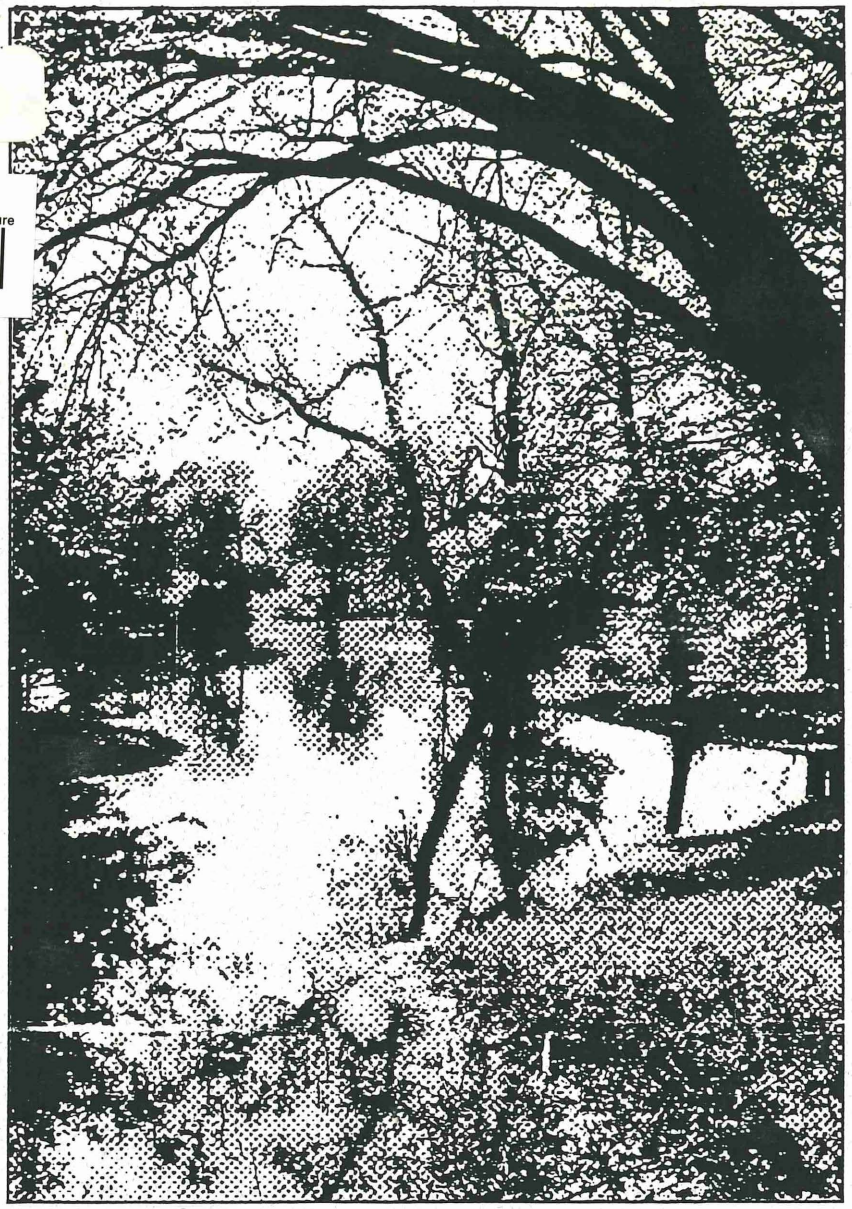

# Toxics in Specified Products

## A Progress Report to the Minnesota Legislature

Minnesota Pollution Control Agency

February 1997



Minn. Stat. 115A.9651 Subd. 2 ;
1994 Minn. Laws Chap. 585 Sec. 30

# PROGRESS REPORT TO THE LEGISLATURE ON



# MINN. STAT. § 115A.9651 TOXICS IN SPECIFIED PRODUCTS

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*This report can be made available in other formats such as Braille, large type or audiotape, upon request.*

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# Executive Summary

Minnesota Statute § 115A.9651, Toxics in Specified Products, (herein after referred to as the Toxics statute), prohibits any intentional introduction, and the incidental presence, over one hundred parts per million (ppm) of lead, mercury, cadmium, and hexavalent chromium in inks, dyes, paints, pigments and fungicides after July 1,1998. An exemption process is set out for companies which could not comply by the original implementation date of September 1, 1994. The Toxics statute also requires the Minnesota Pollution Control Agency (MPCA) to report to the legislature in 1996, on the progress made by all the companies which were granted an exemption in 1994.

