Taking back our stolen future

Hormone disruption and PVC plastic

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1. Introduction/summary

The quality of men's sperm declined steadily in the early years of the 21st century until hardly anyone could reproduce in the normal way. Meanwhile, the countryside was virtually emptied of animals as natural populations crashed. The first signs of the impending catastrophe were noted in the 1990's, but few people then believed that a cocktail of pollutants that mimic human hormones could have such profound effects. And so nothing was done until it was too late. (This chilling scenario was hypothesized in the New Scientist, 1995.)

Over the last few years, an increasing number of reports have appeared about reproductive problems in both wildlife and humans. Reports of alligators with malformed reproductive organs,[1] feminisation of fish in UK rivers[2] and changes in the mating behaviour of gulls[3] have appeared alongside studies showing a decline in human sperm count and sperm quality,[4] an increase in testicular cancer and genital abnormalities, such as undescended testicles[5], and a rise in the incidence of breast cancer in women.[6]

The conclusion of many of these studies is that man made chemicals in the environment are suspected to be interfering with hormonal systems in both humans and wildlife.[7] Hormones are chemical messengers which control or mediate vital bodily functions. The hormonal system regulates the development of vital functions in the foetus including the reproductive organs, the immune system and intelligence and behaviour.

It is our children that are most at risk. Persistent chemicals in the mothers body pass through the placenta to the foetus.[8] The developing foetus is also more susceptible to the adverse effects of any pollutants, because it is growing rapidly and is immature in a number of its bodily functions.9 Many chemicals are also passed through the mothers breast milk to the nursing infant.10 It has been estimated that an infant which is breast fed for one year will receive between 4 and 12% of its total lifetime exposure to dioxins.11 As Dr Theo Colborn says in her newly released book Our Stolen Future Children have the right to be born chemical free. 12

As the evidence about wildlife and human health effects accumulates, the list of chemicals identified as synthetic hormone disrupters has also grown longer. These chemicals can work in different ways; for example, among those that disrupt sex related functions, many mimic the female hormone oestrogen (and have a feminising effect). Others might be anti androgens (which would block testosterone and have a demasculinising effect).

Unlike natural hormones, some of these synthetic hormone disrupters build up in body fat, are highly resistant to breakdown, and accumulate through the food chain. Natural hormones are broken down once their message has been delivered; persistent hormone pollutants can cause damage over and over again.

Synthetic chemicals known to be hormone disruptors:13

- numerous pesticides, many of them synthetic chlorinated chemicals, such as DDT, lindane, methoxychlor, chlordane, dieldrin, hexachlorobenzene, kepone ,14 dicofol, kelthane, synthetic pyrethroids, and triazines (eg. atrazine). Breakdown products of some pesticides can also cause hormonal disruption.
- PCBs, industrial chemicals used as heat transfer and hydraulic fluids, flame retardants, dielectric fluids for capacitors and transformers. Production in the US was banned in 1977 & they are no longer produced.
- dioxins and furans, an accidental by-product of the chlorine industry, especially the manufacture, disposal and combustion of the chlorinated plastic PVC. They are also organochlorines.
- bisphenol A (a key ingredient of the plastic polycarbonate, which is produced using chlorine and phosgene. It is an ingredient in the coating inside some tin cans, some reusable milk bottles, and in dental fillings),
- alkylphenols (a breakdown product of industrial detergents)
- phthalates, chemical plasticisers extensively used in PVC and food packaging materials. At least 95% of DEHP, the most common phthalate, is used in PVC plastic15, which is a product of the chlorine industry. Over three million tonnes of phthalates are consumed every year 16 and they are found throughout the environment. 17
- butylated hydroxyanisole (BHA) a food anti-oxidant.

Chlorine and PVC

Many of the chemicals known as hormone disruptors are linked to the manufacture of chlorine. Some such as DDT, Lindane and 2,4-D pesticides are produced intentionally. But others, dioxins and furans, for example, are accidental by-products of numerous processes which produce, process, or dispose of materials containing chlorine, such as the chlorinated plastic PVC. These chemicals are all called organochlorines.

Many hormone disruptors have already been banned such as PCBs, or restricted in some countries, such as DDT. In contrast, the chlorinated plastic PVC, responsible for two significant hormone disruptors, is still a common consumer product D the second most common plastic used today. The world market for PVC plastic is still growing at a rate of 5% annually,18 particularly in East Asia.19

Dioxin, a highly potent synthetic hormone disruptor, is generated during the production and disposal of PVC, and also during accidental fires. Phthalates, used in making soft PVC products, are the most common of the hormone disruptors, in terms of the quantity found in the environment. PVC plastic uses the largest quantities of the phthalates.

Virtually all uses of PVC plastic are avoidable. By choosing alternatives to PVC, which are readily available, and thus ending the production of PVC, we could dramatically reduce the levels of these hormone disruptors entering the environment. We don't need to risk our childrens health, their future, or the environment, by delaying action, as proposed by industry and some governments.

No safe dose

Many current regulations designed to protect human health are based on risk assessment, which attempts to determine safe doses of individual chemicals doses which will not cause unacceptable levels of clearly identifiable health effects such as cancer. This is a permissive approach trying to identify how much pollution you can expose people to without making too many of them ill.

The same approach is used when pollutants are released by industrial processes into the environment. Again the assumption is made that there is a safe level of pollution that the environment can cope with. Such safe limits also don't take into account the total release of pollutants throughout the life cycle of a product from production, through to its use and disposal.

Time and again, it has been found that this permissive approach does not work. For example, it was impossible to predict the damage caused to the ozone layer by CFCs. Scientists did not predict that many chemicals which were thought to be safe at the doses individuals were exposed to would disrupt hormone systems and have the potential to cause permanent damage to developing children.

