odour masking properties. However, they do not address the source of malodours and this could mean that problems may pass unnoticed and be gradually exacerbated (potentially leading to blockages). Alternative urinal blocks aim to address the source of the malodour[55] but their longevity is significantly affected by the flushing patterns of the urinal due to their solubility in water. In waterless urinals, following proper installation and maintenance, control of odours can in theory be achieved

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market. The product could potentially be more effective than regular 1,4 dichlorobenzene-based products but it also has an increased cost.

54 Limescale is unwanted because this is where odorous molecules may accumulate.

55 They will not necessarily address all sources of malodours – as shown earlier in this report, malodours may not emanate from drain pipes but from general lack of cleanliness (for instance, urine spillages on the toilet room floor).

without losses through flushing or water wastage; however, retrofitting may not necessarily have the desired effect.

The poorer odour masking properties of alternatives make them less effective at masking malodours that are not associated with drain pipes, for example, malodours resulting from spillages and general lack of cleanliness.

Low water solubility and resistance to chemical cleaning agents are the key elements of 1,4 dichlorobenzene-based urinal blocks that make them particularly cost-effective under certain conditions of use; such conditions appear to include high-traffic toilet rooms, high flush urinals as well as urinals which hold standing water.

On the other hand, alternatives offer cleaning/descaling/bleaching action which 1,4 dichlorobenzene-based products do not. If toilet rooms remain unattended and are simply deodorised with 1,4 dichlorobenzene without appropriate cleaning, it is possible that the build up of uric scale may cause blockages which can be both inconvenient and costly. Blockages, however, may still arise in low flushing urinals due to the potential inability of low-flushing systems to remove debris and urine. The hardness of the water also plays a key role.

A6.5 Relative Longevity and Cost of Alternative Urinal Blocks

A6.5.1 Relative Longevity of Alternative Products

Table A6.2 summarises the available information on the longevity of different urinal blocks.

Table A6.2: Longevity of Different Urinal Block Products			
Supplier	**Nominal weight (g)**	**Longevity (days)**	**Notes**
1,4 dichlorobenzene-based blocks			
A	85 – 115	30	Non-EU made
B	25 – 80	21	For a product with >95% 1,4 dichlorobenzene
B	25 – 80	14	For a product with 70% 1,4 dichlorobenzene
1,4 dichlorobenzene-free blocks			
V	Not known	30	Theoretical – aim is to last for 1,000 flushes
W	100	200 flushes	
X	100	21-28	For high flush urinals
X	100	7-10	For high flush urinals; half-price per kg compared to product above
Y	25	8-10	If an attempt were made to slow down the dissolution process, it would impair the efficacy of the product as well as the intensity of the perfume.

Table A6.2: Longevity of Different Urinal Block Products			
Supplier	**Nominal weight (g)**	**Longevity (days)**	**Notes**
Z	35	4-6 but possibly up to 10	If the product lasted for more than 10 days, it would not work properly (the perfume would be too weak), if it lasted fewer than 3 days, there would not be sufficient biomass build up so it could not be effective. 4-6 days is the optimal for efficacy but this also depends on the number of blocks. Most users tend to use 2-3 at any time. The use instructions advise the user to place one biological urinal block into each urinal bowl once a week. The product is formulated so the correct level of bacteria will be released over one week, so even if there is some of the previous block in the bowl, this should be removed and replaced with a new block.
Source: Consultation			

The above table suggests that 1,4 dichlorobenzene-based products generally tend to last longer than alternative blocks. This also is the assertion of a non-EU manufacturer of urinal blocks who has reportedly conducted detailed studies, comparing the deodorising effectiveness and longevity of 1,4 dichlorobenzene-based and 1,4 dichlorobenzene-free blocks.

As already mentioned earlier in this Annex, what crucially dictates the longevity of alternative urinal blocks is the frequency of flushing. This is why the very same product may display very different longevity when placed in two separate urinals of different water flushing patterns. This lack of dissolution control can result in a significant difference in the effectiveness of the deodorising effect. On the other hand, the sublimation of 1,4 dichlorobenzene-based urinal blocks may depend on the conditions of temperature, ventilation and humidity. For instance, a manufacturer of 1,4 dichlorobenzene-based products has indicated that under ‘normal’ temperature (20°C), his products may last for 2-3 weeks per block; however, at 25°C they may last fewer than 10 days.

The longevity of the odour masking effect will also depend on the number of products used at any one time. While some industry consultees argue that users of urinal blocks may be keen to control costs and hence they may use only one block per urinal, some suppliers may recommend the use of multiple blocks (the use of 3-5 blocks is recommended by Dr Weipert & Co (2008)). Multiple blocks are also very likely to be used in urinal troughs.

Box A6.4: Comparison of Longevity of Urinal Block Products
A non-EU manufacturer of both 1,4 dichlorobenzene-based products and alternatives has provided details of longevity testing undertaken in association with a customer (a building service company) in 2008. Six facilities were selected and 1,4 dichlorobenzene-based urinal blocks were deposited in 28 urinals. The blocks lasted 28-33 days. Afterwards, 28 1,4 dichlorobenzene-based urinal blocks were deposited in the same urinals. These lasted between 9 days and 36 days. 24 of them lasted less than 21 days and 11 of those lasted less than 14 days; in one particular facility (3 urinals), one of the alternative blocks lasted 16 days, another lasted 19 days and one lasted 34 days (the urinal closest to the door lasted the longest time). All of the alternative blocks were from the same batch and weighed 88-94 g (3.1-3.3oz).

A6.5.2 Relative Cost of Alternative Products

Costs for Urinal Block Manufacturers

The relative cost of chemical inputs into alternative urinal block formulations may be higher when compared to 1,4 dichlorobenzene-based compositions.

A manufacturer of urinal blocks has indicated that the cost of raw materials could vary with enzymes costing 20 times more than 1,4 dichlorobenzene and other fragrances costing up to four times as much. A point made by the company is that the number of components in alternative formulations is significantly higher than for 1,4 dichlorobenzene-based products: surfactants, fragrances, additives (salt, talcum, starch), etc. The more labour-intensive process required for manufacturing the alternative urinal blocks drives their cost further up.

It has also been suggested that the raw materials for 1,4 dichlorobenzene-free blocks (soap and surfactants) has increased over the past few years due to rising oil costs.

Costs for Urinal Block Users

<u>Information from Consultation and Online Suppliers</u>

A supplier of urinal blocks has indicated that low-cost alternatives may be available on the market at a price 10-20% higher than the price of 1,4 dichlorobenzene-based products but high quality blocks containing micro-organisms could be up to 60% more costly.

A manufacturer of urinal blocks has suggested that the relative cost of 1,4 dichlorobenzene-free urinal blocks could range between -15% for those based on simple surfactant technology, up to +50% for enzyme-based blocks and up to +400% for blocks based on specialised fragrances that could in theory achieve comparable malodour masking effectiveness to that of 1,4 dichlorobenzene-based products.

Two other companies that supply both 1,4 dichlorobenzene-based and 1,4 dichlorobenzene-free urinal blocks suggest that their cost is approximately the same.

It is worth noting the point made by a manufacturer of bacteria-based products: the price of their products is considerably higher than 1,4 dichlorobenzene-based one; however this also reflects the limited popularity of their products. If the products became more popular, there could be some economies of scale and the price could become lower.

Table A6.3 summarises the information collected from online suppliers on the price of urinal blocks.

Table A6.3: Prices of Selected 1,4 Dichlorobenzene-based and 1,4 Dichlorobenzene-free Urinal Blocks

Product name	**Price in € (incl. VAT)**	**Member State of sale**	**Quantity**	**Price (€)**		**Source**
				Per kg	**Per piece**	
1,4 dichlorobenzene-based products						
Ribo Special	6.90	DE	1 kg	6.90	-	HygieneVetrieb (2009)
Dr Becher Extra	34.05	DE	2.5 kg	13.62	-	Dr Becher (2009)
Fresh Urinal Para Block	10.75	CZ	1 kg (12 pieces)	10.75	0.90	Davkovace (2009)
Lemon Channel Blocks	19.40	UK	3 kg	6.46	-	E-Shop Supplies (2010)
Citrus Channel Cubes	28.40	UK	3 kg	9.47	-	MSC J&L Industrial Supply (2010)
1,4 dichlorobenzene product A	6.25*	DK	1 kg	6.25	-	Consultation
1,4 dichlorobenzene-free products						
Ribo Bio	8.62	DE	n/a	-	-	HygieneVetrieb (2009)
Dr Becher Gruene	17.62	DE	35 pieces	-	0.50	Dr Becher (2009)
Dr Becher Standard	11.88	DE	30 pieces	-	0.40	Dr Becher (2009)
Fresh 40	9.64	CZ	750 g (~ 40 pieces)	12.85	0.24	Davkovace (2009)
Fresh Urinal Toss Block	33.00	CZ	20 pieces	-	1.65	Davkovace (2009)
Biological Toss Blocks	13.70	UK	1.1 kg (50 pieces)	12.45	0.27	Gentworks (2010)
Biological product A	35.00*	DK	1 kg (20 pieces)	35.00	1.75	Consultation
Biological product B	17.50*	DK	1 kg (38-42 pieces)	17.50	0.42-0.46	Consultation
Surfactant product C	8.75*	DK	1 kg	8.75	-	Consultation

Notes: (a) high value order discounts not taken into account; retail prices in the Czech Republic quoted in Czech Koruna (CZK) and converted using exchange rate of 23 November 2009 (€ 1 = CZK 25.9); exchange rate £1=€1.14
** includes VAT at 25%*

The table suggests that while 1,4 dichlorobenzene-based products may cost up to ca. €14 per kilogram, alternative formulations may well reach €35 pr kilogram, for products based on bacteria cultures. It is clear that a direct comparison of prices is not appropriate, because the longevity of the product under various conditions (e.g. high traffic or standing water urinals, temperature, etc.) greatly affects the rate at which products are spent and effectively the cost of using a urinal block product.