## Legislative History

The Toxics statute was originally passed in 1991, the same year as the Prohibition of Selected Toxics in Packaging statute. In 1993, 'inks' and 'pigments' were added to the list of regulated products. In addition, several specific exemptions were granted for uses by local companies which were actively working towards finding substitutes, but which would not be able to meet the 1994 deadline. By 1994, more companies were coming forward requesting exemptions, at which point the Toxics statute was amended to provide for a temporary exemption process for any manufacturer who could not meet the upcoming deadline.

Six Minnesota users of the listed products submitted an exemption request, on behalf of the manufacturer, for the products they use. Seventy-nine individual manufacturing companies applied for exemptions, three trade associations applied on behalf of some of their members, (an additional 15 manufacturers), for a total of 94. Of the manufacturers, seven were located in Minnesota and 87 were from the rest of the United States and Canada. Currently, the list of exempted companies stands at 82. (See Appendix 2 for a complete list of exempted companies.)

## Connection With the CONEG Model Packaging Legislation

The connection between the Toxics in Products statute and the Toxics in Packaging statute is important. The Toxics in Packaging statute was based on model legislation developed by the Coalition of Northeastern Governors (CONEG), and has now been adopted by 18 states. There are a number of important similarities between the Toxics in Products statute and the Toxics in Packaging statute, as well as some key differences.

## Toxicity of the Regulated Metals

(Unless otherwise noted, all of the information below is taken from the United States Department of Health and Human Services Toxicological Reports for each of the metals.)

### *Mercury*

Mercury is an elemental metal that occurs naturally in several forms and can combine with other elements such as sulfur, chlorine and oxygen to form inorganic compounds or salts. Studies indicate that 75 percent of the mercury in atmospheric deposition is from human sources (Swain,

et. al., 1992). Mercury is similar to other metals in that it is persistent in the environment and is not destroyed by combustion or bacterial degradation. Inorganic mercury is used for things like thermometers, electric switches and pigments. This form of mercury can easily exist as a vapor and can be inhaled, where it is quickly absorbed into the blood and affects a variety of internal organs. Organic mercury (methylmercury) is similar to other organic compounds, in that it bioaccumulates through food chains and can vaporize under normal atmospheric conditions (Swain, 1994). It was once used as an anti-fungal agent on seed grains. Methylmercury primarily affects the central nervous system. "All three forms of mercury, elemental, methyl, and oxidized, can be converted to each other and back again. Therefore, it is essential to restrict the release of all forms of mercury" (Swain, 1994).

***Cadmium***

Cadmium is an element that occurs naturally in the earth's crust, but most of the cadmium found in the environment is the result of human activities. Most cadmium used worldwide is a byproduct of refining other metals such as zinc, lead, or copper. Cadmium is used mainly in batteries, pigments, metal coatings, and plastic (U.S. EPA, 1986). Cadmium does not break down in environment, but it can change forms, some of which dissolve in water. Dissolved cadmium can bioaccumulate up the food chain, so ingestion is a common route of exposure.

The U. S. Environmental Protection Agency (EPA) has classified cadmium as a probable human carcinogen by inhalation based on animal and human data.

***Lead***

Lead is a naturally occurring metal found in the earth's crust. However, most of the lead dispersed throughout the environment comes from human activity. There is no beneficial purpose for lead in the human body. The largest use of lead is in the production of some types of batteries. It is also used in ammunition, ceramic glazes, and medical, scientific and military equipment.

For the general population, most exposure results from eating foods with lead in them, or from leaded paint. Lead can be found in a variety of foods including produce, meats, grains, seafood, soft drinks and wine. Estimates of blood-lead levels for children under five years old indicated that nearly nine percent, or approximately two million children have blood-lead levels of ten micrograms/deciliter or higher, which the Center for Disease Control considers to be the level indicating lead poisoning. A large body of literature clearly indicates that high levels of lead cause adverse effects on both male and female human reproductive functions. Lead is a teratogen that can cause fetal malformation, a mutagen that can affect both sperm and eggs, and a reproductive toxin that can impair fertility.

***Hexavalent Chromium***

Chromium is a natural element found in rocks, animals, plants, and soil. Chromium can take several different chemical forms or valent states; chromium, trivalent chromium or hexavalent chromium. Trivalent chromium occurs naturally, and in small amounts is an essential nutrient for humans. Hexavalent chromium is very toxic and is used in chrome plating, in manufacturing dyes and pigments, leather tanning and wood preserving.

For the general population, the most common route of exposure is by eating foods containing hexavalent chromium. Exposure through inhalation can occur for those in occupations such as chromate pigment production and chrome plating. The Department of Health and Human Services and the International Agency for Research on Cancer has determined that some hexavalent chromium compounds are carcinogenic in humans.