Regulators and industry may have to accept that there are not necessarily safe doses of many of the chemicals that are produced. To date, only a few of the tens of thousands of man-made chemicals produced have yet been tested for their ability to disrupt the hormonal system.20

Time for precautionary action

In Article 2 of the OSPAR Convention, the signatories agreed that:

> The contracting parties shall apply:
>
> The precautionary principle, by virtue of which preventive measures are to be taken when there are reasonable grounds for concern that substances or energy introduced, directly or indirectly, into the marine environment may bring about hazards to human health, harm living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea, even when there is no conclusive evidence of a causal relationship between the inputs and the effects.

The traditional risk assessment approach, which does not even begin to address the problem of hormone pollution, is no longer valid. New strategies are needed, based on the precautionary principle, which calls for preventive action against chemicals where there is any evidence of harm. It means that all efforts should be taken to prevent the release of these chemicals into the environment, particularly those which persist and build up in human bodies, and can therefore be passed on to the next generation. In practice, this will mean ceasing to manufacture or use them.

In line with the precautionary principle, some communities, local and national Governments are already acting to phase out products which use or release these chemicals. For example, in November 1995, the Swedish Parliament voted to phase out plasticised PVC and rigid PVC with harmful additives, because PVC is not a part of an ecological society.21

The question is not whether to phase out PVC
but how PVC should be phased out.[22]
Swedish Environment Minister, Anna Lindh, November 1995.

This report explains the links between PVC plastic and two significant hormone disruptors dioxin and phthalates. It also highlights the available alternatives and points to action that can be taken to avoid the risks that PVC presents to the hormonal systems of human and wildlife.

2. The hormone system

The body's hormone system, also known as the endocrine system, is a complex internal chemical messenger system, which regulates vital functions such as our reproductive systems, behaviour, and immune systems. In particular, the hormone system controls the development of these vital functions in the unborn child. Hormones are produced by a variety of glands in different parts of the body and released into the blood stream. The hormones bind to special receptors in organs or tissues and cause them to respond in a specific way. Hormones are extremely powerful, having effects at levels of only parts per trillion. But in our bodies, concentrations of hormones are strictly controlled.

One of the most familiar hormones is adrenaline, which is released in response to danger or stress and which prepares the body for swift action the fight or flight reaction. Also well known are the sex hormones. The female hormones progesterone and oestrogen control the menstrual cycle, pregnancy and childbirth. The male counterpart, testosterone, is responsible for masculine libido and behaviour. The sex hormones are also vital for the correct development of each child's reproductive system in the early stages of life.

The primary function of most hormones are known, but there are complex interactions and subtle effects that scientists do not yet fully understand. However, it is becoming clear that a large number of industrial chemicals have the ability to disrupt this intricate control system, with potentially disastrous results for health and well-being.

The best studied chemicals are those which are oestrogen mimics or, simply, oestrogenic. These chemicals can disrupt the development of the reproductive system if given to the mother at the critical period of pregnancy; for example in animals exposed to the phthalate BBP (butyl benzyl phthalate)23 and in humans exposed to the synthetic hormone DES (diethylstylbestrol). Daughters born to mothers who took DES suffer increased rates of a rare vaginal cancer, and both sons and daughers experience congenital abnormalities of their reproductive systems.24 It is a complex area of research:

> It's a major nightmare trying to unravel what is going on, to find out how much oestrogen is present and what its consequences are 50 years of research is needed.25

Other chemicals may act in other ways, such as by counteracting male hormones. These are known as anti-androgens, which can block the effects of testosterone and affect the development of the male reproductive system.26 Hormone disruptors can also act by preventing hormones from being produced, accelarating the breakdown and elimination of hormones, and interfering with the breakdown process so that they cant be excreted.27

3. Evidence of effects in humans and wildlife

Over the last three years there have been several reports that sperm count has been seriously reduced in humans.28 Sperm quality has also been affected.29 Environmental factors, including hormone disruptors are suspected to be an important factor in this decline.30 One possible way that this could happen is through the reduction of the number of Sertoli cells in the testes. Since these cells support the sperm cells as they develop, less Sertoli cells means less sperm.31

The industry often cites studies that show that other factors are responsible, for example heat, driving, and conclude that chemicals cannot be considered a factor.32 Lifestyle may indeed be a factor for some men. However, if these were overriding factors it could be expected that older men, who would have been affected in these ways for much longer, would have a lower sperm count. In fact, studies show a real sperm count drop in younger men.33 Further, animal studies demonstrate that dioxin 34 octylphenol, DES and BBP 35 reduce sperm counts. Lifestyle can hardly be considered a factor in animals.

In addition, attempts are sometimes made to confuse the issue. As reported by the German PVC industry,36 a National Institute of Health seminar in Norway came to the conclusion that there is no evidence at all of disruptions to male procreative capacity. These claims are highly misleading, as reports have been concerned with the phenomena of reduced sperm counts, and reduced fertility has not been widely observed, although if the trend continues a decline in fertility is possible.37

It is not possible at this time to link specific chemicals directly to these reductions. There are probably many factors, including lifestyle, that could play a part alongside environmental contaminants. However, the evidence strongly suggests that hormone disrupting chemicals are involved and, further, that dioxins and phthalates can have these effects if administered before birth.38

Hormone disruptors, especially organochlorines, are also thought to be to influencing a rise in reproductive problems in wildlife, and have been shown to cause adverse effects on animals in laboratory experiments. In July 1991, Theo Colborn invited a group of 20 scientists to discuss their research. To their surprise, the scientists all agreed that, in their individual research, they were seeing evidence that industrial chemicals in the environment were harming the endocrine systems of fish, birds and mammals. They issued a consensus document, now known as the Wingspread statement, which began39:

> We are certain of the following:
>
> A large number of man-made chemicals that have been released into the environment, as well as a few natural ones, have the potential to disrupt the endocrine system of animals, including humans. Among these are the persistent, bioaccumulative, organohalogen compounds that include some pesticides (fungicides, herbicides, and insecticides) and industrial chemicals, other synthetic products, and some metals.
>
> Many wildlife populations are already affected by these compounds. The impacts include thyroid dysfunction in birds and fish; decreased fertility in birds, fish, shellfish, and mammals; decreased hatching success in birds, fish and turtles; gross birth deformities in birds, fish and turtles; metabolic

abnormalities in birds, fish, and mammals; behavioural abnormalities in birds; demasculinization and feminization in male fish, birds, and mammals; defeminization and masculinization of female fish and birds; and compromised immune systems in birds and mammals.