Another parameter which may affect the price of urinal blocks is the use of plastic screens. When screens with integrated block compartments are used, the price increases considerably (up to €4 per screen). The price depends on the quality of the screen: the cheapest are made of polyethylene, better ones are made of polypropylene.

As a result, the prices in the table should only be taken as indicative of the end-price paid for urinal block products currently on the market. It generally appears that alternative products, especially sophisticated ones are more costly than 1,4 dichlorobenzene blocks.

Information from non-EU Sources

Some information is available from non-EU sources. The California Air Resources Board (CARB, 2004) provides information on the cost of 1,4 dichlorobenzene toilet blocks and their alternatives in the United States in 2004. This indicates that, in general, 1,4 dichlorobenzene-based toilet blocks are less costly, in some cases being sold for half the price of an alternative product, but a substantial overlap in prices of products reviewed was discovered (in particular where blocks are sold within a plastic screen). A typical 1,4 dichlorobenzene product consisting of 12 blocks (each weighing approx. 100 grams and each having a lifetime of 30 days) cost between €6.25 – 10.[56] The comparable price for 1,4 dichlorobenzene-free toilet block (however, with a screen included) was on average €21 for a box of 12 blocks, each lasting for 30 days.

CARB (2004) further notes that similar price differentials were identified in the case of toilet bowl rim block products. 1,4 dichlorobenzene-based product retailed for €11 while an alternative product was being sold for €23 (however, where 1,4 dichlorobenzene-based products contain an additional fragrance and a screen, the price can be significantly higher). In addition, it was noted that enzyme-based products are most expensive with a product consisting of 12 blocks being sold for €31.

Some examples of the additional cost faced by US users of urinal products following the introduction of restrictions on 1,4 dichlorobenzene in several US States were provided by a US-based manufacturer and are presented in the following box.

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56 Exchange rate US$1 = €0.8 was used. Exchange rate is an average for 2004. Source: http://www.oanda.com/currency/historical-rates.

Box A6.5: Examples of Costs Incurred by Users when Replacing 1,4 Dichlorobenzene-based Urinal Blocks

The facility of a customer is equipped with approximately 80 urinals and is located in a US State where a prohibition on 1,4 dichlorobenzene-based urinal blocks currently applies. When 1,4 dichlorobenzene-based products were permitted, the maintenance staff would use approximately 80 blocks per month to service the urinals. Every month, the staff would service the urinals and replace the blocks (in plastic screen enclosures). As a direct result of the regulatory changes in the State, members of staff are required to use alternative urinal blocks. The use of the blocks increased by a factor of 6-10 (depending on bathroom location). The best-performing alternative blocks were found to only last 4-5 days (at most) and the staff were required to use around 550 units per month (compared to 80, when using 1,4 dichlorobenzene-based blocks). The staff reportedly also commented that the poor deodorising effect of the alternative blocks forced them to clean the urinals with liquid cleaners (including bleach) more frequently – to make the bathroom "smell clean".

Another, more recent example was a highway station in another US State. Following the change to alternative products, the operator commented that the usage of alternative blocks was approximately five times greater than when they were using 1,4 dichlorobenzene-based blocks. The maintenance manager reportedly stated that he would need to "triple his budget" to maintain the restrooms deodorised with 1,4 dichlorobenzene-based products.

Chemical Cleaning Agents Consumption

When bacteria-based urinal blocks are used, suppliers insist that cleaning personnel uses appropriate cleaning products which will not kill the 'friendly' bacteria. These should be used in the place of hard cleaners, like bleach, as they foster the growth of beneficial cultures and enhance the action of the alternative urinal blocks. We have identified the prices of two such cleaning products:

- a manufacturer of bacteria-based urinal blocks and cleaning products supplies 5-litre containers of such chemicals at a price of ca. €14.25; and
- another supplier of such biological cleaners suitable for use with waterless urinals sells cleaning concentrate. This contains spores of bacteria which remain inactive for long periods producing a shelf stable product. When this is mixed with water at the recommended ratio of 20:1, the bacteria become active and in this state have a shelf life of up to six months. When this solution is applied to the toilet room surface the bacteria multiply producing a lasting result in the fight against other bacteria. The cost of 10 litres of the concentrate (which will be diluted to 200 litres of cleaning fluid) has been quoted as ca. €92 (incl. VAT).

A 5-litre container of bleach could cost ca. €3[57]. While this would appear less costly than the first product described above, it could prove to be more costly than the second product (after dilution). It is not possible to ascertain which cleaning liquid is the least costly as we do not have information on the rate at which different products are consumed

[57] See for example the product available for purchase on this website: http://www.janitorialdirect.co.uk/product/?pid=1016. Apart from bleach, many other cleaning products are available on the market some of which may have similar costs to bacteria-based products.

(which may well depend on the traffic in the toilet room or the habits of the cleaning personnel). What we can be certain of is that, if alternative bacteria-based urinal blocks were to be used, there would be a need for better education and awareness among cleaning personnel.

Water Consumption

An indirect, but by no means guaranteed, result of moving to alternative urinal blocks could be a reduction in the flushing frequency. This could take place as the alternatives generally display cleaning action, hence a very high flow of water is not necessary. At the same time, water-soluble alternatives would perform more efficiently if the flushing frequency was reduced (for many bacteria-based products flushing twice to four times a day could be sufficient). Irrespective of the changes in urinal blocks, a reduction in water consumption would have a positive effect on the ecological footprint of toilets/buildings and is indeed required under regulations in counties such as the UK.

A 'traditional' urinal may flush every 15-20 minutes and indeed around the clock whether the toilet room is being used or not. Assuming a release of 6 litres of water per flush (every 20 minutes), this would equate to (365 x 24 x 60)/20 = 26,280 flushes per year per urinal or ca. 158 m^3 per urinal per year (Stay Fresh Systems, 2010).

In the UK, under the Water Fittings Regulations 1999, urinals should use no more than 7.5 litres per bowl per hour when positioned in a group (10 litres for a single bowl) and should have a device fitted to prevent flushing when the building is not being used (Environment Agency, 2009). Assuming correct adjustment this means that each bowl uses about 27 m^3/year for a public toilet open for 10 hours every day. An uncontrolled urinal, but still adjusted to the correct rate would use over 60 m^3/y (Green Building Store, 2010).

If, in accordance to the requirements of some alternative urinal blocks, urinals are flushed only 4 times a day 6 litres of water per flush, then annually, such a urinal would consume 4 x 6 x 365 = 8,760 litres or ca. 9 m^3. This would be lower if the urinal was only flushed on weekdays (if located in an office toilet room, for example).

In summary, the following water savings could theoretically be envisaged:

Table A6.4: Comparison of Water Consumption for Different Urinal Scenarios (UK)			
Type of urinal	**Water consumption (m^3)**	**Water saving (m^3)**	**Cost savings per urinal***
'Traditional' urinal	158	-	Nil
Urinal with reduced flushing rate – single (10 l/hr)	88	70	€126/y
Urinal with reduced flushing rate – in a group (7.5 l/hr)	60	98	€177/y
Urinal with reduced flushing rate (10 l/hr) operating only 10 hrs a day – single	37	121	€188/y
Urinal with reduced flushing rate (7.5 l/hr) operating only 10 hrs a day – in a group	27	131	€236/y
Urinal flushed only 4 times a day (365 days)	9	149	€268/y
Waterless urinal*	2**	156	€281/y
Notes: * *we have used a cost of water of £1.58 per cubic metre (used in calculations in Environment Agency, 2009) and an exchange rate of £=€1.14* ** *we assume a manual flushing of 6 litres of water per day as part of maintenance – some systems may only require one flushing per week*			

Of course, the reduction of flushing could imply costs for appropriate cleaning products, maintenance, replacement of cartridges in waterless urinals, etc. Construction Resources (2010) refers to the need to replace a cartridge between 2-4 times per year on average depending on usage. Replacement cartridges have an indicative cost of cost £34.95 plus VAT (€47). Other waterless systems may have different additional costs; the service costs of a system without a cartridge could be substantially lower (Airflush, 2010).