**Effects on the Endocrine System**

Over the last fifteen to twenty years, a growing body of research has uncovered the effects of a number of chemicals on the immune, endocrine and reproductive systems of animals and humans. Frequently referred to as endocrine disrupters or hormone mimics, these chemicals mimic the effects of naturally produced hormones in the body and disrupt or interfere with normal development of the nervous, immune, endocrine, or reproductive systems.

In addition, early in-vitro exposure to these hormone copy-cats may confuse or inhibit the development of a male fetus. Studies in Europe show an increase in the incidence of undescended testicles in newborn males and an increased rate of testicular cancer in young men. Analysis of data from studies of over 14,900 men also indicates a drop in sperm density and number. The connection between the research being conducted on endocrine disrupters and the Toxics in Products statute is that lead, cadmium and mercury are on the list of suspected endocrine disrupters.

**Pollution Prevention**

One of the most important aspects of the Toxics statute (and the Packaging statute) is the strong pollution prevention requirements written into the law. Unlike disposal bans, and traditional regulatory controls which set contamination and leaching levels, this Toxics statute moves the regulatory focus upstream to the manufacturers who have control of the formulation of the regulated products. This is a much different approach than trying to control or remediate the fate of the metals at the disposal "end-of-the-pipe." Our experience with end-of-the-pipe control has proven that the costs to the state, counties, and ultimately the tax payer of the end-of-the-pipe approach, are always tremendous.

**Fate of the Four Regulated Metals in the Solid Waste Management System**

More than half of solid waste, including demolition, construction and industrial waste, generated in Minnesota is landfilled. Two of the byproducts of landfilling are leachate and gas. Leachate is produced as water from rain or melted snow percolates through the waste. It contains particles, metals and chemicals which are picked up from the waste. In some communities disposal of the leachate is expensive and difficult because of the metals it contains. Landfill gas is generated as materials decompose. The constituents of the waste determine the composition of the gas. Mercury because it volatilizes at low temperatures has been detected in landfill gas.

The municipal solid waste (MSW) compost facilities in Minnesota have, at times, had difficulty selling or even giving away the finished compost. Sometimes this has been because of operational difficulties, but frequently the problem has been that the level of the regulated metals has pushed the compost into the restricted use, Class II classification. The contamination of the compost by heavy metals has been costly for facility operators.

Incineration of MSW raises different issues. Metals which become part of the matrix of the materials they are used in, and which under normal landfill conditions might not leach in a landfill, may be released to the environment when burned in an incinerator. Of the products effected by the Toxics statute, this is particularly true with plastics. Heavy metals cannot be destroyed in an incinerator. They must exit or accumulate within the unit. Most of the metals will remain in the bottom ash, a portion become gases and exit with the flue gases. The metals may attach themselves to the particulate matter in the flue gases and some will be captured in the flue gas cleaning equipment (Jackson, 1993). Control of mercury during incineration is particularly difficult. The most effective pollution control equipment can remove at least 85 percent of mercury in the flue gas, and at some facilities can remove greater than 95 percent of the flue gas mercury.

**Business Innovation**

It is possible to look at the Toxics statute from a different angle, other than what the Toxics statute prohibits and how it seeks to protect human health and the environment. There are those studying and writing in the area of business theory who argue that the right kind of environmental or safety regulation can stimulate innovation, and compliant companies become early-movers on potential markets elsewhere. These regulations should focus on outcomes not technologies, and thus can provide outside pressure to overcome organizational inertia and foster creative thinking (Porter and Van der Lind, 1995).

**Flaws in the Current Legislation**

One of the major flaws in the legislation as it is written is that in many cases it only regulates the ingredients in a manufacturing process, not the final product. This leads to a loophole, in that the products containing the regulated metals can be made elsewhere and shipped in-state. In some cases, consumer goods which contain the regulated metals eventually end up in the waste stream and nothing has been gained in terms of toxicity reduction. Because Minnesota is currently the only state with an eventual ban on the use of these metal-containing products, the state becomes an island. This provides an incentive for some companies to move to other nearby states. Finally, the Toxics statute regulates just part of the total use of the four metals. The law also ignores the other heavy metals. While the four metals regulated by the Toxics statute were chosen because of the tremendous body of research which has been done on them and their effect, the negative effects of other heavy metals, like arsenic for example, are also well known.