4. Hormone pollutants and PVC

Some of the chemicals known to disrupt the hormone system are used mainly in industrial applications rather than in consumer products and only indirectly reach the consumer, through releases into the environment and food chain during the production process and/or use. There is one product, however, which is produced in quantities of millions of tons per year, and which is routinely made into consumer products. It is PVC.

There are two main groups of hormone disrupting chemicals associated with PVC. During the production, disposal and combustion of PVC, large quantities of dioxins are formed as an unwanted by-product.40 Dioxin already has a reputation as the most toxic man-made chemical ever. Most attention has focused on dioxin's carcinogenicity, but it is also a potent hormone disruptor. The other group of hormone disruptors associated with PVC is the phthalates.41 These are plasticisers - chemicals mixed in with the PVC to soften it and make it flexible.

In addition to dioxin and phthalates, other substances suspected as hormone disruptors are also used as additives in PVC plastic, including the organotins, cadmium, lead 42 and small quantities of alkylphenols. Alkyl phenols are used as a process chemical in the polymerisation of vinyl chloride monomer (VCM).43 PCBs can also be created as by-products during the manufacture or disposal of PVC plastic.44

5 Dioxin and hormone disruption

Dioxin has been looked at most closely in relation to its cancer-effects, but a large body of evidence has also established its abilities as a potent hormone disruptor.

Dioxin toxicology is complex. The basic mechanism of action via a receptor known as the Ah receptor is well established, but the detailed biochemical routes by which its various effects take place are not yet fully understood. Most research has been carried out on the most toxic form of dioxin, 2,3,7,8-TCDD, which is also sometimes called TCDD or simply dioxin.

Hormone disruption caused by dioxins

TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin) is known to be an anti-androgen. Several animal studies indicate that 2,3,7,8-TCDD affects the levels of reproductive hormones (see US EPA 1994 for review). In adult men that have been exposed to dioxins at work, levels of testosterone were reduced.45 The ability of dioxin to affect testosterone levels also has implications for the unborn male. When pregnant rats were given just one dose of dioxin, on a particular day of pregnancy, the male offspring had lowered levels of testosterone 46 and a reduced sperm count.47 Their sexual behaviour was also demasculinised and feminised.48

While not all the reasons for these changes have been discovered, alteration of the levels of testosterone and other hormones at the critical time for the development of the male reproductive system is thought to be an important factor. 49 Worryingly, the effects of dioxin on male animals affected before birth seem to be permanent.50

This indicates that the timing of the dose is critical and may be more important than its concentration; extremely low levels can cause permanent damage at particular stages of development.

Dioxin is also known to alter the concentrations of thyroid hormones in animals51 and new-born human babies.52 Correct functioning of the thyroid and its hormone systems are essential for correct development and growth in children including the developing central nervous system and brain. Possible effects of disruption of the thyroid hormones include low birth weight, hyperactivity, impaired learning and memory. Again, damage before birth may cause changes that are permanent.53

6 The link between PVC and dioxin

Dioxins are now present throughout the environment and the food chain; everyone is exposed to them in their diets, particularly through fatty foods such as dairy products.55 The evidence is reviewed in the Greenpeace report Body of Evidence; the effects of chlorine on human health.56 Dioxins produced in the PVC lifecycle will enter the global environment and build up in the food chain, becoming part of the everyday exposure that the whole human and animal population is now subjected to.

PVC, which is the second most common plastic, is used in numerous different products. The largest quantity is used in building materials, such as cables, floorings, window frames, water pipes and wallpapers. It is also used in packaging, including food packaging, furniture and children's toys. PVC is linked in numerous ways with the formation and release of dioxin, as follows:

a) Manufacturing by-products

It has been known since 1989 that dioxin is produced in the manufacturing of the chemicals from which PVC is made. It was first discovered by Erik Evers; his investigations showed that dioxins were generated in the oxychlorination process, a fundamental step in the PVC production chain.57 This results in contamination of the liquid wastes. ICI, who uses this process at their plant at Runcorn, in the north-west of England, described the oxychlorination process and the creation of dioxins as by-products, as follows:

The reactions include all of the ingredients and conditions necessary to form (the dioxins)

> PCDD/PCDFs, i.e. air or oxygen, a hydrocarbon (ethylene etc.), chlorine or hydrogen chloride, a copper catalyst, an ideal temperature and an adequate residence time. It is difficult to see how any of these conditions could be modified so as to prevent PCDD/PCDF formation without seriously impairing the reaction for which the process is designed.58

The wastes produced at ICI's plant contain high levels of dioxins.59 Greenpeace found a similar picture in 1994 when they investigated the PVC industry in the USA.60

Despite having been identified as a dioxin source, however, very little research has been done on the PVC industry. Nevertheless, where it has been done, there always appear to be problems. Although dioxins are produced by other processes such as incinerators, the dioxins produced by the oxychlorination process have a very clear fingerprint which can often be tied to dioxins found near factories. In the Netherlands, the manufacture of vinyl chloride monomer (VCM) caused extensive dioxin contamination of Rotterdam harbour.61 In Venice, Greenpeace analysed sediment from the Porto Marghera. It clearly showed contamination of the lagoon with dioxin by the Enichem plant, where VCM is among the chlorinated chemicals manufactured. After conducting their own sampling, the authorities were so concerned about the findings that they have closed down the wastewater treatment plant responsible for the releases while they conduct further investigations.62 Greenpeace has also found that local mussels have been contaminated with the typical PVC industry-type dioxins. Consequently, these pollutants may be entering the human food chain.