Cost of Installing and Operating Waterless Urinals

There is some conflicting evidence on the costs of installing and running waterless urinals. A German-based manufacturer of flushed urinal bowls has provided the following costs for typical ceramic urinals and waterless urinals (we will assume these figures apply for the rest of the EU):

Flushed urinals

- Cost of urinal: €100-400
- Installation: €50-100
- Maintenance: not needed if used according to manufacturer's instructions

Waterless urinals

- Cost of urinal: €500
- Installation: €150
- Maintenance: change of odour trap (€50/y) and use of special cleaners (€100 per 10 litres)

On the other hand, a supplier of waterless urinals has argued that their installation is less costly when compared with a traditional water flush urinal and its associated bowl, cistern, waste pipework, water supply pipework and any flush controls. A recent cost comparison for one of his clients for one urinal showed that the cost of the equipment for a waterless urinal installation was approximately 25% less than a water flush urinal installation. This did not take into account the fact that the installation cost is significantly less with a waterless urinal due to the absence of a water supply and its associated equipment and labour cost. We consider that the discrepancy in the two views may reflect the fact that new installation of waterless urinals may indeed by less costly but retrofitting may require additional effort and expenditure to adapt the existing plumbing to the new waterless urinal.

Further, we do not consider it realistic to assume that flushed urinals require no maintenance. Indeed problems with blockages may well arise. This has been taken into account in the cost calculations of potential cost savings from installing waterless urinals in a school or a public house (bar) as provided by a supplier of waterless urinals – these are shown in the following table. These figures may not be considered representative of all waterless systems available; however, they give an indication of the types of costs and savings operators of public toilets may need to consider before opting for waterless systems.

Table A6.5: Example Calculations for Savings Realised from Installing Waterless Urinals in Public Houses and Schools (UK)

Parameter	Calculations for one urinal in a public house		Calculations for one urinal in a school	
	Flushed urinal	Waterless urinal	Flushed urinal	Waterless urinal
Average uses per day	180	180	180	180
Days open per year	360	360	250	250
Uses per year	64,800	64,800	45,000	45,000
Drinking water consumption per flush	4 litres	-	4 litres	-
Drinking water consumption per year	259,200 litres	150 litres***	180,000 litres	150 litres***
Sewage and water fee per 1000 litres	£2.50	£2.50	£2.50	£2.50
Sewage and water fee per year	£648	£0.38	£450	£0.38
Average maintenance costs per year*	£180	-	£180	-
Running costs for waterless urinals**	-	£270	-	£190
Yearly running costs	***£828***	***£270.38***	***£630***	***£190.38***
Cost savings with waterless urinal	***£557.62 or ca. €640***		***£439.62 or ca. €505***	

Source: Biotec International (2008)
Notes:
** the repair costs of damaged flushing mechanisms, electronics, deposits of uric acid stone, chlorine stone, of water flushed urinals*
*** costs of the siphon filters per year for the described usage of the waterless urinal*
**** 360 x 0.25 litres to control the function + 60 litres for cleaning per year*

The above figures presumable assume correct installation of the waterless urinals with the appropriate pipework fitted to ensure correct removal of urine.

Flushing controllers can be retrofit in 'traditional' urinals to reduce the flushing frequency and the amount of water flushed. For instance, the Environment Agency for England and Wales refers to a case study of a school where urinal flush controllers were installed and the following savings materialised (Environment Agency, 2009):

- water use due to urinals: 1,314 m^3 per year
- water use after fitting controllers: 419 m^3 per year
- water saved: 895m^3 per year
- money saved: £1,414 per year
- cost of installation: £960
- payback: around eight months

The Water Fittings Regulations 1999 in the UK permit the use of single urinal bowls with pressure-flushing valves and a flush volume no greater than 1.5 litres. Each office urinal might serve between one and thirty male workers (British Standard, 6465 Part 1, 2006. BSI). Flush per use systems can be more economical when each urinal serves less than about 15 users, assuming the automatically flushed urinals are correctly controlled and adjusted (Environment Agency, 2009).

A6.6 Assessment of Theoretical Impacts from a Restriction on Professional Uses

A6.6.1 Introduction

The following paragraphs present a concise assessment of the impacts from an EU-wide restriction that would target professional uses of 1,4 dichlorobenzene-based products. It focuses on urinal blocks as this has been identified as the key professional application. This discussion in also useful in another context: if consumer uses of 1,4 dichlorobenzene-based products account for a substantial share of the overall EU market for these products and, as suggested by a manufacturer of the substance, a restriction on them could be capable of affecting the entire EU market, the discussion below could provide a quick overview of the scale of the overall impact from the loss of both the consumer and professional uses markets.

A6.6.2 Operating Costs for Stakeholders

EU-based Manufacturers of 1,4 Dichlorobenzene

We discussed the potential impacts to manufacturers of the substance from a prohibition on the sales of 1,4 dichlorobenzene-based air fresheners and toilet blocks to consumers in Section 5 of the main report. Impacts would be particularly adverse if they led to the cessation of the flaking of 1,4 dichlorobenzene in the EU. These impacts would be even more certain to arise if a restriction was introduced on professional uses which are more prominent than consumer uses across the EU.

Importers of 1,4 Dichlorobenzene

Imports of the substance appear to be quite substantial and account for more than 50% of the amount of 1,4 dichlorobenzene used in the EU in the manufacture of air fresheners and toilet blocks. As discussed earlier in the report, the estimated total amount of 1,4 dichlorobenzene used in the EU for these products is 800 tonnes per year. On the assumption that non-EU importers account for 50-75% of this usage and with a value per tonne of €1,000-3,000, the estimate loss of this market for non-EU manufacturers of the substance could range between €0.4 million and €1.8 million per year.

EU-based Manufacturers and Suppliers of 1,4 Dichlorobenzene-based Products

We discussed in Section 5.2.3 of the main report the different cost elements that may arise for a few manufacturers of air fresheners and toilet rim blocks if a prohibition of sales of these products to the general public. These cost elements would also arise for manufacturers that manufacture air fresheners and toilet blocks for professional use, if a restriction on these uses were to be introduced. The key difference is that there would be several more companies that would be affected by such a measure. In the course of this impact assessment, we identified numerous manufacturers and suppliers of urinal blocks based on 1,4 dichlorobenzene. A restriction on their use would have an impact far more significant than a prohibition on consumer uses only.

On the other hand, some of these manufacturers also place on the market alternative products. Therefore, if a prohibition on consumer use of 1,4 dichlorobenzene-based products effectively resulted in removal of these products from the market for both consumer and professional uses, this policy option would likely result in some lost business on the 1,4 dichlorobenzene side, but will likely cause growth on the non-1,4 dichlorobenzene side of their businesses. This would naturally depend on whether any individual manufacturer offers alternatives.

A final point that perhaps needs to be made is the fact that many companies which may appear to manufacture 1,4 dichlorobenzene products are in fact selling own-branded products which have been manufactured by another company. The impacts from the restriction on these resellers would significantly less severe.

Non-EU Manufacturers of 1,4 Dichlorobenzene-based Products

It is difficult to estimate the likely impacts on non-EU manufacturers of these products, as we do not know how important the EU market is for individual manufacturers. Our estimates however would suggest that imports of products might be considerable. It has been suggested that 1,4 dichlorobenzene-based products tend to be more widely used outside the EU; therefore, the impacts on non-EU manufacturers who would still be able to sell their products outside the EU could be less severe than for EU-based manufacturers. Again, the extent to which a company supplies alternative products could define the extent to which sales of alternatives could dampen or totally counterbalance the losses associated with the EU restriction on the use of 1,4 dichlorobenzene.

Professional Users of 1,4 Dichlorobenzene-based Products

Manufacturers of 1,4 dichlorobenzene-based products have argued that there is still a group of customers that have a need for 1,4 dichlorobenzene-based urinal blocks, because they function in a controlled manner that is not seen with other technologies and are still the most cost effective option. High-flush urinals, high traffic toilet rooms and standing water urinal systems may particularly lend themselves to ongoing usage of 1,4 dichlorobenzene. In such situations, a prohibition on consumer uses of 1,4 dichlorobenzene-based products which would lead to impacts on the professional uses market for these products would have adverse effects professional users, especially those relying on 1,4 dichlorobenzene-based urinal blocks. By users we mean both the cleaning service providers and those operating public toilets. Consultation indicates that as much as 50% of cleaning operations may be undertaken in-house (for instance, by cleaning personnel directly employed by a hotel, restaurant, etc.).