## Information Gathered From the 1996 Progress Reports

Subdivision 2 (e) of the Toxics statute requires each manufacturer which has been granted an exemption, to report by July 1, 1996, on progress made toward compliance. To facilitate reporting, a questionnaire was sent to all the manufacturers and Minnesota users who had applied for an exemption (see Appendix 6). The manufacturers were also required to report the date compliance was, or is anticipated to be, achieved and how compliance was achieved. If compliance can not be achieved by July 1, 1998, the questionnaire asked for a technical explanation of why not, whether compliance could be achieved with more time and whether there were any health or safety factors which should be considered. A data base was developed including the information from the original exemption request and the subsequent progress report.

### Summary of Information Obtained

A total of approximately 1,995 products were reported on, either individually or as product lines. In some cases, a company was represented in the data base on a single line, but the single entry represented dozens or even hundreds of products. As the data was entered into the data base, each product was assigned to one of the statutory categories. It is important to note that in some cases the distinction between these product categories was not clear and assigning them to a category was somewhat arbitrary.

**Figure 3: Number of products in each of the regulated categories**

Statutory Category

| I | D | P | Pm | F |
|---|---|---|---|---|
| *Inks* | *Dyes* | *Paints* | *Pigments* | *Fungicides* |
| 124 | 1 | 939 | 930 | 1 |

The exempted products or product lines were analyzed for metal use. The table below shows the number of times use of the metal was cited. Over half of the products contain more than one of the regulated metals.

**Figure 4: Regulated Metal Used**

| Pb | Cd | Hg | Pb/Cr | Hex/Cr |
|---|---|---|---|---|
| *Lead* | *Cadmium* | *Mercury* | *Lead Chromate* | *Hex/Chromium* |
| 1,123 | 719 | 187 | 458 | 1,007 |

***Compliance status***

The companies reported on the compliance status of each of the exempted products or product lines. If it seemed doubtful that a product would be in compliance by July 1, 1998, the product was assigned to the "No" category. If the product would be in compliance only by the cease of sale of the product in Minnesota, the product was assigned to the "No" category.

**Figure 5: Number of Products or Product Lines in Compliance**

| Yes | Will Be | No | Uncertain |
|---|---|---|---|
| 405 | 205 | 1,382 | 3 |

## Optional Questions

The optional questions asked about involvement in International Standards Organization (ISO) 14000, and about other pollution prevention activities the company had undertaken. ISO 14000 is a set of environmental management standards developed by the ISO. Twenty-three companies said they were not considering it, 21 indicated they were considering it, two were actively pursuing certification, and one company felt confident that they would achieve certification in 1997. Twenty-seven companies indicated that they were involved in other pollution prevention activities.

A number of companies responded to the questions on direct and indirect costs of compliance with the Toxics statute. The information provided was stated only in general terms and indicated that there had been additional costs associated with compliance with the Toxics statute. Fewer companies responded to the question about direct and indirect savings. Again it seemed that few companies broke out costs and savings in terms of reduction of the use of heavy metals. Of the companies that replied to the question about the differences between federal standards and the Toxics statute, most said the Minnesota Toxics statute was more stringent.

## Environmental Outcome

In one of the optional questions, companies were asked to attempt to quantify the amount of metals avoided for those exempted products which were in compliance with the Toxics statute in 1995. The purpose of this question was to attempt to quantify the environmental benefits of the Toxics statute for a one year time period. Most of the companies could not answer that question with specific numbers, twelve companies gave an estimate. Of the twelve companies which gave an estimate, a range of approximately 44,812 to 56,850 pounds of heavy metals were avoided in 1995. In addition, MPCA staff, with the assistance of Minnesota Department of Transportation (MNDOT) staff estimated that an additional 111,690 pounds of lead and 28,058 pounds of chromium were avoided in 1995 by using non-metal containing highway striping paint on Minnesota roads. **The total amount of metals avoided due to the Toxics statute is 184,560 to 196,598 pounds in 1995.**

## Areas Where Compliance Seems Technically Unlikely By 1998

The most often cited reasons for non-compliance with the Toxics statute was that even after years of research there is still no alternative. In other cases there are substitutes but they are inferior in performance or are much more expensive, or both. Use of one of the regulated metals is sometimes required by military specification. In general, there has been movement away from use of lead and hexavalent chromium by the Department of Defense in their materials specifications and several have been changed in the last two years.

In similar applications, commercial airlines frequently use military aviation, or similar specifications for manufacture and maintenance of their planes. Again, the tolerance for corrosion is at or near zero. In this situation, there may be safety considerations that may outweigh the environmental concerns. From all the information gathered by MPCA staff, there does not appear to be substitutes in this area of corrosion protection which have the same anti-corrosive characteristics.

