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Clearing the Air

Hidden Hazards of Air Fresheners

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Executive Summary

Of all the products in the home, clean-smelling air fresheners seem to pose little risk. But the fresh scent of air fresheners may mask a health threat—chemicals called phthalates (pronounced *thal-ates*) that can cause hormonal abnormalities, birth defects, and reproductive problems. NRDC's independent testing discovered phthalates in 86 percent (12 of 14) of air freshener products tested, including those marketed as "all-natural" or "unscented"—and none of the products we tested listed phthalates on their labels. To protect consumers, government regulators should follow up by doing more thorough tests on these products and enacting basic measures to limit exposure to these chemicals. Meanwhile, consumers may wish to avoid using air fresheners—especially in places where there are children or pregnant women.

Phthalates are versatile chemicals, used as solvents in perfumes and fragrances, as softeners in plastics, as anti-foam agents in aerosols, and as sealants and adhesives. Given their many uses, phthalates are found in a wide array of consumer products, including cosmetics and fragrances, pesticides, pharmaceuticals, vinyl children's toys, automobiles, paints, and interior finishes.[1] Phthalates are used in air fresheners to dissolve and carry the smell of fragrances.

When people use air fresheners, the phthalates are released into the air. They may then be inhaled, or the aerosol particles may land on the skin and be absorbed.[2] Once these chemicals enter the bloodstream, they can alter hormone levels and cause other health problems.

There has been a boom in air freshener use in recent years, driven by advertising that promotes a scented environment as a clean and healthy environment. Air fresheners are now a $1.72 billion industry in the United States—a 50 percent increase from 2003—and are used in an estimated 75 percent of households. Air fresheners are also being used in a greater number of rooms throughout the home, further increasing exposure.[3] Moreover, air freshener advertising is targeting the younger generation of tweens and teenagers, making the potential health impacts associated with the products that much more worrisome.

CHEMICALS IN AIR FRESHENERS COULD CAUSE HEALTH PROBLEMS

Unfortunately, the rise in popularity of air fresheners has outpaced awareness of the potential health threats from exposure to the chemicals they may contain. Most phthalates are well known to interfere with production of the male hormone, testosterone, and have been associated with reproductive abnormalities. Numerous animal studies have linked prenatal exposure to certain phthalates with decreases in testosterone, malformations of the genitalia, and reduced sperm production.[4] In humans, phthalates have been associated with changes in hormone levels, poor semen quality, and changes in genital development.[5] Five phthalates—including one that we found in air freshener products—are listed by the State of California as chemicals "known to cause birth defects or reproductive harm."[6] Phthalate exposure in indoor environments has also been associated with allergic symptoms and asthma.[7]

Because there are no labeling requirements and even "natural" products can contain toxic chemicals, it is virtually impossible for the average consumer to know which products may pose a risk.

RECOMMENDATIONS FOR SAFER HOME AIR QUALITY

Air fresheners are rarely necessary. Because they cannot substitute for good ventilation, the best solution is to open windows to bring in fresh air or to use fans to maintain air circulation. Air fresheners also are not a solution to poor air quality; they mask bad odors but they do not eliminate the chemicals that cause them.

If you decide you do want to use an air freshener, careful selection may reduce phthalate exposures to you and your family. Of the 14 products tested by NRDC, there was wide variation in the level of phthalates contained. The three products with the highest level of phthalates—Ozium Glycol-ized Air Sanitizer, Walgreens Air Freshener, and Walgreens Scented Bouquet—all contained greater than 100 parts per million (ppm) of phthalates, with one containing 7,300 ppm (see Table 1). Two products—Febreze Air Effects and Renuzit Subtle Effects—contained no detectable levels of phthalates. However, we only tested one sample of each product, and more thorough testing is necessary to confirm the levels we detected.

There is a clear need for closer monitoring of the types of chemicals manufacturers are allowed to put into air fresheners—and for consumers to be provided with better information about what is in the products they do purchase. In the near term, government agencies need to more thoroughly test air fresheners and inform consumers about what they contain. NRDC recommends the following:

- Consumers should avoid using air fresheners, but when necessary should use products with the lowest levels of phthalates to limit exposures to toxic chemicals.
- The Environmental Protection Agency should require manufacturers to test and submit data on phthalates found in air fresheners, the extent of human exposure to phthalates in air fresheners, the health effects of the exposure, and the toxicity, persistence, sensitization, and other health effects of inhaling chemicals in air fresheners.
- The Consumer Product Safety Commission should ban hazardous phthalates in consumer products and should require that manufacturers provide ingredient information on the label.