In Germany, the Environmental Ministry of Lower Saxony 63 found extremely high levels of dioxins in sludges from the waste water treatment plant for EVC's PVC production at Wilhelmshaven. Dioxin was also found in a dump where these sludges were disposed.

In addition to dioxin resulting from the PVC production process, whenever PVC is burned (either deliberately by incineration or accidentally in fires), or is recycled (for example, when metals such as copper or steel are recycled), they can contribute to emissions of dioxin into the environment, as follows:

b) Accidental fires

PVC causes dioxin formation at accidental fires, when PVC is present in building materials or furnishings. The German EPA recommended in the long run, PVC products should be substituted by other materials in all areas where the potential dioxin and hydrogen chloride formation in case of fire poses a substantial risk for human health and the environment.64

c) Recycling and Disposal

During the recycling or disposal of products containing PVC, dioxins can be released. Numerous PVC compounds, or combinations of PVC with other materials, have been identified as potential dioxin sources. These include PVC + paper (e.g. wallpaper), PVC + copper (cables), PVC + wood (furniture), PVC + steel (cars), etc.65 The reasons for the dioxin formation are numerous.

- PVC coated (wall) paper and wood (furniture) is often burned in the open by individuals in their back yards, or by companies in inadequate furnaces that are not suited at all for burning such hazardous wastes (no scrubbers, low temperature incineration etc.) 66 The German EPA requires all furnaces, (from household fires to industrial furnaces) to be free of material containing chlorine, such as PVC.67
- The presence of PVC in steel products leads to the release of large amounts of dioxin when these products (for example, cars) are scrapped and sent to (secondary) steel mills for steel recycling. While of course metal recycling is an important and reasonable practice to cut down primary steel production and conserve raw materials, the environmental impact of steel recycling is greatly increased when scrap metal is contaminated with chlorinated compounds, including PVC plastic.68
- Also secondary copper smelters recycling PVC contaminated copper scrap (for example, PVC coated cables) are a major source of dioxin contamination in the environment via dioxin emissions. This is partly because the formation of dioxin is catalysed by the presence of copper. Copper smelters are recognised as an important dioxin source. For example, in February 1988, the regional authorities responsible for the Austrian copper smelter of Montanwerke Brixlegg AG issued a ban on the use of PVC containing material to cut down on dioxin emissions. This resulted in an immediate reduction of one third of these emissions. 69

In addition, in many parts of the world, cable scrap is burned in the open air. For example, in 1994 Greenpeace discovered that imported PVC cables are recycled in the slums of Jakarta, Indonesia simply by burning the PVC off the cables in big steel drums in people's backyards.70

d) PVC and incineration

PVC is usually the main source of chlorine in the municipal waste stream, in the form of packaging, household products, old furniture and fittings, and therefore is the main contributor to dioxin formation in municipal waste incinerators.71

Another important dioxin source is hospital incineration. For example, the US EPA listed hospital incinerators as the No. 1 dioxin source in the US.72 Looking at the feedstock of hospital incinerators, PVC medical products are a major source of chlorine. PVC is used in hospitals in many disposable products such as tubing systems, blood and infusion bags, gloves and often also packaging. The practice of burning those medical products (which often also contain the phthalate DEHP) leads to the release of dioxin from hospital incinerators.

7 Phthalates and hormone disruption

The phthalates are a group of compounds used to soften PVC and make it more flexible. They have already been identified as priority substances under some legislation because of their toxicity, which includes possible carcinogenicity.73 However, they have also recently been added to the list of chemicals which mimic the female hormone oestrogen.

Not all of the phthalates in use have been tested for their ability to disrupt hormones. However, three phthalates tested by one group of researchers (bis(2-ethylhexyl)phthalate (DEHP), butyl benzyl phthalate (BBP), di-n-butyl phthalate (DBP)) were all weakly oestrogenic. They may still be toxicologically important because of the high doses to which people may be exposed. A related compound, bis-(2-ethylhexyl)adipate (DEHA), was also oestrogenic. All four of these compounds are used in PVC products.74 BBP has also been shown to reduce the testicular weight and function of rats exposed via their mother before and shortly after birth. Sperm production was also reduced.75

The phthalates are known to be toxic to developing embryos, causing malformation and death.76 The death of foetuses caused by butylbenzyl phthalate appears to be linked to reduced levels of progesterone, a female hormone essential for the control of pregnancy.77 Phthalates are global polluters. DEHP can be found anywhere in the sea, lakes and rivers as well as in the rain, the soil and sediments all over the globe.78 For example, they have been found in Antarctic sediments,79 and in air over the Pacific and Atlantic oceans.80 They are thought to be the most abundant environmental contaminants.81

Phthalates are persistent and can bioaccumulate, so generalised environmental contamination can lead to exposure of humans through food. Phthalates and other oestrogenics such as DEHA used in food packaging can also be directly transferred into food.82

8 Phthalates and PVC

Large quantities of phthalates are produced each year. Globally, it is estimated that the world consumption of phthalates is 3.25 million tonnes, and that of this quantity, DEHP accounts for about 2.1 million tonnes.83 In Germany alone 250,000 tonnes are produced annually, with BASF being the biggest German producer.84 In the USA, it is estimated that 300 million pounds of phthalates are produced every year about 270 million pounds of this is DEHP.85 The major chemical companies producing DEHP and PVC are listed in Appendix 1.