The plastics industry is another area where, in total, compliance seems unlikely by July 1, 1998. What was evident from the progress reports was that the uses of heavy metal-containing pigments in plastics industry were widespread and that the requirements of the industry are hugely varied. Cadmium is used to produce bright yellow, orange, red, and maroon colors. As a pigment it has good opacity and is very color-fast. Lead, usually in the form of lead chromate, is used as a pigment as well. The substitutes, in some applications, are not considered as durable and some of the colors cannot be matched.

Lead and cadmium are used as colorants in glass and ceramic glazes. Also, because of the high firing temperatures of glass and ceramics, lead is used in the glaze so that the glaze expands at the same rate as the substrate it is applied to. According to local ceramic decorators and members of the Glass and Ceramic Decorators trade association, achieving a true red color is not possible without the use of lead. One cosmetics company believes they have developed a substitute process for applying decoration to glass and ceramics using ultraviolet light rather than heat curing. They believe their process offers a full color palette.

## Future Implementation of the Toxics Statute

In analyzing the information submitted by the companies with exemptions, the exempted products generally fell into one of the three categories listed below:

**A) P2 Now:** This category consists of those who should be in compliance by July 1, 1998. Included in this group are those who are currently in compliance or have indicated they will be by July 1, 1998. Those manufacturers and users in this category are self-selected; their progress reports certify they will be in compliance by July 1,1998. The products in this category should, in our view, comply with the current deadline of 1998.

**B) Needs More Time to Come Into Compliance:** This category consists of those who are still actively seeking alternatives but will not be able to make the July 1,1998, deadline. Some companies have informed MPCA staff that they need more time, sometimes significantly more time in order to comply. They are honestly, actively, working on substitutes, but are very unlikely to have one by July 1, 1998. Placement in the second group was based again, on self-selection.

**C) Should be exempted from the Toxics statute:** The products in this category are those for which the MPCA believes there are overriding health or safety considerations, or use of one of the regulated metals is currently required by military specifications and there are no substitutes. In addition, it is unlikely that the items these primers or paints are used on, would end up in the solid waste stream. These are the following:

The MPCA was charged with submitting a list of all those who sought an exemption along with copies of the exemption requests. In addition, MPCA staff reported to the Legislative Commission on Waste Management on November 21, 1994, and at that time submitted a short interim report, with an update in October, 1995.

Six Minnesota users of the listed products submitted an exemption request, on behalf of the manufacturer, for the products they use. Seventy-nine individual manufacturing companies applied for exemptions, three trade associations applied on behalf of some of their members, (an additional 15 manufacturers), for a total of 94. Of the manufacturers, 7 were located in Minnesota and 87 were from the rest of the United States and Canada.

Since 1994, the MPCA determined that three of those companies manufacture products that fall outside the Toxics statute, specifically, art supplies and lubricants. Several manufacturers applied for an exemption just to be sure they were covered, then determined they really did not need it. Seven of the manufacturers on the original list have since merged, so the list of exempted companies now stands at 82. (See Appendix 2 for a complete list of currently exempted companies.)

In the two years since the 1994 deadline for exemptions, the MPCA has had requests from several exempted companies for exemptions for new products which have been created since September 1, 1994. One of those was a replacement for an exempted product. Under the statute a user may get an exemption for a product after the September 1, 1994, deadline if the replacement product has "significantly less: of the listed metals. No new products which were not replacements have been granted exemptions. Expanding the number of exempted products was deemed contrary to the intent of the Toxics statute.

*The following states have enacted "toxics in packaging" statutes: Connecticut, Florida, Georgia, Iowa, Illinois, Maine, Maryland, Minnesota, Missouri, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, Washington, and Wisconsin.*

**Connection With the CONEG Model Packaging Legislation**

The connection between the Toxics in Products statute and the Toxics in Packaging statute is important. The Toxics in Packaging statute was based on model legislation developed by the Coalition of Northeastern Governors (CONEG), and has now been adopted by 18 states. There are a number of important similarities between the Toxics in Products statute and the Toxics in Packaging statute, as well as some key differences.

One obvious similarity is that both statutes regulate the same four heavy metals. These metals were chosen by consensus, from among all the heavy metals, by a group consisting of corporations, industry representatives, scientists, environmental groups and government representatives who developed the original model legislation. (See Appendix 3 for a list of participants.) Lead, mercury, cadmium and hexavalent chromium were chosen because of their extreme toxicity

and because there is a huge amount of data on these metals. The overall human health and environmental effects are clear.