"Although our study is far from comprehensive, it does suggest that there's a problem with many air freshener products. Our work raises concerns that should be followed up immediately by thorough government testing of these products. Meanwhile, consumers should be aware that the pretty label and sweet scent may mask something much less pleasant."

Gina Solomon, M.D., M.P.H., Senior Scientist, NRDC

Table 1: Phthalate Level in Air Fresheners Tested

Brand	Level of Toxic Phthalates Found	Phthalates Found
Air Wick Scented Oil	◒	0.75 ppm DBP; 6.3 ppm DEP; 1.6 ppm DIBP; 2.1 ppm DIHP
Citrus Magic	○	0.25 ppm DBT
Febreze Air Effects Air Refresher	⊙	0
Febreze NOTICEables Scented Oil	◒	0.19 ppm DBP; 1.5 ppm DIBP
Glade Air Infusions	◒	1.5 ppm DEP
Glade PlugIn Scented Oil	◒	4.5 ppm DBP
Lysol Brand II Disinfectant	○	0.12 ppm DBP; 0.49 ppm DEP
Oust Air Sanitizer Spray	◒	5.7 ppm DEP
Oust Fan Liquid Refills	○	0.78 ppm DEP; 0.24 ppm DIBP
Ozium Glycol-ized Air Sanitizer	●	360 ppm DEP; 0.15 ppm DMP
Renuzit Subtle Effects	⊙	0
Walgreens Air Freshener Spray	●	1,100 ppm of DEP
Walgreens Scented Bouquet Air Freshener	●	7,300 ppm of DEP; 0.47 ppm of DBP; 6.5 ppm DMP
Walgreens Solid Air Freshener	●	23 ppm DEP

Legend:

● = Contained highest level of phthalates (more than 10 ppm of total phthalates)

◒ = Contained moderate level of phthalates (between 1 and 10 ppm of total phthalates)

○ = Contained trace level of phthalates (less than 1 ppm of total phthalates)

⊙ = Contained no phthalates

BEYOND PHTHALATES: OTHER RISKY CHEMICALS HIDDEN IN AIR FRESHENERS

While the focus of this issue paper is the presence of phthalates in air fresheners, it is worth noting that researchers have detected other chemicals of concern to human health in these products as well. A 2005 European Consumers Union study, for example, found volatile organic compounds (VOCs) in these products at high levels and concluded that VOCs substantially contributed to indoor air pollution. In particular, the European study detected cancer-causing chemicals such as benzene and formaldehyde in some air fresheners. Benzene is known to cause leukemia in humans, and formaldehyde has been linked to cancers of the upper airways. The majority of products also contained allergens (such as limonene).[8] People with allergies to these chemicals could have adverse reactions, including rashes or even asthma attacks, from exposures to air freshener products.

Exposure to phthalates can come from many sources. And, according to studies done by the U.S. Centers for Disease Control, the majority of the U.S. population is routinely exposed to at least five different phthalates.9 Although the measured levels in the human blood stream are small, they are significant because a mixture of phthalates at low doses can act in an additive manner to cause the same health hazards as just one phthalate at a higher dose.10 Human exposure to phthalates via inhalation from the ambient environment is also a cause of concern. Studies in New York City and Krakow, Poland have demonstrated that levels of phthalates in the air are correlated with levels of phthalate metabolites in the body.11

The difficulty of avoiding general exposure is all the more reason to eliminate further exposure in an environment over which you have much more control—your home.

From Berry Burst to Cleansing Rain: 14 Air Fresheners Tested

NRDC purchased one sample each of 14 different air freshener products at a major San Francisco Bay Area retail chain, including eight aerosol sprays, five continuously emitting liquids, and one solid. Products included all the brands available for sale at that store, and represented a variety of methods of scent dispersal and a variety of scents (see Table 2). The products were sent to a commercial lab for testing for 15 different phthalates. (See Appendix A for a detailed methodology of laboratory procedure and Appendix B for a list of the phthalates tested.) This sampling is not comprehensive; however, it is the first such testing that we are aware of in the United States. More thorough testing should be done to follow up on these findings.