Phthalates can be released into the environment not only by the factories that manufacture them, but during the processing of plastics that contain them, during the products life and even after it is disposed of.86 The highest volume phthalate produced is DEHP (di-ethyl-hexyl-phthalate) which represents between 50 and 90% of DEHP phthalate production.87 In 1993, at least 95% of DEHP produced was used as an additive for PVC plastic.88 Phthalates in general and DEHP in particular are used as a plastic additive, a softener, to produce soft PVC products such as PVC (vinyl) floorings, wall paper, cable coatings, toys, packaging and fashion goods.

Although the phthalate DEHP has to be labeled in the European Union as environmentally hazardous because of its toxic properties and its persistence,89 there are no regulations restricting the use of DEHP, and products containing DEHP are not labeled. Some products, for example, mouldings and sealants, can contain up to 60% of the total weight of plasticiser, making it the single largest part of the product, even more than the PVC itself.90

With phthalates the usual approach of reducing or minimising emissions from the production process does not work. The German EPA stated that: As the greater proportion of emissions is released diffusely from products containing DEHP as a plasticiser, including principally PVC, regulatory measures must be imposed at this point. We are therefore of the opinion that the use of DEHP plasticiser must be considerably restricted.91 No time should be wasted as the current environmental concentrations in compartments with release potential are already so high that they may cause environmental damage. 92

9 PVC alternatives

Taking into account that the annual global PVC production is about 20 million tonnes and about half of the raw PVC is processed to make soft PVC products containing plasticiser, the contribution of PVC to the quantities of hormone disruptors released into the environment is very large. It is also avoidable for the vast majority of uses.

Alternatives to virtually all PVC products exist. The following chart gives an overview of the main substitution materials for the most frequent PVC applications. All of these products are effective substitutes for PVC, however, in some cases, environmental considerations should also be taken into account, for example, with aluminium, which is uses large amounts of energy during raw material processing. It is generally preferable to select natural products such as wood or glass, rather than other chlorine free plastics, except when these are not available. It is important to ensure that wood, for example, is sourced from sustainable forest resources.

PVC Product	Substitution Material
WINDOWS	wood (pine, larch, fir, spruce, beech), chlorine free plastics
FLOORINGS	ceramic tiles, wood, parquetry, linoleum, rubber, stoneware tiles, cork, sisal hemp, terrazzo (Venetian wash), chlorine free plastic (polyolefine)
WALLS	brickwork, pebble dash, wood, gypsum plaster board
WALLPAPER	uncoated paper (made from chlorine free recycled fibres), environmentally sound paints, paper wallpaper with protective coating on acrylate base, ceramic tiles
FACADES, CURTAIN WALLS	plaster, wood
ROLL JOINTS, HAND RAILS	wood, metal
FURNITURE	wood, metal
BLINDS, SHUTTERS	wood, wooden shutters, textile blinds inside, etc.
WEATHER/DRAUGHT STRIPS	natural rubber
SEWAGE PIPES	concrete, earthenware, stoneware, polyethylene and polypropylene pipes
SANITARY INSTALLATIONS	earthenware pipes, stoneware, steel, cast iron, (e.g., pipes, pipe casing) copper pipes, polyethylene and polypropylene pipes
ELECTRICAL INSTALLATIONS & CABLES	chlorine free plastics like PE, special rubber
ROOF SHEETING	polyolefins, bitumen sheeting

PACKAGING	if packaging is necessary, reusable packaging, cardboard, wood; if plastic is necessary, PE, PP
MEDICAL PRODUCTS	change from disposable (usually PVC) to reusable products e.g. redon bottles; reusable scalpel handles, refillable glass bottles; if disposable products are necessary, for example tubings and blood bags, chlorine free plastics like PE gloves, or latex, natural rubber, PE infusion bags, PE bags.
TOYS	Wood, textiles.

10. Phasing out PVC

A large number of communities and states have restricted the use of PVC, showing that it is possible to use alternative materials. In addition, some national Governments have also taken action for a wider ban on PVC.

PVC free Communities

Germany: The first PVC free community was Bielefeld, in1987. Since then, restrictions on PVC have grown and about 200 communities and states now have PVC restrictions in place.

Australia: The Sydney 2,000 Olympics is committed to environmental criteria based on the concept of ecologically sustainable development, including:

OA commitment to minimise the use of PVC. In particular, no PVC to be used in plumbing and drainage pipes or flooring material (vinyl).94

Austria: 6 States and regional capitals, including Vienna, and at least 11 smaller communities have

resolutions to avoid PVC.

Japan: Abiko City and Narasino City assemblies have passed resolutions to reduce the use of PVC. In addition the Chiba prefecture and Nakano congress have also passed similar resolutions.

Luxembourg: The City of Luxembourg authorities avoid PVC, although there is no formal resolution. A PVC free construction working group, with representatives from several Government Ministries, has existed since 1993.

Netherlands: 17 Dutch communities have signed a declaration to avoid PVC, 147 have also stated they will avoid PVC wherever possible; these include Amsterdam, Rotterdam, Utrecht and Den Hague.

Norway: Norway's second biggest town Bergen made a decision in 1991 to phase out PVC.

Sweden: 128 communities in Sweden have agreed to avoid PVC, including Gothenberg.

Denmark: The county of Aarhus have introduced a policy of buying PVC free alternatives for all public purchases.

National commitments

Spain: The Spanish Senate has asked the government to substitute the use of PVC in packaging with other non polluting materials and to make a study on the risks of PVC and the possibilities of a PVC phase out in Spain.