The Toxics in Products statute sets the same 100 ppm level as is in the Toxics in Packaging statute for the incidental presence of these metals when they have not been intentionally added. It is important to note that the level for the incidental presence of those metals is not set at zero. The 100 ppm level was chosen based on research done by the National Product Safety Commission and the National Academy of Science in the mid-seventies. The 100 ppm level as a background level was generally agreed to be realistic and achievable by the industries and citizen groups working on the packaging legislation.

Both statutes forbid the intentional introduction of the four heavy metals. These statutes take a different approach from many other laws and many of the regulations at the federal level. Both statutes regulate the heavy metal content of a product, not the amount that leaches out or the environmental fate of the metals after disposal of the product.

There is one important difference between the Toxics in Packaging legislation and the Toxics in Products legislation. The difference is in WHAT is regulated and WHERE in the chain from creation to consumer use, the product is. The packaging statute regulates the contents of an end product, packaging, whether used by the consumer or by the grocer, as in the case of transport packaging. But packaging would not be used as a manufacturing element of something else. The Toxics in Products statute has a broader scope. Some of the products regulated are consumer products, (car touch-up paint, sign paints, and farm equipment paint). Many are used in industrial settings by what might be considered industrial consumers, (highway striping paint, architectural panel paint, outdoor sign paints, and primers for commercial aircraft).

In addition, some items regulated under the Toxics in Products statute are inputs in a manufacturing process. A product may not be regulated under the Toxics in Products statute if it is used as an ingredient in a manufacturing process outside the state. Therefore, an item containing one of the regulated products could be manufactured elsewhere and used or sold in Minnesota. Examples include pigments used to color all manner of plastic items, as well as ceramic and glass housewares, and colorants for vinyl. Copper chromated arsenic (CCA) treated wood, electric signs, some building parts, and electronic component markers are also included in this category.

The similarities between the Toxics in Products statute and the Toxics in Packaging statute in terms of the metals regulated and the level of the incidental presence are important when looking at the question of how the products statute is designed to protect human health and the environment. Both statutes seek to eliminate the use of the four heavy metals in the products themselves. That is,

*Minnesota has pioneered the reduction of some of these toxic materials, but industry-wide the call for safer, more environmentally friendly products has driven the advancement of coatings which meet those criteria, no matter what your location.*

*We believe that our continued effort to reformulate to reduce toxic materials from its products, and eventually the environment, has made us a leader in product safety and environmental compliance.*

***A Paint Manufacturer***

reduce the total use of the metals. This affects the disposal system and the factories where the metals are used. The section below provides basic information on the four heavy metals, most common routes of exposure, their toxicity, and effect on human health that influenced the decision to regulate inputs into a product rather than emissions from these products.

## Toxicity of the Regulated Metals

(Unless otherwise noted, all of the information below is taken from the United States Department of Health and Human Services Toxicological Reports for each of the metals).

*While we have ample proof from our excellent health, safety, and environmental records that these materials are not acute hazards and that they can be properly managed to reduce or eliminate toxic effects, we have set a course to eliminate their use in our products. We view it as appropriate risk reduction.*

*Ultimate compliance with the Minnesota statute will assure financial, regulatory, and liability relief. It will also assure we have met our own business goals as responsible manufacturers. Since we have been working for a number of years to develop the needed products, we believe we have a strong competitive position in Minnesota.*

***A Paint and Pigment Manufacturer***

***Mercury***

Mercury is an elemental metal that occurs naturally in several forms and can combine with other elements such as sulfur, chlorine and oxygen to form inorganic compounds or salts. Studies indicate that 75 percent of the mercury in atmospheric deposition is from human sources (Swain, et al. 1992). Appendix 4 shows the relative contribution of mercury to the environment by various mercury-containing products.

Mercury is similar to other metals in that it is persistent in the environment and is not destroyed by combustion or bacterial degradation. Inorganic mercury is used for things like thermometers, electric switches and pigments. Organic mercury (methylmercury) is similar to other organic compounds, in that it bioaccumulates through food chains and can vaporize under normal atmospheric conditions (Swain, 1994). Methylmercury is the only form of mercury which bioaccumulates, can be produced by microorganisms or by chemical reactions in the environment. It was once used as an anti-fungal agent on seed grains. Phenyl mercury, another form of organic mercury, was used as an anti-fungal agent on golf courses and in paints until about 1991.

Taken together, these organic/inorganic characteristics mean that mercury is a mobile but persistent toxic. "All three forms of mercury, elemental, methyl, and oxidized, can be converted to each other and back again. Therefore, it is essential to restrict the release of all forms of mercury" (Swain, 1994).