To estimate the impacts on professional users, we consider the following parameters:

- the relative cost of alternative formulations;
- the longevity of alternative formulations;
- any increased need for cleaning of public toilet room facilities; and
- the costs and savings associated with the installation of low/no flush urinals.

The envisaged cost elements might include:

- ***Cost of alternative formulations***: as discussed in Section A6.5.2, it is possible that 1,4 dichlorobenzene-based and alternative urinal blocks are being sold at variable prices. The comparison of prices is difficult because two blocks of the same weight may have very different longevities; hence, one may need to be replaced before the lifetime of the other expires.

  To simplify our analysis, we consider the average price per kilogram for 1,4 dichlorobenzene-based and for alternative products, as presented in Table A6.3. For the former, an average price of €8.90 per kg is calculated. For the latter, an average price of €17.30 per kg is calculated. This figure takes into consideration a costly product based on bacterial cultures. When this product is excluded from the calculation, the average price of alternatives is reduced to €12.90 per kg.

  Furthermore, the longevity of alternative products appears to be shorter than the longevity of 1,4 dichlorobenzene-based products. From the information in Table A6.2, we may deduce that alternative urinal blocks of equivalent weight may have a 2-4 times shorter longevity than 1,4 dichlorobenzene-based products (however, some alternatives are marketed as being of roughly equal longevity).

A few (arguably simplistic) calculations would suggest:

- for blocks of 80 g, 1,4 dichlorobenzene formulations would come at a cost of €0.71 per block (= 8.90 x 80/1000). For alternatives, the cost per block could be €1.03. This would be an increase of ca. 45%; and
- each 1,4 dichlorobenzene block would need to be replaced by 2-4 alternative blocks within a given period. The cost of these 2-4 alternative blocks would be: ca. €2-4.

If we assume that the 80 g 1,4 dichlorobenzene-based block lasts 21 days, each urinal bowl will consume 365/21 = 17 blocks per year at a cost of €0.71 x 17 = ca. €12 per year (assuming only 1 urinal block is used per urinal). Instead, for alternatives, the number of blocks consumed per year will be 2-4 times higher, i.e. 34-68 blocks. The cost of these would be €35-70 per urinal per year (assuming 1 block per urinal). These simple calculations suggest a cost 3-6 times higher in case a restriction were to be implemented. If all 710,000 assumed urinals currently deodorised with 1,4 dichlorobenzene were to be deodorised with alternative blocks, the additional cost per year would reach ca. **€16-41 million**.

Please note that the above calculations are only a theoretical example. The cost of different products varies and the rate at which different products are used crucially depends on several factors such as ventilation, temperature, flushing frequency, visitor frequency, etc.

- ***Cost of additional cleaning***: 1,4 dichlorobenzene offers no cleaning action; it simply masks malodours and, it could be argued, it is used to mask problems that, if time and money were not an issue, should be duly addressed. As shown in Section A6.4.2, the source of malodours in a toilet room may differ; in fact, it is most likely resulting from problems that have little to do with how urinals operate. In this sense, 1,4 dichlorobenzene-based products have a significant advantage over alternatives: their odour is so intense that they mask problems arising from a variety of sources (inadequate cleaning, inadequate flushing, waste pipe issues, pipework problems, and very heavy use) without distinction. On the other hand, alternative products claim to offer cleaning capabilities; these may address the build-up of biofilm and odour-generating bacteria inside the drain pipes but their less effective odour masking properties have limited capability of masking odour problems in the surrounding area.

  Following from the above, the use of alternative products may well be accompanied by the need for additional cleaning to address underlying malodour problems which can no longer be masked with deodorisers. A tentative assumption based on some information provided by consultees is that 70% of all urinals currently deodorised with 1,4 dichlorobenzene (i.e. ca. 500,000 urinals), would need to receive additional cleaning if 1,4 dichlorobenzene-based blocks were replaced by alternatives.

  We further assume that the cleaning of an individual urinal (both the bowl and the surrounding area/floor space) takes on average 5 minutes. If we assume that the additional cleaning each urinal needs would be required between once a week and once a day (depending on the number of visitors), and the cost of hiring a cleaner is €13.50/hr[58], the additional cleaning of each urinal will require between:

(5/60) x 52 x €13.50 = €58.50 per year per urinal and
(5/60) x 230 x €13.50 = €258.75 per year per urinal (at 52 wks/y, 230 days/y).

Multiplying these figures by the total of 500,000 urinals gives a total annual cost of **€29-129 million**. This is obviously a cost for those operating public toilet rooms but also a benefit to those offering cleaning services.

Again, the above calculations should be considered to be indicative. In addition, it can be assumed that certain alternatives (e.g. bacteria-based urinal blocks) may require an additional expenditure for the purchase of compatible cleaning solutions. We cannot estimate what the additional costs would be but it is expected that it would be significantly lower than the cost of the services offered by cleaning staff. At the same time, it is evident that there is a need for better education and awareness of the user of alternative urinal blocks.

- ***Costs and savings from altering the flushing patterns***: the loss of 1,4 dichlorobenzene-based products, especially urinal blocks, could provide an incentive to alter the flushing of installed urinals (in order to make them more compatible with water-soluble alternative deodorisers) or to replace old urinals with low flush or waterless systems which could reduce the maintenance and cleaning required. If this were the case, professional users (on this instance, owners of public toilet rooms) would face both a cost for altering their urinal systems but also potential benefits.

  Scenario (i): for the purpose of the following calculation, we assume that a public toilet room operator opts for installing a flush regulator. The cost of each of them could range between €160 and €225[59]. We will assume that the cost is €190 on average. We further assume the following:

  - the water flushed in the urinal is reduced from 158 m^3 per year to 60 m^3 (see values in Table A6.4);
  - the combined cost of water and sewage removal in the UK is £2.5, i.e. €2.85 per m^3 (and, in the absence of other information, we assume this to apply across the EU);
  - costs for 1,4 dichlorobenzene-based urinal blocks are eliminated (- €12/year) but costs for alternative urinal blocks may arise (we assume the lower cost of €35/year since lower flushing frequency and volumes could increase the longevity of alternative products); and

58 Cost based on typical costs of cleaning services in the UK.

59 Based on figures shown on the Gentworks Internet site (http://www.gentworks.co.uk/passive-infra-red-urinal-flush-controllers/) and using a VAT rate of 17.5% and an exchange rate of £1=€1.14.

- the new urinal would require two additional 5-minute cleaning sessions per week at a cost of 2 x (5/60) x 52 x €13.50 = ca. €117 (this is a conservative scenario).

The overall costs are summarised in the following table.

Table A6.6: Example Cost Calculation for a Professional User of Urinal Blocks – Installation of Flush Controller		
Parameter	**Cost/Saving per Urinal – Year 0***	**Cost/Saving per Urinal – Year 1+**
Installation of flush controller	€190	Nil
Cost of water and sewage removal	-€245	-€245
Cost of air fresheners	€23	€23
Cost of additional cleaning	€117	€117
Total cost	***€85***	***-€105***
** a negative sign indicates cost savings*		

It appears that while a certain cost would be required in the first year (essentially due to the cost of the flush controller), for every year thereafter even higher savings could be realised as a result of savings on water and sewage removal costs. If we wished to estimate the costs across the EU, we could make the assumption that 30% of the identified 710,000 urinals are indeed 'traditional' urinals flushing around 158 m^3 of water per year. If we assume that a certain proportion of these could be fitted with flushing controllers, the associated savings could be those shown in the table below.

Table A6.7: Assumed Cost Savings for Professional Users across the EU from Installing Flush Controllers				
	Percentage of high-flush urinals switching to 7.5 l/hr flushing			
	25%	**50%**	**75%**	**100%**
Number or urinals converting to low flush	53,750	107,500	161,250	215,000
Cost (+) / savings (-) per urinal	Year 0: €85 Year 1+: - €105/year			
Total costs on installation year	€4.6 million	€9.1 million	€13.7 million	€18.3 million
Total cost savings per year (Year 1+)	-€5.6 million	-€11.3 million	-€16.9 million	-€22.6 million

The figures suggest that at the end of Year 1, the owners of the urinal bowl will have recouped the installation costs of Year 0.