Table 2: Air Freshener Products Tested

Product name	Scent name	Type of product	Ingredients	Distributor
Citrus Magic	Tropical Citrus Blend	Spray	100% PURE & NATURAL premium concentrate citrus fragrance oils from oranges, lemons, limes, tangerines, and grapefruits.	Beaumont Products, Inc.
Febreze Air Effects Air Refresher	Spring & Renewal	Spray	None listed	Procter and Gamble
Glade Air Infusions	Refreshing Springs	Spray	None listed	S. C. Johnson and Son, Inc.
Lysol Brand II Disinfectant	Summer Breeze	Spray	Active ingredients: alkyl dimethyl benzyl ammonium saccharinate (.106%), ethanol (79.646%) and inert ingredients (20.248%)	Reckitt Benckiser Inc.
Oust Air Sanitizer	Floral Scent	Spray	Triethylene glycol (6%, active ingredient). Inert ingredients (94%).	S.C. Johnson and Son, Inc.
Ozium Glycol-ized Air Sanitizer	Original	Spray	Active ingredients: triethylene glycol (4.4%), propylene glycol (4.4%). Inert ingredients: 91.2%.	SOPUS Products
Renuzit Subtle Effects	Cool Morning Air	Spray	None listed	Dial Corporation
Walgreens Air Freshener	Fresh Country	Spray	None listed	Walgreen Co.
Walgreens Solid Air Freshener	Potpourri Scented	Solid	None listed	Walgreen Co.
Air Wick Scented Oil Refill (for Air Wick warmer)	Relaxation Lavender & Chamomile	Liquid (oil)	None listed	Reckitt Benckiser Inc.
Febreze NOTICEables	Morning Walk & Cleansing Rain	Liquid (oil)	None listed	Procter and Gamble
Glade PlugIns Scented Oil	Berry Burst	Liquid (oil)	None listed	S. C. Johnson and Son, Inc.
Oust Fan Refill (for use in Oust Fan)	Citrus Scent	Liquid	None listed	S.C. Johnson and Son, Inc.
Walgreens Scented Bouquet Air Freshener	Rose	Liquid	None listed	East West Distributing Co.

Masking the Risk: Phthalates Found in Majority of Fresheners

Eighty-six percent (12 of 14) of the products tested had detectable levels of phthalates, including an "all-natural" product and an "unscented" air sanitizer (see Figure 1).

There was a wide range of concentrations of phthalates in our samples (see Figure 2). Nearly one-quarter of the products (three of 14) had very high levels—more than 100 parts per million (ppm)—including products that ranged from 360 ppm to 7,307 ppm. Seventy percent (10 of 14) of all products had more than 1 part per million of total phthalates. The reporting limit from the testing laboratory ranged from 0.1 to 1.0 ppm, depending on the specific phthalate chemical (see Appendix A for the laboratory methodology).

The major phthalates found were di-butyl phthalate (DBP), di-ethyl phthalate (DEP), di-isobutyl phthalate (DIBP), and di-methyl phthalate (DMP) (see Figure 3). Di-isohexyl phthalate (DIHP) was also found in a single sample.