Switzerland: In 1992, the Swiss Government banned the use of PVC mineral water bottles, after a voluntary scheme set up by industry failed. Despite challenges by the PVC industry, the Supreme Court rejected their case and upheld the ban.

Denmark: The Danish Parliament is currently considering a proposal by the Socialist People's Party to phase out PVC by 2000. The Danish Minister, has put forward thoughts along the same lines.

Sweden: In November 1995, the Swedish Parliament voted to phase out both soft and rigid PVC speedily, following a recommendation from the Committee for Agriculture, which stated:

> The Committee's opinion is that it is possible to make an overall assessment of today's PVC in all its parts from chlorine manufacture to waste. It is the Committee's opinion that such an overall assessment shows that PVC cannot be part of an eco-cycle society. Today's plasticised PVC, as well as rigid PVC with environmentally harmful additives, should therefore be phased out. The phase out should begin speedily.

11. What should be done

> *The stakes are so high here that I don't believe we can wait and I can imagine twenty years from now, the grandchild coming to us and saying:*

well, you knew this was going on with animals, why didn't you do anything about it? Can we afford to say well, we were waiting to confirm this state in humans? And I think the answer is no, we shouldn't be waiting, we should be doing something now.

-- Dr Ann Soto, BBC Horizon, 1996.96

As has been demonstrated by progressive countries, industries and communities, it is possible to take steps to address hormone disruption. The first and most immediate step is to phase out PVC plastic, and replace it with readily available alternatives.

- All policy, both national and international must be based on the precautionary principle, which takes action when there are reasonable grounds to suspect that adverse effects may be occurring or may occur.
- Other countries must follow the example of Sweden and begin a PVC phase out.
- Countries around the North Sea, who are already committed to eliminate the emission of all hazardous substances within 25 years under the North Sea Ministers' Conference 1995, should prioritise PVC for phase out.
- The US Environmental Protection Agency, which is currently re-assessing dioxin, should take the lead with an action plan to phase out products which result in dioxin pollution, with the priority on PVC.
- An international instrument which addresses the elimination of Persistent Organic Pollutants D many of which are hormone polluters such as dioxin needs to be negotiated urgently. This process has already begun with the Washington Declaration, which was agreed at a UN Sponsored meeting in November 1995, attended by 100 countries. It identified the need to eliminate Persistent Organic Pollutants, with the priority on 12 dirty dozen chemicals, all of them organochlorines, which include dioxins, PCBs and several pesticides.
- Industry should clearly label PVC to identify what it is to the consumer
- Alternatives should be labeled PVC or chlorine free.
- Consumers, local authorities and retailers should stop buying PVC where they can identify it, and where it is impossible to identify, avoid plastics. The easiest way to identify PVC is by the number 3 in the recycling symbol, however, not all PVC is identified in this way.

12. Appendices

TABLE OF MAJOR EUROPEAN AND US PRODUCERS OF DEHP AND PVC

COMPANY NAME & LOCATION	COUNTRY	CHEMICAL
Auseon Pty. Ltd., Altona, Victoria	Australia	PVC
ICI Australia Operations Pty. Ltd. Rhodes, New South Wales	Australia	DOP
ICI Australia Operations Pty. Ltd Botany, New South Wales.	Australia	PVC
ICI Laverton North, Victoria	Australia	PVC
BASF Antwerpen NV, Antwerpen	Belgium	PVC
LVM NV, Tessenderlo, Limburg	Belgium	PVC
Pantochim S.A., Feluy, Hainaut	Belgium	DEHP
Solvic snc, Jemeppe sur Sambre Namur	Belgium	PVC
UCB-Ftal sa, Oostende West Vlaanderen	Belgium	DEHP
Spolana, Neratovice, Stredocesky	Czech Rep.	PVC
Neste Oy, Chemicals, Porvoo, Uusimaa	Finland	DEHP
Neste Oy, Polystyrene, Porvoo, Uusimaa	Finland	PVC
Elf Atochem SA, Chauny, Aisne	France	DEHP
Elf Atochem SA, - Balan, Ain. - Brignoud, Isere - Saint Auban, Alpes Maritimes - Saint Fons, Rhone	France	PVC
Shell Chimie SA, Berre-l'Etang, Bouches du Rhone	France	PVC
Societe Artesienne de Vinyle SA, Mazingarbe, Pas de Calais	France	PVC

Solvay SA, Tavaux, Jura	France	PVC
BASF Aktiengesellschaft Ludwigshafen, Rheinland -Pfalz	Germany	DEHP, PVC
BUNA GmbH, Schkopau, Sachsen-Anhalt	Germany	DEHP, PVC
EVC (Deutschland) GmbH, Wilhelmshaven, Niedersachsen	Germany	PVC
Hoechst Aktiengesellschaft, Frankfurt am Main, Hessen Oberhausen, Nordhein-Westfalen	Germany	DEHP
Huels Aktiengesellschaft, Marl Nordhein-Westfalen	Germany	DEHP,PVC
Solvay Kunststoffe Gmbh, Rheinberg Nordrhein-Westfalen	Germany	PVC
Vinnolit Kunststoff Gmbh, - Burghausen, Bayern - Burgkirchen, Bayern - Hurth, Nordhein-Westfalen - Koln, Nordrhein Westfalen	Germany	PVC
EKO-Hellenic Refineries and Chemicals of Macedonia Industrial and Commercial Company AE Thessaloniki	Greece	PVC
Borsodchem Rt, Kazincbarcika, Borsod-Abauj-Zemplen	Hungary	PVC