Scenario (ii): we may further assume that a public toilet room operator opts for replacing a 'traditional' high flush urinal with a waterless urinal. In our calculations, we will use the figures presented by Biotec International (2008) (see Table A6.5) according to which the price different between maintenance of a flushed urinal (repair costs of damaged flushing mechanisms, electronics, deposits of uric acid stone, chlorine stone) and those of a waterless urinal (costs of the odour trap and chemical cleaning agents) are £90 or ca. €100 (in other words, maintenance of waterless urinals is more costly).

We further assume the following:

- the water flushed in the urinal is reduced from 158 m^3 per year to 2 m^3 (see values in Table A6.4 – this could even be a conservative estimate as Table A6.5 suggest a much lower annual water consumption in waterless urinals);
- the combined cost of water and sewage removal in the UK is £2.5, i.e. €2.85 per m^3 (and, in the absence of other information, we assume this to apply across the EU). Hence the savings from eliminating the need for sewage removal would be (158-2) x €2.85 = ca. €445;
- costs for 1,4 dichlorobenzene-based urinal blocks are eliminated (-€12/year) and no replacement urinal deodorisers are used; and
- the old urinal required 5 cleaning sessions per week and these can be reduced to 1 following the installation of the waterless urinal. The cost savings would thus be (5/60) x (5-1) x 52 x €13.50 = €234.

The overall costs are summarised in the table below.

Table A6.8: Example Cost Calculation for a Professional User of Urinal Blocks – Installation of a Waterless Urinal

Parameter	Cost/Saving per Urinal – Year 0*		Cost/Saving per Urinal – Year 1+	
Cost of waterless urinal	€500**		Nil	
Installation of waterless urinal	€150***		Nil	
Cost of water and sewage removal	-€445		-€445	
Cost of air fresheners	-€12		-€12	
Cost of additional cleaning	*Reduction of cleaning*	*Increase in cleaning*	*Reduction of cleaning*	*Increase in cleaning*
	-€234	€293	-€234	€293
Cost of additional maintenance****	€100	€150	€100	€150
Total cost	***€59***	***€586***	***-€591***	***-€64***

** a negative sign indicates cost savings*
*** it is easy to identify waterless urinal bowls sold on the Internet at prices lower than €500; however, costs of waterless urinal troughs can be much higher*
**** in our calculation we assume a higher cost for the installation of a waterless urinal due to the need to retrofit which would be accompanied with the necessary alterations to the existing plumbing system*
***** this is the difference of €100 calculated on the previous page*

It appears that, following the year of installation where an overall modest cost would arise, annual savings would arise thereafter, predominantly due to the elimination of swage removal costs.

However, one could argue that without the presence of 1,4 dichlorobenzene, malodours from sources such as urine spillages, pipe malfunctions, etc. would be more frequent and prominent. Therefore, cleaning of the urinal and the surrounding area would still be required (even perhaps at an increased rate) following the installation of the waterless urinal. The above table has therefore been amended to take this sub-scenario into account and assumes a conservative five additional cleaning sessions per week at a cost of ca. €293/year per urinal (see the grey areas in the table). This would make the costs of the year of installation much greater but would still allow for savings to be made in subsequent years.

If we wished to estimate the costs across the EU, we could make the assumption that 30% of the identified 710,000 urinals are indeed ‘traditional’ urinals flushing around 158 m^3 of water per year. If we assume that waterless urinals could replace a certain proportion of these, the associated savings could be those shown in the next table. The table makes conservative assumptions on the number of waterless urinals that may be installed, since retrofitting may not always be appropriate or indeed possible (unless significant expenditure for altering the plumbing is involved). The figures suggest that at the end of Year 1, the owners of the urinal bowl will have recouped the installation costs of Year 0.

Table A6.9: Assumed Cost Savings for Professional Users across the EU from Replacing Existing Urinals with Waterless Urinals

	Percentage of high-flush urinals replaced by waterless urinals			
	1%	**5%**	**10%**	**25%**
Number or urinals converting to waterless	2,150	10,750	21,500	53,750
Cost (+) / savings (-) per urinal	Year 0: ca. €59-586 Year 1+: ca. - €64-591/year			
Total costs on installation year	€0.1-1.3 million	€0.6-6.3 million	€1.3-12.6 million	€3.2-31.5 million
Total cost savings per year (Year 1+)	- €0.1-1.3 million	- €0.7-6.4 million	- €1.4-12.7 million	- €3.4-31.8 million

To conclude, we cannot be certain how serious an incentive the restriction on the use of 1,4 dichlorobenzene may give to operators of public toilet rooms to adjust the flushing of their urinals. It appears that initial attempts to install waterless urinals a few years ago have been largely unsuccessful as some inferior models were introduced to the market and this potentially damaged the reputation of the waterless technology. While waterless urinals have the ability to reduce water consumption and theoretically to prevent blockages and malodours, they do require correct installation, careful maintenance and cleaning staff who know how to keep them clean. Although some consultees (from Germany and the UK) have suggested that waterless urinals find increasing use in motorway station toilet rooms which are not frequently cleaned as well as in airports, we believe that it would be unlikely that any drive towards these new technologies would occur solely due to a restriction on 1,4 dichlorobenzene.

The following table summarises the cost calculations presented above. Note that the maximum cost (savings) figures should be considered to be indicative only. We would expect that different users (operators of public toilet rooms) may take different routes in response to on the loss of 1,4 dichlorobenzene-based urinal blocks in the EU. By way of conclusion, we believe that overall, a restriction on professional sues of 1,4 dichlorobenzene-based products (particularly urinal blocks) would result in additional costs for professional users as alternatives are generally more costly and less effective at masking unpleasant odours. Overall savings might arise only if a considerable number of waterless urinals were to be installed and if significant additional cleaning of toilet rooms would not be required. This scenario, however, is considered to be unlikely to occur.

Table A6.10: Summary of Example Costs/Savings for Professional Users of 1,4 Dichlorobenzene-based Urinal Blocks under Option 6a

Scenario	Cost per urinal per year	Maximum number of urinals	Cost across EU per year*
Replacement of 1,4 dichlorobenzene-based blocks with effective alternatives	ca. €23-58	710,000	€16 to 41 million
Replacement of 1,4 dichlorobenzene-based with less effective alternatives – additional cleaning once per week	ca. €82-117	500,000	€41 to 59 million
Replacement of 1,4 dichlorobenzene-based with less effective alternatives – additional cleaning five times per week	ca. €282-317	500,000	€141 to 159 million
Fitting flush controllers to reduce water consumption from 158 m^3 to 60 m^3 per year	ca. - €105	215,000	- €6 to -€23 million
Fitting waterless urinals and reducing cleaning sessions by a factor of five	ca. - €591	53,750	- €1 to -€32 million
Fitting waterless urinals and increase cleaning sessions by five per week	ca. - €64	53,750	- €0.1 to -€3.4 million

** a negative sign indicates cost savings*

Manufacturers and Suppliers of Alternative Deodorisers

Benefits would arise for those companies manufacturing and supplying alternative products. However, it is likely that these companies would largely be the same companies that manufacture and supply 1,4 dichlorobenzene-based products as most appear to supply alternative urinal blocks too. It is also worth noting a comment made by certain manufacturers of innovative bacteria-based alternative urinal blocks according to which recent regulatory changes on the classification of 1,4 dichlorobenzene and the withdrawal of several companies from the market led to their products increasing their market share by only a small margin. We believe that this reflects the fact that the manufacturers which ceased supplying 1,4 dichlorobenzene-based products in the past simply ‘moved’ their customers to their own ranges of alternative products.

Manufacturers and Suppliers of Low/no Flush Urinal Systems

As shown above, a restriction on the marketing and use of 1,4 dichlorobenzene-based urinal blocks were to be introduced, the potential installation of flush controllers and waterless urinals would come at a certain cost for operators of public toilet rooms. These costs would translate into increased turnover for the companies manufacturing and supplying the relevant equipment. As discussed above, we assume that the average cost of a flush controller would be €190 while the cost of a waterless urinal could be €500 with an associated installation cost of €150. However, it would be unrealistic to expect a significant number of such installations to take place solely as a result of such a restriction on 1,4 dichlorobenzene.

Installers of Urinal Systems

Plumbers could see their services in greater demand if operators of public toilet rooms decided to install flush controllers or waterless urinals. However, such systems could mean that plumbers might be called to perform maintenance of urinals less frequently, given that waterless urinal systems lack mechanical parts such as cisterns and flush pipes which are found in traditional urinal systems and which often need maintenance. There have been reports (from the year 2006) according to which US plumbers in Philadelphia expressed disappointment at the prospect of waterless urinals becoming more popular as they were apparently concerned with the fact that waterless systems required less effort to install and maintain.