Figure 1: Proportion of Air Fresheners Tested that Contain Phthalates

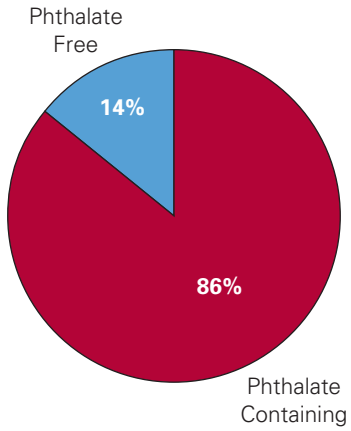
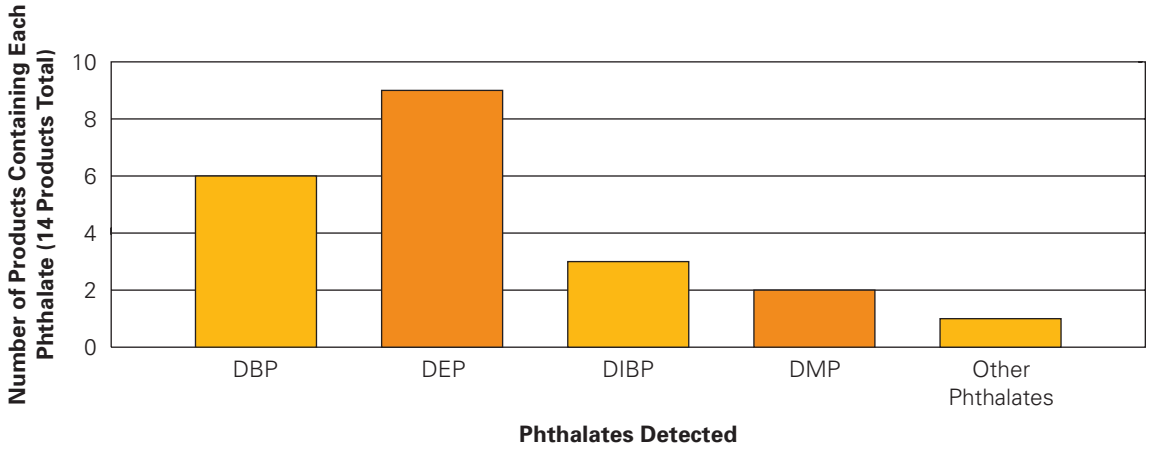


Figure 2: Phthalates Present in Air Fresheners



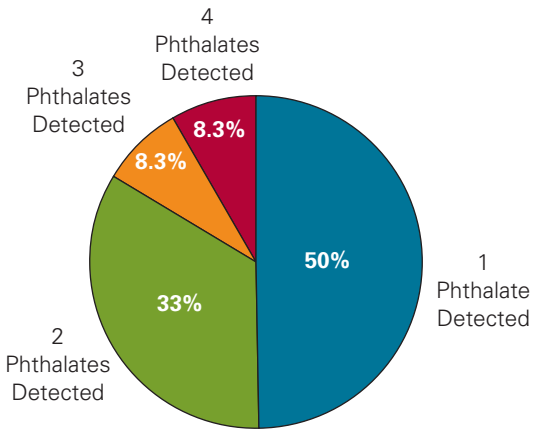
Many of the products we tested contained more than one phthalate chemical. One-half of the phthalate-containing air fresheners (six of 12) had two or more phthalates, including one product that contained four different phthalates (see Figure 4). Mixtures of phthalates in consumer products are of particular concern because phthalates may act in combination to have a more toxic effect than they would alone.

How Much of the Phthalates Get Into People from Air Fresheners?

When phthalates or other toxic chemicals are used in air fresheners, some but not all of it gets into our bodies. There's no simple answer to the question of whether enough of the phthalates get into people to pose a health hazard. The answer depends on many factors, including the amount of phthalates in the product that's being used, the size of the room it's used in, the frequency of use, and how much time people spend in that room. It also depends on whether the person is an adult or a child, how much of their skin is bare, and even on how hard and fast the person breathes. To make matters more complicated, health risks from skin or inhalation exposure are tricky to predict because most of the studies done on phthalate toxicity focus on oral exposure rather than inhalation, and susceptibility varies widely.

Common sense suggests that products that contain higher levels of phthalates would be more risky than those that contain none. It is also NRDC's opinion that these exposures are unnecessary and should thus be avoided.

Figure 3: Frequency of Phthalate Mixtures



Di-ethyl Phthalate (DEP)

NRDC detected DEP in three-quarters (nine of 12) of phthalate-containing samples. Five of these samples contained DEP only; four contained other phthalates as well. DEP levels in these products ranged from 0.8 ppm to a shocking 7,300 ppm. The average level among DEP-containing products was 977 ppm.

DEP is used in personal care products, food packaging, pesticides, and molded plastics.[12] DEP has been shown in animal studies to affect growth and food consumption, but has not been shown to affect male reproductive development in animal studies.[13] However, human studies have repeatedly associated exposure to DEP in a mixture of phthalates with adverse reproductive outcomes, including changes in hormone levels, poor semen quality, and changes in genital development.[14] Until we have more evidence, it would be prudent to avoid exposure to this chemical.