EVC (Italia) SpA, - Brindisi, Puglia - Porto Marghera, Veneto - Porto Torres, Sardegna - Ravenna, Emilia-Romagna	Italy	PVC
Industrie Generali SpA, Samarate Lombardia	Italy	DEHP,PVC
Lonza SpA, San Giovanni Valdarno, Toscana	Italy	DEHP
Solvay SA, Ferrara, Emilia-Romagna	Italy	PVC
Societa Italiana Serie Acetica Sintetica SpA, Pioltello, Lombardia	Italy	DEHP
Asahi Glass Company Ltd	Japan	PVC
Central Chemical Company Ltd,		
Kawasaki, Kanagawa	Japan	PVC
Chisso Corporation, Minamata, Kumamoto Mizushima, Okayama	Japan	PVC
Chisso Petrochemical Corporation, Ichihara, Chiba	Japan	DEHP, PVC
Denki Kagaku Kogyo K.K., Ichihara, Chiba	Japan	PVC
Japan PVC Ltd, Senboku, Osaka	Japan	PVC
Kaneka Corporation, Kashima, Ibaraki, Settsu, Osaka	Japan	PVC

Takasago, Hyogo		
Kawasaki Organic Chemical Co., Ltd, Kawasaki, Kanagawa	Japan	PVC
Kureha Chemical Industry Co., Ltd, Iwaki, Fukushima	Japan	PVC
Kyowa Yuka Company Ltd, Yokkaichi, Mie	Japan	DEHP
Mitsubishi Gas Chemical Company Inc. Misushima, Kurashiki, Okayama	Japan	DEHP
Mitsubishi Kasei Vinyl Company, Kurashiki, Okayama Yokkaichi, Mie	Japan	PVC
Nippon Zeon Company, Ltd, Misushima, Kurashiki, Okayama, Takaoka, Toyama	Japan	PVC
Shin-Etsu Chemical Company, Ltd. Kashima, Ibaraki	Japan	PVC
Sumitomo Chemical Company, Ltd, Ichihara, Chiba Nihama, Ehime	Japan	PVC
Sun Arrow Chemical Company, Ltd, Tokuyama, Yamaguchi	Japan	PVC
Toagosei Chemical Industry Co., Ltd, Tokushima, Tokushima	Japan	PVC
Toho Rika Kogyo K.K. Nagoya, Aichi	Japan	DEHP

Tokuyama Sekisui Co., Ltd, Shin-Nanyo, Yamaguchi	Japan	PVC
Tosoh Corporation, Shin Nanyo, Yamaguchi	Japan	PVC
DSM Resins Benelux BV, Hoek van Holland, Zuid Holland	Netherlands	DEHP
LVM Limburg BV, Beek-Geleen, Limburg	Netherlands	PVC
ROVIN vof, Rotterdam-Pernis, Zuid Holland	Netherlands	PVC
Norsk Hydro a.s., Petrochemicals Division, Heroya, Telemark	Norway	PVC
Zaklady Azotowe Kedzierzyn SA Kedzierzyn-Kozle, Opole	Poland	DEHP
Zaklady Tworzyw Sztucznych Boryszew D Erg, Warszawa	Poland	DEHP
Zaklady Azotowe Wloclawek,Wtoctawek	Poland	PVC
Zaklady Azotowe W Tarnowie- Moscicach SA, Tarnow	Poland	PVC
Zaklady Chemiczne Oswiecim, Bielsko- Biata	Poland	PVC
Companhia Industrial de Resinas Sinteticas, CIRES SA, Estarreja, Aveiro	Portugal	PVC
GDP, Lisboa	Portugal	DEHP
Chemicke Zavody Novacke sp, Novaky, Stredosovensky	Slovak Rep.	PVC
Aiscondel, SA, - Monzon del Rio Cinca,Huesca - Vilaseca, Tarragona	Spain	PVC
BASF Espanola SA, Tarragona	Spain	DEHP

Compania Espanola de Petroleos, SA, Luchana-Baracaldo, Vizcaya	Spain	DEHP
Elf Atochem Espana SA, - Hernani, Guipuzcoa - Miranda de Ebro, Burgos	Spain	PVC
Hispavic Industrial SA, (owned by Solvay) Martorell, Barcelona	Spain	PVC
Hydro Plast AB, Stenungsund, Goteborg-Bohus	Sweden	PVC
Neste Oxo AB, Stenungsund, Gotegorg-Bohus	Sweden	DEHP
European Vinyls Corporation (Switzerland) AG, Sins, Aargau	Switzerland	PVC
BP Chemicals Ltd, Hull, Humberside	UK	DEHP
European Vinyls Corporation (UK) Ltd, - Barry, South Glamorgan, Wales - Fleetwood, Lancashire - Runcorn, Cheshire	UK	PVC
Hydro Polymers Ltd, Newton Aycliffe, Durham	UK	PVC
Aristech Chemical Corporation, Chemicals Division, Neville Island Pennsylvania	USA	DEHP
BASF Corporation, South Kearney New Jersey	USA	DEHP
Borden Chemicals and Plastics Operating Limited Partnership, - Geismar, Louisiana - Illiopolis, Illinois	USA	PVC
Certain Teed Coproration, Lake Charles, Louisiana	USA	PVC

Eastman Chemical Company, Tennessee Eastman Division, Kingsport Tennessee	USA	DEHP
Formosa Plastics Corporation, - Baton Rouge, Louisiana - Delaware City, Delaware - Point Comfort, Texas	USA	PVC
The Geon Company, - Deer Park, Texas - Henry Illinois - Louisville Kentucky - Pedricktown, New Jersey	USA	PVC
Georgia Gulf Corporation, Delaware City, Delaware Plaquemine, Louisiana	USA	PVC
The Goodyear Tire and Rubber Company Chemical Division, Niagara Falls, New York	USA	PVC
Hatco Chemical Company, Fords, New Jersey	USA	DEHP
Huls America Inc, Chestertown, Maryland	USA	DEHP
Keysor-Century Corporation, Santa Clarita, California	USA	PVC