Other Stakeholders

In the course of consultation we were contacted by European storage companies which, in the past, used 1,4 dichlorobenzene-based moth balls in their storage facilities. These companies expressed concern over a potential restriction on the use of the substance; they believe that a restriction on 1,4 dichlorobenzene under REACH would practically eliminate the possibility of a future registration of the substance as a moth repellent under the Biocidal Products Directive. However, given the current state of play with the Directive, no real impact would be envisaged for such companies under this policy option.

A6.6.3 Impacts on Small and Medium Enterprises

The majority of companies involved in the relevant supply chain are small enterprises. Operators of public toilet rooms who may be responsible for purchasing alternative deodorising products and for arranging for additional cleaning of the rooms to take place, and those cleaning contractors who may be responsible for purchasing more costly alternatives and perhaps work under a fixed remuneration contract and might need to put more effort into keeping the toilet rooms deodorised on behalf of their clients. Especially the cleaning contractor industry may include a significant number of SMEs.

Box A6.6: Overview of the EU Cleaning Sector

The cleaning sector generated a turnover of over €54 billion in 2006 in 20 European countries[60]. The number of companies in this sector has grown continuously since 1989 (31,809 contractors in 1989; 47,439 in 1996) up to 129,000 cleaning contractors in 2006 that employed about 3.6 million workers. However, the real figures are considered to be higher due to the high number of unregistered workers in the profession. This growth is particularly important in the newer EU Member States. The cleaning sector is, in terms of company dimensions, mainly composed of small and very small companies. There are also many self-employed cleaners. In 2006, about 89% of the cleaning companies had less than 50 employees and only 11% had more than 50 employees. On average at EU level, about 70% of the employees in the sector work on a part-time basis. The other characteristic of the cleaning sector in terms of employment is the high proportion of women in the cleaning workforce: 77% cleaning workers were women in 2003 (EU OSHA, undated).

Industrial cleaning work is generally performed as contract cleaning, where the cleaners are subcontracted, i.e. are employed by a cleaning company, but work within the premises of one or more 'host companies'. Their employer, i.e. the cleaning company, is responsible for their health and safety, but is not in control of the environment in which they work. The services offered by such cleaning companies are most often designed for enterprises and organisations and are only occasionally found in private households. Another type of cleaning workers is those directly employed by the organisation where the cleaning work is performed. They are hired on a freelance basis or are part of the staff of the company. This is mostly the case in hotels and catering services or schools. These employees are not included in the employment and accident and disease figures of industrial cleaning, but are included in the figures related to these specific sectors (EU OSHA, undated).

FENI (2010) estimates that at least 50% of large buildings are outsourcing their cleaning operations to companies such as FENI members. Still however, as much as 50% of cleaning operations may be undertaken in-house (for instance, by cleaning personnel directly employed by a hotel, restaurant, etc.).

It is clear that a restriction on the professional uses of 1,4 dichlorobenzene-based urinal blocks could have considerable adverse effects to SMEs, particularly those companies that wish to mask malodours in public toilets while working on a tight budget.

A6.6.4 Employment and Labour Markets

Manufacturers of 1,4 Dichlorobenzene

The EU market for air fresheners and toilet blocks has different significance for the two EU manufacturers of the substance: while one supplies a significant tonnage of 1,4 dichlorobenzene to EU manufacturers of air fresheners and toilet blocks, the other supplies relatively small tonnages to EU customers. Information on the expected impacts from this option has been provided by the first company only. According to this, the company is concerned about the knock-on effect of a restriction on the sales of 1,4 dichlorobenzene for other applications in the EU as well as the sales of 1,4 dichlorobenzene to non-EU customers and the production of 1,2 dichlorobenzene. If those concerns materialised, the company would potentially have to make up to 100 employees redundant.

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60 Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom.

Manufacturers of 1,4 Dichlorobenzene-based Products

An EU manufacturer who has provided detailed responses on the possible impacts from a possible marketing and use restriction on the substance, has indicated that such risk management action could jeopardise the jobs of his 15 employees, as the company specialises in 1,4 dichlorobenzene-based products and a restriction would have a direct impact on the company. However, the company appears to have been working on alternatives for quite some time; moreover, out of the total staff, only four people are involved in the pressing of 1,4 dichlorobenzene products, an activity that accounts for approximately 60% of the working time of these four individuals. It is reasonable to expect that these workers would have to be allocated to tasks relevant to the production of alternative products (perhaps following appropriate training). On the basis of available information, we can assume that EU-based manufacturers currently employ several hundreds staff in the relevant production activities; therefore, the impact of this measure on the EU-wide employment rate may be limited.

Users of 1,4 Dichlorobenzene-based Products

Some manufacturers of these products have indicated their popularity in public toilet rooms with heavy traffic, high flushing frequency, unsupervised usage, and low cleaning budgets. Assuming that alternative products do not offer equivalent odour masking ability, cleaning personnel may be required to provide more frequent cleaning of the toilet rooms.

Our estimate is that around 710,000 urinals are currently deodorised with 1,4 dichlorobenzene-based blocks in the EU. We cannot assume that all of these are to be found in toilet rooms which are unsupervised or operate on tight cleaning budgets. Consultation with an EU manufacturer of urinal blocks suggests that up to 60-70% of sales of 1,4 dichlorobenzene-based urinal blocks are to those companies/organisations which wish to keep toilet rooms deodorised effectively while working on a tight cleaning budget. This is only an estimate but in the absence of more detailed information, we estimate that 70% of all urinals currently deodorised with 1,4 dichlorobenzene (i.e. ca. 500,000 urinals), will need to receive additional cleaning if 1,4 dichlorobenzene-based blocks are replaced by alternatives.

We further assume that the cleaning of an individual urinal (both the bowl and the surrounding area/floor space) takes on average five minutes. If we assume that the additional cleaning each urinal needs would be required between once a week and once a day (depending on the number of visitors), the additional cleaning of all 500,000 urinals will require between:

500,000 x (5 x 52)/(60 x 8 x 230) = ca. **1,180** person working years; and
500,000 x (5 x 230)/(60 x 8 x 230) = ca. **5,200** person working years (at 8 hr/day, 52 wks/y, 230 days/y).

Box A6.6 above suggests that the number of cleaning workers in the EU in 2.6 was 3.6 million workers. In a crude calculation, we might assume that since 5% of all EU urinal bowls are deodorised with 1,4 dichlorobenzene, only 6% of this workforce (i.e. 3,600,000 x 0.06 = 216,000 workers may currently be exposed to 1,4 dichlorobenzene. Within this worker sub-population, the increased employment associated with the additional person working years calculated above (1,180-5,200) would appear to be of limited significance.

A6.6.5 Benefits to Public Health and Worker Health

Key Sources of Information

The EU RAR (EU, 2004), in considering the available mechanistic studies (particularly the chronic rodent species) noted the liver tumour effect noted in mice was not considered to arise as a result of a genotoxic (non-threshold) mechanisms and probably arose as a result of a chronic proliferative-mediated mechanism. As such, a clear mechanism for its carcinogenicity was not established and a threshold mechanism was considered likely, although the threshold level at which no response would be expected was not defined. Several recently published mechanistic papers (discussed in Annex 3 of this report) further strengthen the EU RAR opinion that 1,4-dichlorobenzene probably elicits liver tumours through a threshold mechanism. However, the situation in humans is as yet uncertain given that no large scale epidemiological studies are yet available, although a limited study by Hsiao *et al* (2009) highlighted that – at least in workers exposed to high level exposures – 1,4 dichlorobenzene does appear to have a potential to elicit hepatic non-neoplastic changes.

At the present time, there is therefore insufficient data available with which to establish robust estimates of any European cancer burden that may be associated with use of 1,4 dichlorobenzene-based products. As discussed in Annex 3, however, a small number of papers have attempted to derive at least indicative estimates of the possible cancer burden that may be associated with the domestic use of products such as moth balls and toilet air fresheners by various populations. Of these papers, those by Sax *et al* (2006), McCarthy *et al* (2009) and Aronson *et al* (2007) in particular provide some useful information on the excess cancer burden that could be associated with exposure to various sources of 1,4 dichlorobenzene. These have therefore been considered with regard to their suitability to tentatively estimate the potential scale of the health effects that could potentially associate with the use of 1,4 dichlorobenzene in public toilet rooms (where urinal blocks may be used). However, it must be appreciated that these estimates are based on unit risk estimates for cancer, derived by US authorities using linear (non-threshold) extrapolation models. As such, estimates thus derived are likely to considerably over-estimate any impact (given its anticipated threshold nature), particularly for situations were exposure levels are low.

Estimation of Public Health Impact

The study by Sax *et al* (2006) utilises the State of California's unit risk factor for this chemical (of 1.1×10^{-5} from exposure to 1 $\mu g/m^3$ over a 70-year life span) to estimate the level of risk associated with actual measures of exposure in US teenagers. The risk factor used was derived from the NTP experimental data on male mouse hepatocarcinoma and adenoma incidence through the derivation of animal cancer potency (q_{animal}) based on linear slope, using a lifetime scaling factor of:

$$q_{animal} = q1 \times (T/Te)^3$$

where T/Te is the ratio of the experimental duration to the lifetime of the animal; in this case, the scaling factor was equal to 1.