Exposure

Mercury enters the body through inhalation, as in the case of metallic mercury vapor, or by ingestion, as in the case of methylmercury. Metallic mercury does not bioaccumulate. Only very low levels of ingested mercury salts are absorbed by the digestive system and transported to the brain. For most people, exposure to methylmercury occurs when contaminated fish is eaten. In addition, fish-consuming wildlife like loons, otters, eagles, osprey, mink, and kingfishers are also exposed. Elevated levels of mercury have been documented in Minnesota's loon,

mink, and otter population (Ensor et. al., 1992, 1993). While humans can be warned to reduce their fish intake to reduce exposure, wildlife cannot.

Toxicological Effect

Methylmercury primarily affects the central nervous system. Human deaths due to ingestion of methylmercury are usually the result of accidental consumption of contaminated grain. The most well known case of mercury poisoning occurred around Minamata Bay in Japan, in the 1950's when hundreds of people were poisoned by eating mercury-contaminated shell fish. It is very difficult to determine the actual dose in these situations. Adults are not as sensitive to the affects of methylmercury as fetuses are. A developing fetus is approximately four times as sensitive to the neurotoxic effects as an adult. Data collected from humans exposed to methylmercury reveal kidney damage, gastrointestinal damage, and cardiovascular changes. Studies of laboratory animals suggest that the male reproductive system is affected at fairly low levels. (One milligram mercury per kilogram per day.)

Metallic mercury can easily exist as a vapor and can be inhaled, where it is quickly absorbed into the blood and affects a variety of internal organs. Most of what we know about exposure to this form of mercury is from occupational studies. At low levels of exposure the central nervous system and the kidneys are affected. At higher levels of exposure renal toxicity has been recorded. An increase in the rate of spontaneous abortions have been reported when the father is exposed prior to pregnancy or the mother is exposed during pregnancy.

***Cadmium***

Cadmium is an element that occurs naturally in the earth's crust. Most of the cadmium found in the environment is the result of human activities. In its natural state, it is usually found as a mineral combined with other elements as cadmium oxides, cadmium chloride, or cadmium sulfide. Most cadmium used worldwide is a byproduct of refining other metals such as zinc, lead, or copper. Cadmium is used mainly in batteries, pigments, metal coatings, and plastic (EPA, 1986). Cadmium does not break down in environment, but it can change forms, some of which dissolve in water.

Exposure

The two main routes of exposure for the general population is by inhalation of cadmium particles and ingestion of food or water containing cadmium. Most cadmium in the environment is in the form of particulate matter in the air and is generated from human activities such as mining, smelting, fuel combustion and incineration of waste or sewage sludge. Cigarette smokers inhale cadmium in the smoke.

Dissolved cadmium can bioaccumulate up the food chain, so ingestion is a common route of exposure. The accumulation of cadmium has been reported in

food crops, livestock, wildlife and aquatic organisms. Cadmium entering the body is excreted slowly over time, but too much cadmium can overload the kidneys and cause damage. Cadmium is a cumulative toxin, so the long-term exposure at an elevated level is a concern.

Toxicological Effects

Workers exposed to cadmium through inhalation have shown signs of renal damage. At higher levels of exposure, calcium deficiencies and bone disorders have been reported, but effects on bones generally appear only after the kidneys have been damaged. Limited evidence exists for an association between inhalation exposure to cadmium and reproductive effects. Female rats exposed to cadmium four to five months prior to mating and during gestation, showed damage to the offspring. The effects were noted at the lowest concentration tested (0.02 mg/m3). These studies indicate that cadmium is a developmental toxin in animals, by inhalation exposure.

The U. S. Environmental Protection Agency (EPA) has classified cadmium as a probable human carcinogen by inhalation based on animal and human data.

The kidneys are the organ most affected after long-term oral exposure. At higher levels, cadmium decreases gastrointestinal uptake of iron, which can result in anemia if a person's diet is low in iron. Painful bone disorders have been observed in some people chronically exposed to food with elevated levels of cadmium. Neurological effects such as lower verbal IQ and disruptive behavior have been reported, but these studies are not definitive because the level of cadmium exposure was unknown and could not be separated from the effects of lead exposure.

Although the evidence for neurotoxicity is uncertain in human studies, it is fairly strong from animal studies, showing decreased motor activities, weakness, and muscle atrophy. Studies of rats and mice indicate that fetal toxicity may be a concern for females orally exposed to cadmium prior to, and during pregnancy. In addition, reproductive success decreases for both male and female rats who are orally exposed to cadmium.

***Lead***

Lead is a naturally occurring metal found in the earth's crust. However, most of the lead dispersed throughout the environment comes from human activity. Leaded gasoline was one of the major sources of airborne lead. Other sources of lead released to the air include burning fuel, such as coal and oil, industrial processes and burning solid waste. The largest use of lead is in the production of some types of batteries. It is also used in ammunition, ceramic glazes, and medical, scientific and military equipment.