Prior Study on Phthalates in Air Fresheners

We are aware of only one previous study on phthalates in air fresheners. This study, done by the European Bureau of Consumers Unions (BEUC), tested a variety of air fragrance products for di-ethyl phthalate (DEP). Results were consistent with NRDC findings. DEP was detected in 13 out of 21 European aerosol products, in three of the 10 liquid diffusers, and in three out of nine gels. Concentrations ranged from 0.2 to 82 ppm. These levels are similar to levels we found in five of the products we tested, although they are lower than what we found in three products.

Di-n-butyl Phthalate (DBP)

NRDC detected DBP in one-half (six of 12) of the phthalate-containing air freshener products tested. Two of these products contained DBP only; the other four had DBP as part of a phthalate mixture. DBP levels in these products ranged from 0.1 ppm to 4.5 ppm. The average level among DBP-containing products was 1.1 ppm.

DBP is recognized as a reproductive toxicant by both the National Toxicology Program and the state of California.[15] In animal studies, exposure to DBP has been associated with a syndrome of reproductive abnormalities that includes malformations of male reproductive organs, low sperm counts, and infertility. In humans, exposure to DBP with a mixture of phthalates has been associated with changes in hormone levels, poor semen quality, and changes in genital development.[16]

Di-isobutyl Phthalate (DIBP)

NRDC detected DIBP in one-quarter (three of 12) of phthalate-containing air freshener products. DIBP levels in these products ranged from 0.2 ppm to 1.6 ppm. The average level was 1.1 ppm.

DIBP has properties similar to DBP and is used as a substitute for DBP in many applications. Although DIBT testing has been limited, this phthalate appears similar to DBP, acting as a male reproductive toxicant that causes decreases in testis weight and lower testosterone levels in rats exposed prenatally.[17] DIBP metabolites have been detected in human urine samples and have been associated with changes in male genital development.[18]

Di-methyl Phthalate (DMP)

NRDC detected DMP in 17 percent (two of 12) of phthalate-containing products, with levels ranging from 0.2 ppm to 6.5 ppm and an average of 3.3 ppm.

DMP is used a wide variety of products, including cosmetics, printing inks, insecticides, adhesives, and paper coatings. There is inconclusive evidence on the reproductive toxicity of DMP in animal studies, and it has not been associated with any adverse effects in any human study to date.

Di-isohexyl Phthalate (DIHP)

One product contained DIHP at a level of 2.1 ppm.

There is limited information on the commercial uses of DIHP. It is known to be used in automotive lubricants.[19] DIHP has similar structural properties to other phthalates that are known to be male reproductive toxicants. Limited toxicity testing has suggested that DIHP is indeed a developmental and reproductive toxicant.[20]

Detailed Individual Product Test Results

Air fresheners with the highest levels of phthalates:
- **Walgreens Scented Bouquet Air Freshener** contained off-the-charts DEP levels of 7,300 ppm, as well as 0.47 ppm DBP and 6.5 ppm DMP.
- **Walgreens Air Freshener Spray** contained 1,100 ppm DEP.
- **Ozium Glycol-ized Air Sanitizer**, an unscented product commonly used in hospitals and similar settings, also contained very high levels of phthalates: 360 ppm DEP and 0.15 ppm DMP.
- **Walgreens Solid Air Freshener** contained 23 ppm DEP.

Air fresheners with moderate levels of phthalates:
- **Air Wick Scented Oil** contained a variety of phthalates: 0.75 ppm DBP, 6.3 ppm DEP, 1.6 ppm DIBP, and 2.1 ppm DIHP.
- **Oust Air Sanitizer** spray contained 5.7 ppm DEP.
- **Glade PlugIn Scented Oil** contained the highest level of DBP—a reproductive toxicant according to the State of California—with a level of 4.5 ppm DBP.
- **Febreze NOTICEables Scented Oil** contained 0.19 ppm DBP and 1.5 ppm DIBP.
- **Glade Air Infusions** contained 1.5 ppm DEP.

Air fresheners with trace levels of phthalates:
- **Oust Fan Liquid Refills** contained 0.78 ppm DEP and 0.24 ppm DIBP.
- **Lysol Brand II Disinfectant**, which is sometimes used as an air freshener, contained 0.12 ppm DBP and 0.49 ppm DEP.
- **Citrus Magic**, an all-natural product, still contained a trace level of DBP of 0.25 ppm.