The value for human cancer potency was then obtained by the equation:

$$q_{human} = q_{animal} \times (bw_h/bw_a)^{1/3} = 0.04 \text{ (mg/kg-day)}^{-1}$$

where bw is the default body weight of human or animal (i.e. mouse) to give a human cancer potency (q_{human}).

The airborne unit risk factor of 1.1×10^{-5} $(\mu g/m^3)^{-1}$ was reached by then applying the default parameters of 70 kg for human body weight and 20 m^3/day breathing rate (OEHHA, 2009).

In their study, Sax *et al* (2006) showed that indoor sources accounted for greater than 40% of total 1,4 dichlorobenzene exposure and also estimated the mean upper-bound excess risk of cancer at between 458 and 403 per million for the two study populations considered (the 90th percentile estimates were 1049 and 1065 per million respectively). However these estimates were based on measurements of personal exposures rather than indoor air measurements and so should not be directly extrapolated to measures of indoor air levels experienced by the European population. Similarly, cancer burden estimates developed by McCarthy *et al* (2009) – again based on the US population – draw on data relating to ambient (outdoor) exposure levels and, in particular, do not inform on the contributions from particular sources.

Aronson *et al* (2007) estimated[61] that life-time (70 year) usage of these products[62] could result in an average intake of about 0.1018 mg/kg/day. For comparison, the realistic worst-case estimate adopted by the EU RAR for the general population was comparable at 0.179 mg/kg/day (0.126-0.242). Based on their intake estimates and again using the OEHHA's inhalation unit cancer risk of 1.1×10^{-5} $(\mu g/m^3)^{-1}$, Aronson *et al* (2007) estimated that the cancer risk could be as high as 3.9×10^{-3} if continuous use throughout

61 Based on an estimated sublimation rate of 1.6 mg/minute for 1,4 dichlorobenzene-based toilet rim blocks, and default assumptions on size of rooms, rim block use levels, and the physiological characteristics of a standard individual.

62 The term 'products' relates to toilet rim block products. The estimates of exposure given were derived based on a domestic-use scenario based on a version of the THERdbASE model which drew on non-conservative emission estimates for the blocks and atmospheric exposure data from actual measured indoor levels. The model assumed 16 hours were spent indoors each day over the course of a 70-year life span, and modelled separate exposure levels for bathrooms and other rooms in the house.

life were assumed[63]. However, the authors noted that this level of usage was unlikely but also derived a series of alternative estimates of potential cancer burdens, based on lower exposure scenarios. One of these alternative scenarios considered a total lifetime exposure equivalent to only 0.1 years (i.e. 36.5 days) for which a cancer risk of 5.6×10^{-6} was calculated (by multiplying the inhalation risk factor by the time-weighted average dose calculated by division of a 70-year dose of 7,126 µg/day by the shorter exposure period assumed in the scenario).

A lifetime (70-year) total exposure of approximately 36.5 days equates to a daily exposure of only 0.03 hours per day (i.e. about 2 minutes/day) over the course of a lifetime. This level of exposure is considered a possible, if somewhat, unlikely worst-case estimate of the exposure that would arise were it to be assumed that a human male might visit a public toilet that uses 1,4 dichlorobenzene-based products, once during the course of each day. This exposure estimate, and the associated cancer risk level, are therefore considered to be suitable, **for illustrative purposes**, to estimate the extent of the cancer burden that could be borne by the European male population as a result of such a source of exposure to 1,4 dichlorobenzene. Thus, based on a total male population for the EU-27 in 2007 of 241,627,637 (Eurostat, 2010), and assuming a 70-year lifetime exposure at average intake of about 0.1018 mg/kg/day, would indicate the possible burden as:

$$(241{,}627{,}637 \times 5.6)/10^6 = \mathbf{1{,}353\ cases\ of\ cancer}$$

This cancer burden is, however, a lifetime estimate so for convenience could be assumed to equate to approximately **19 cases of cancer per year** (assuming a 70-year lifespan). The concern about the carcinogenicity of 1,4 dichlorobenzene relates to primary hepatic cancers (murine liver cancer was used to derive the unit risk), a type for which long-term survival has historically been low, e.g. 1-year survival: 16% in European for 1978–1989 (Faivre *et al*, 1998) and 15.6% in males for 1985-89 in the US (NCI, 2010). While there has been some improvement in short-term survival (39.8% in males in 2005 in US (NCI, 2010)) long term (>5 years) survival is poor so it could be assumed that for the majority of the estimated 19 cases per annum, death would be likely within five years of diagnosis.

The above estimate is, however, clearly based on an ‘absolute’ worst-case since it assumes, not only that the linear (non-threshold) model on which the risk estimate is based is valid, that the whole of the male European population will utilise public toilets that use 1,4 dichlorobenzene based products. The indications are, however, that the percentage of these facilities that still utilise such products is actually much lower, our estimate is only 6% of flushed urinals. A more realistic case is therefore to assume that only 6% of the European male population – rather than 100% – are exposed for 2 minutes each day. Applying this adjustment to the estimate of cancer burden derived above indicates that a

63 ‘Continuous use’ relates to the assumption that the bathroom contained only one rim block product at a time which was immediately replaced on depletion throughout the life of the individual.

more realistic estimate of cancer burden in the general population would be of the order of **1.1, i.e. one case per year**[64].

Estimation of Occupationally-related Health Impact

While it appears that usage of these products in Europe has diminished over time (and will probably continue to do so), the approach of Aronson *et al* (2007) can also be used to provide an indication of the potential occupational health savings in terms of attributable cancer cases amongst toilet attendants and cleaners/maintenance workers in public conveniences, that could arise from a rapid elimination of 1,4 dichlorobenzene-based products from public toilet rooms. For this, it has been assumed that, without regulatory action, 5% of these workers may continue to be exposed to the chemical during the course of their working hours for a nominal further period of 10 years. There is great uncertainty over the size of the total European working population in this sector, so as a conservative assumption a value of only 3.6 million workers has been adopted. Furthermore, on the basis of available evidence, it is assumed that only 6% of the workers are exposed; this equates to a possible exposed population of ca. 216,000.

Other assumptions made for this scenario are that, over the course of a working day, a worker would only spend 60 minutes a day in the general vicinity of these products (i.e. at risk of inhalation exposure; it is accepted that the duration of exposure of attendants – as opposed to just cleaning staff – would be much greater) and that they work only 5 days per week for 46 weeks per year. This would equate to, over the 10 years period being considered, a total occupational exposure duration of approximately 96 days (i.e. 0.26 years).

Adopting the Aronson *et al* (2007) risk estimates and adjusting the life time (70 year) cancer risk to this shorter exposure duration suggests a cancer risk of 1.449×10^{-5}. As might be anticipated this is somewhat higher than that applied to the general population (see above).

Applying this life-time equivalent risk to the assumed target population of 216,000 suggests there could be 3.1 cancer cases attributable to 1,4 dichlorobenzene over a life time (70 year period). This would equate to annual values of **<0.1 cases per year, i.e. effectively zero**. Again, this is based on use of a linear (non-threshold) extrapolation model.

Calculation of Margins of Safety

Available Measurements of 1,4 Dichlorobenzene Levels in Public Toilets

The EU RAR and NICNAS (2000) report a limited investigation of the levels of 1,4 dichlorobenzene occurring in toilet rooms in Germany (Globol Werke GmbH, 1986). In

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64 The unit risk factor is based on the extrapolation to humans of murine experimental data based on dose-response information for the compound (1,4 dichlorobenzene) and hence should not be regarded as source (i.e. toilet rim block or air freshener or moth repellent) specific.

one facility, morning airborne concentrations were 0.3-5.8 (mean 1.8) mg/m^3 while in the other, levels were 0.6-13.3 (mean 3.5) mg/m^3. Corresponding values for the afternoon were 0.6-10.1 (mean 3.6) mg/m^3 and 0.6-7.5 (mean 3.9) mg/m^3, respectively. The only other information identified on levels occurring in public toilet facilities is presented in AIST (2008) and relates to measurements taken in the toilets of a Japanese school; the median value was 0.29 mg/m^3 (maximum 1.3 mg/m^3). As a worst-case estimate of likely levels, it is proposed to assume a value of 3.9 mg/m^3. Notably, a manufacturer of 1,4 dichlorobenzene-based air fresheners and toilet blocks has informed us that measurements of atmospheric levels of 1,4 dichlorobenzene in offices and toilet rooms in his facilities were found to be below 1 ppm (ca. 6.2 mg/m^3) but were not further quantified.