Occidental Chemical Corporation, Polymers and Plastics, Vinyls Division, - Addis, Louisiana - Burlington, New Jersey - Pasadena, Texas - Pottstown, Pennsylvania	USA	PVC
Shintech Incorporated, Freeport, Texas	USA	PVC
Teknor Apex Company, - Brownsville, Texas - Hebronville, Massachusetts	USA	DEHP
Union Carbide Corporation Solvents and Intermediates, Texas City, Texas	USA	PVC
Vista Chemical Company, Olefins & Vinyl Division, Aberdeen, Mississippi Oklahoma City, Oklahoma	USA	PVC
Westlake PVC Corporation, - Calvert City, Kentucky - Pace, Florida	USA	PVC

Source: SRI International, 1995 Directory of Chemical Producers, Europe, and United States.,

Source: US Department of Health and Human Services, Toxicological Profile for DEHP, April 1993.

US VCM and EDC Manufacturers

Borden Chemicals and Plastics Geismar, LA	USA	EDC, VCM
Dow Chemicals USA, Freeport, TX and Oyster Creek, TX	USA	EDC, VCM
Dow Chemicals USA, Plaquemine, LA	USA	EDC, VCM
Formosa Plastics Corp Baton Rouge, LA	USA	EDC, VCM
Formosa Plastics Corp. Point Comfort, TX	USA	EDC, VCM
Geon Vinyl (BFGoodrich) La Porte, TX	USA	EDC, VCM
Georgia Gulf Corp. Plaquemine, LA	USA	EDC, VCM
Occidental Chemical Corp. Convent, LA	USA	EDC
Occidental Chemical Corp. Deer park, TX	USA	EDC, VCM
Oxymar, Ingleside, TX	USA	EDC, VCM
PPG Industries Inc.	USA	EDC, VCM

Lake Charles, LA		
Vista Chemical Company Lake Charles, LA	USA	EDC, VCM
Vulcan Chemicals Geismar, LA	USA	EDC
Westlake Monomers Corp. Calvert City, KY	USA	EDC, VCM

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14. Notes

1 Guillette et al. ,1994

2 Jobling et al, 1995

3 Fox, 1992, Geisy et. al., 1994

4 e.g. Carlsen et al. 1992, Auger et al, 1995

5 Giwercman and Skakkebaek, 1992

6 Harris et al., 1992

7 Danish EPA, 1995

8 e.g. Jacobson et al, 1985, Ando et al., 1986, Kanja et al, 1992, Koopman-Esseboom et al., 1994

9 South West Environmental Protection Agency, 1995

10 Hall, 1992

11 US EPA, 1994

12 Colborn et. al, 1996, p. 212

13 Danish EPA, 1995, unless otherwise noted

14 Danish EPA, 1995

15 US Dept. of Health and Human Services, DEHP, 1993

16 Danish Technological Institute, 1996

17 German EPA, 1994

18 Modern Plastics, 1995

19 European Chemical News, 1996

20 Danish EPA, 1995

21 Swedish Parliamentary Standing Committee on Agriculture, 1995

22 Swedish Environment Minister Anna Lindh, November 1995

23 Sharpe et al, 1995

24 Colborn and Clement, 1992

25 Dr John Sumpter, of Brunel University, quoted in New Scientist, 1995

26 Kelce et al., 1995

27 Colborn et al., 1996

28 Carlsen et al., 1992, Auger et al., 1995, Irvine et al., 1996

29 Auger et al., 1995

30 Sharpe & Skakkabaek 1993, Auger et al., 1995, Irvine et al. 1996

31 see e.g. Sharpe & Skakkabaek, 1993

32 Arbeitsgemeinschaft PVC und Umwelt e.V., 1996

33 Auger et al. ,1995, Irvine et al., 1996

34 Mably et al., 1992c

35 Sharpe et al., 1995

36 Arbeitsgemeinschaft PVC und Umwelt e.V., 1996

37 Augur et al., 1995

38 Mably et al., 1992c, Sharpe et al., 1995

39 Colborn and Clement, 1992

40 Evers, 1989, Fluthwedel & Pohle, 1993

41 Jobling et al, 1995

42 Danish Technological Institute, 1996

43 Danish Technological Institute, 1996

44 Dow Chemical Company, 1981, Goldman, L., 1994

45 Egeland et al., 1994

46 Mably et al., 1991, Mably et al., 1992a

47 Mably et al., 1991, Mably et al., 1992c

48 Mably et al., 1991, Peterson et al., 1992, Mably et al., 1992b

49 Mably et al., 1991, Peterson et al., (1992)

50 Gray et al., 1995, Peterson et al., 1992, Mably et al., 1992a,b&c

51 Porterfield, 1994

52 Pluim et al., 1992, 1993

53 Porterfield, 1994

54 Iwata et al, 1993

55 Rappe, 1992, Henry et al, 1992

56 Allsopp et al., 1995

57 Evers, 1989

58 ICI, 1994

59 ICI, 1994

60 Stringer et al., 1995

61 Wenning et al., 1992

62 Fortuna, Judge, 1995

63 Environmental Ministry of Lower Saxony, 1994

64 Fluthwedel & Pohle, 1993

65 State Committee for Emission Protection, 1993

66 Wilken, 1994

67 German EPA press release, 1994

68 Angrick & Batz, 1994, U.Lahl, personal communication, 1993

69 Riss, A, 1990

70 Bokerman, 1994

71 Wagner et al, 1993, Danish Technological Institute, 1996

72 US EPA, 1994b

73 see e.g. Meek & Chan, 1994a,b&c

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