Air fresheners with no phthalates detected:
- **Febreze Air Effects Air Refresher**
- **Renuzit Subtle Effects**

Appendix A: Methodology of Laboratory Procedure, Provided by Analytical Sciences Laboratories

Samples were analyzed by GC/MS according to a modified version of EPA method 8270 for semi-volatile organic compounds. One to two milliliters (ml) of liquid was obtained directly from a liquid product or by spraying an aerosol product into a new 40 ml volatile organics analysis (VOA) vial. All spraying was conducted inside of an operating fume hood to prevent sample cross-contamination. Only one sample was present in the fume hood at any one time and VOA vials were sealed immediately after spraying. One sample was a gel. A weighed amount of the gel was soaked in 1 ml of acetone in a sealed vial. The acetone extract of the gel was then analyzed. The liquid products exhibited varying degrees of polarity of the primary ingredients as observed by their variable solubility in hexane. The phthalates to be determined would be expected to dissolve completely in the hexane solvent even if some of the freshener chemical constituents would not.

After a liquid sample was obtained from all products, a volumetric dilution was made directly into hexane to accomplish the two GC/MS analyses conducted. The first GC/MS analysis utilized six microliters of product in 300 microliters of hexane (50X dilution). A full scan GC/MS analysis (similar to EPA method 8270) was conducted with an instrument calibrated using a fresh 16 component mixed phthalate standard purchased from Absolute Standards (part# 80601). The initial analysis allowed an evaluation of the magnitude of the phthalate presence in the product and permitted the important assessment of the magnitude of other non-target hydrocarbons.

The second GC/MS analysis was identical in all respects to the first except the instrument was operated in "Selective Ion Monitoring Scan" (SIMS) mode using ions 163 and 149. Ion 163 was used solely to observe dimethyl phthalate. Ion 149 is the primary and common ion to most phthalates and was used to observe the other 15 phthalates. The instrument was calibrated for both phthalate retention time and quantity prior to the SIMS analysis. The SIMS GC/MS technique is well recognized as a means to lower detection limits by focusing all the mass spectrometers time resources on the specific target ion of the contaminants of concern. This technique makes compounds containing other ions, of which there are many, completely unobserved thereby simplifying the chromatogram obtained. It is estimated that the sensitivity of the instrument was increased by approximately 100-fold using this SIMS technique. QA/QC was performed according to standard practices. Blanks were negative, and a quality assurance report was provided with the sample results.

Appendix B: Phthalates Tested in Each Sample and Lab Reporting Detection Limit

Phthalate	CAS Number	Detection Limit (ppm)
Dimethyl Phthalate (DMP)	00131-11-3	0.10
Diethyl Phthalate (DEP)	00084-66-2	0.10
Diisobutyl Phthalate (DIBP)	00084-69-5	0.10
Di-n-butyl Phthalate (DBP)	00084-74-2	0.10
Bis(2-methoxyethyl) Phthalate	00117-82-8	1.00
Diisohexyl phthalate (DIHP)	00146-50-9	0.10
Bis(2-ethoxyethyl) Phthalate	00605-54-9	1.00
Diamyl Phthalate (DAP)	00131-18-0	0.10
Dihexyl Phthalate (DHP)	00084-75-3	0.10
Butyl benzyl Phthalate (BBP)	00085-68-7	0.50
Bis(2-n-butoxyethyl)Phthalate	00117-83-9	1.00
Bis(2-ethylhexyl) Phthalate (DEHP)	00117-81-7	0.50
Dicyclohexyl Phthalate (DCP)	00084-61-7	0.10
Di-n-octyl Phthalate (DOP)	00117-84-0	0.50
Dinonyl Phthalate	00084-76-0	0.50

Endnotes

1. Detailed information regarding the chemical properties, production, use, and health effects of certain phthalates can be found on the web: Agency for Toxic Substances and Disease Registry, US Dept. of Health and Human Services, Public Health Service, Toxicological Profiles for Diethyl Phthalate (DEP); Di-n-butyl phthalate (DBP), http://www.atsdr.cdc.gov/toxpro2.html0 (September 5, 2007); Australian National Industrial Chemicals Notification and Assessment Scheme, 2007. Draft Human Health Hazard Assessment of diisobutyl phthalate (DIBP), http://www.nicnas.gov.au/Industry/Existing_Chemicals/Phthalate_Hazard_Assessments/DiBP%20hazard%20assessment%2030-4-07.pdf (July 25, 2007).

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