Margin of Safety for the General Public

If it is assumed that – as a somewhat realistic exposure scenario – that members of the general public were exposed to 1,4 dichlorobenzene products at this level for no more than 2 minutes per day from this source, this would equate to an equivalent continuous daily exposure level of 5.417 x 10^{-3} mg/m^3 or a daily body burden of 1.16 x 10^{-3} mg/kg/day (assuming daily inhalation rate of 20 m^3 for a 70 kg male, with 75% systemic absorption via the respiratory system, as used in the EU RAR).
The EU RAR has established that the experimental NOAEL for carcinogenicity is 75 ppm, 6 hours per day, 5 days per week via inhalation in rats and mice, which is equivalent to 13 ppm or 80 mg/m^3 under continuous exposure conditions, and none of the more recently published data considered in the current report challenges the validity of this opinion.

Comparing the experimental inhalation NOAEL value of 80 mg/m^3 for continuous exposure to the estimated equivalent human exposure of 5.417 x 10^{-3} mg/m^3 suggests a margin of safety (assuming exposure limited to this source only) of the order of **14,768** [65].

Margin of Safety for Toilet Attendants and Cleaners/Maintenance Workers in Public Toilets

If it is assumed that – as a somewhat realistic exposure scenario – cleaning workers were exposed to 1,4 dichlorobenzene products at this level for no more than 60 minutes per day, this would equate to an equivalent daily exposure level of 0.488 mg/m^3 or a daily body burden of 0.061 mg/kg/day (assuming an 8-hour working day inhalation rate of 10 m^3 for a 60 kg individual, with 75% systemic absorption via the respiratory system, in line with the assumptions of the EU RAR).

Comparing the experimental inhalation NOAEL value of 80 mg/m^3 for continuous exposure to the estimated equivalent human exposure of 0.488 mg/m^3 suggests a margin of safety (assuming exposure limited to this source only) of the order of **163**. The EU RAR suggests that, starting with an inhalation study in mice, a minimal MOS of 45 (3 for interspecies, 3 for intra-species and 5 for severity of the effects (expert judgment)) is

65 If we had used the exposure value of 23.8 mg/m^3 which the EU RAR uses for characterisation of the risk of acute toxicity, then the corresponding MOS for consumers would be 2,424 – still offering sufficient protection.

required for this carcinogenic endpoint for workers, indicating that the calculated MOS of 163 is sufficient for worker health protection[66].

Overview of Relevance of Cancer Burden Estimates

The estimated cancer burden of 1 case per year for consumers applies to an estimated exposed population of ca. 14 million out of a total European male population of 241,627,637. Significant caution is, however, required with this estimate since it assumes a linear extrapolation is valid from OEHHA's inhalation unit cancer risk of 1.1 x 10^{-5} $(\mu g/m^3)^{-1}$ to the very short daily exposure (2 minutes) scenario considered, from which only an extremely low total daily exposure is expected. Biologically, this assumption is highly questionable since the mechanism of carcinogenicity is believed to be non-genotoxic and threshold in nature. Given this, the alternative approach to estimating the extent of any risk which considers margin of safety is much more informative since this illustrates a very high margin (14,768) suggesting that there would be, in practical terms, very little risk of an adverse cancer outcome for this exposed population.

For individuals exposed to this source as part of their work, a reasonably conservative estimate of 60 minutes per working day was adopted. Thus, while the number estimated to be exposed (216,000) is considerably smaller than that for consumers (ca. 14 million), the magnitude of their overall exposure is considerably greater and, therefore, - although again limited as a result of the assumed linear relationship - this estimate of impact is considered of somewhat greater plausibility. The estimated margin of safety (163) associated with this scenario also suggests that there would not be concerns with regard to the possible level of exposure that may be experienced by this worker population (although the conclusion would be different if the maximum concentration of 23.8 mg/m^3 had been used). However, a definitive assessment of the extent of any impact would require establishment of a threshold of effect level for cancer for 1,4-dichlorobenzene by an authoritative body.

Other Metrics of Public Health Impacts

Based upon the information available at the time, the EU RAR identified no specific concerns regarding the effect of repeated low-level exposure to 1,4 dichlorobenzene in the general population in relation to impaired respiratory function or development/exacerbation of asthma. Subsequently, a study in Australia on children (Rumchev *et al*, 2004) has also failed to show a significant association between risk of developing asthma and exposure to the 1,4 isomer of dichlorobenzene although other isomers did show an apparent association. A US study by Delfino *et al* (2003) also failed to show any association with exacerbation of asthma symptoms.

On the other hand, based on data drawn from a major US monitoring programme (NHANES III), Elliott *et al* (2006) found that there was a robust correlation between

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[66] If we had used the exposure value of 23.8 mg/m^3 which the EU RAR uses for characterisation of the risk of acute toxicity, then the corresponding MOS for workers would be 27 – this would be below the minimal MOS of 45 indicated in the EU RAR.

non-occupational exposure to 1,4 dichlorobenzene (as assessed in terms of blood level) and some important measures of lung function, in particular FEV1 and MMEFR; this effect was apparent across the races and sexes considered. For the combined study population, a reduction in FEV1 of -153 ml/sec was noted for those with the highest decile of blood 1,4 dichlorobenzene levels compared with those with the lowest decile, a difference in blood level of 3.76 µg/L. Thus, for the purposes of this estimation, if it is assumed that a linear relationship exists, it could be conjectured that each 1µg/L change in blood 1,4 dichlorobenzene equates with a decrease in FEV1 of about 40 ml. Since it is well established that strong correlations exist between some air pollutants and lung function (e.g. Frye *et al*, 2003), the finding of an association between lung function impairment and 1,4 dichlorobenzene exposure may not be particularly surprising. However, this finding highlights that there may be a cause for concern about the impact of this chemical on the health of the general public that extends beyond cancer endpoints. Indeed, a recent epidemiological study involving a 26-year follow-up of a cohort of healthy middle-aged Norwegian men (Stavem *et al*, 2005) found a statistically significant correlation between decline in FEV1 and mortality (when expressed as all cause, cancer or respiratory deaths); for example, a 10% decrease from predicted FEV1 was found to associate with a relative risk (RR) for all causes of 1.10 (95%CI 1.06-1.15). Thus it might be conjectured that the 1,4 dichlorobenzene-related reduction in FEV1 reported by Elliott *et al* (2006) might ultimately be expressed in terms of non-cancer mortality in exposed populations. Unfortunately, within the context of the current study there is inadequate information available to attempt to estimate the possible size of any impact on the European population. However, this aspect may warrant further consideration as additional epidemiological data become available.

A6.6.6 Benefits to the Environment

As discussed above, an indirect but by no means guaranteed result of moving to alternative urinal blocks could be a reduction in the flushing frequency. This could take place as the alternatives generally display cleaning action; hence a very high flow of water is not necessary. At the same time, water-soluble alternatives would perform more efficiently if the flushing frequency was reduced (for many bacteria-based products flushing twice to four times a day could be sufficient). Irrespective of the changes in urinal blocks, a reduction in water consumption would have a positive effect on the footprint of toilets/buildings and is indeed required under regulations in counties such as the UK.

A6.6.7 Conclusion on Costs and Benefits from a Restriction on Professional Uses of 1,4 Dichlorobenzene-based Products

The above discussion shows that a potential restriction on the use of 1,4 dichlorobenzene in air fresheners and toilet blocks intended for professional use (i.e. use in public toilets) could result in considerable financial and competitiveness impacts for the key EU industry stakeholders, particularly manufacturers of these products as well as producers of the substance (the competitiveness of whom might be impacted on the global scale). Moreover, 1,4 dichlorobenzene-based products (especially urinal blocks) perform particularly well when used in public toilets with old-fashioned (high-flushing) urinal systems or where tight cleaning budgets or high traffic result in extensive malodour problems. In such situations, a restriction on professional uses of these products would have adverse effects for professional users as the cost of deodorisers and potentially for the cleaning of the toilet installations would increase.

On the other hand, the benefits from such a restriction would be very small. Calculations of cancer cases presented above are based on assumptions which, biologically, are highly questionable since the mechanism of carcinogenicity is believed to be non-genotoxic and threshold in nature. The estimation of risk based on the margin of safety is much more informative and robust; this shows that for both consumers (visitors to the public toilets) and workers (cleaning personnel), very little risk of an adverse cancer outcome exist.

In conclusion, the above analysis shows that costs from a theoretical restriction on professional uses of 1,4 dichlorobenzene-based air fresheners and toilet blocks would outweigh the resulting benefits to health (with particular regard to cancer outcome) and, on the basis of the above discussion, such a regulatory intervention would not be recommended.