The release of lead to the air is now less than the release of lead to the soil. Most of the elevated levels of lead in soils comes from landfills, leaded paint, mining wastes, ammunition manufacturing, and other industrial activities such as battery production. Lead is removed from the air by rain and once deposited on soil, usually adheres to soil particles.

The levels of lead may build up in plants and animals in areas where air, water, or soil are contaminated with lead. If animals eat contaminated plants or animals, most of the lead that they eat will pass though their bodies. It is the small amount absorbed that can cause harmful effects.

Exposure

For the general population, most exposure results from eating foods with lead in them, or from leaded paint. Lead can be found in a variety of foods including produce, meats, grains, seafood, soft drinks and wine. Usually, low levels of lead are found in drinking water. However, the amount of lead in drinking water can increase if the water supply is acidic, leaching lead from lead pipes, solder or brass faucets.

Large numbers of workers are potentially exposed to lead in the workplace. People employed in lead smelting and refining jobs, rubber products and plastic industries, steel welding or cutting operations, battery manufacturing plants, construction work, those who work at municipal waste incinerators, pottery and ceramics industries or remove old lead-based paint may all be exposed. The Occupational Safety and Health Administration (OSHA) requires that a worker with a blood-lead level over 40 ug/deciliter be removed from the area of exposure. A study of workers in a ceramics industry indicated that family members of exposed workers also had elevated blood-lead levels, most likely because of the dust accidentally brought home by workers.

Inhalation is the main pathway of exposure for people whose occupation exposes them to lead particles. Once in the lower respiratory tract, lead is almost completely absorbed. Absorption of lead in adults through ingestion is relatively low, unless ingested while the person is fasting. However, the rate of absorption through ingestion for young children is four to five times higher than for adults. Exposure data is expressed in terms of absorbed dose, usually measured as levels of lead in the blood.

Estimates of blood-lead levels for children under five years old indicated that nearly nine percent, or approximately two million children have blood-lead levels of 10 ug/deciliter or higher, which the Center for Disease Control considers to be the level indicating lead poisoning.

Toxicological Effects

There is no beneficial purpose for lead in the human body. Lead has been shown to affect virtually every major organ in the body. The most sensitive organs appear to be the nervous system (particularly in children), the circulatory system and the cardiovascular system. In addition colic is a consistent early symptom of lead poisoning. In adults, symptoms of neurological effects include dullness, irritability, poor attention span, headaches, muscular tremors, loss of memory, and hallucinations. The condition may then worsen, sometimes abruptly, to delirium, convulsions, paralysis, coma and death.

In children, many of the same symptoms occur along with hyper-irritability and convulsions. There is a greater incidence of permanent neurological and cognitive impairments in children. Even at lower levels without the severe symptoms described above, there may be permanent damage.

A large body of literature clearly indicates that high levels of lead cause adverse effects on both male and female human reproductive functions. Lead is a teratogen that can cause fetal malformation, a mutagen that can affect both sperm and eggs, and a reproductive toxin that can impair fertility. Women who are exposed during pregnancy have experienced miscarriages and stillbirths. Several studies in males indicates that at moderate blood-lead levels (40-50 micrograms (ug)/deciliter) sperm production may be affected. Other studies, while of limited sample size or lacking a matched control group, taken together provide evidence for lead induced endocrine disturbances and reproductive disfunction in male workers exposed to lead.

The chart below developed by the MPCA, summarizes the effects of lead on children and adults at various blood lead levels.

**Figure 1: Summary of Human Health Effects of Lead**

| Summary of Human Health Effects Reported at Various Blood-Lead Levels (ug lead/deciliter blood) | | |
|---|---|---|
| Children | ug/deciliter blood | Adults |
| | 150 | |
| Death | | |
| | 100 | |
| Decreased renal function | | |
| Colic | | Colic |
| | 50 | Decrease renal function |
| Anemia | 40 | Decreased male reproductive function |
| | | Decreased neurological function |
| Decreased hemoglobin syntheses | 30 | |
| | | |
| Decreased nerve function | 20 | Increased male blood pressure |
| Developmental toxicity, including decreased IQ, hearing and growth functions. | 10 | Changes in blood system. |
| Changes in blood system. | | |

*Source: MPCA*

***Hexavalent Chromium***

Chromium is a natural element found in rocks, animals, plants, and soil. Chromium can take several different chemical forms or valent states; chromium, trivalent chromium or hexavalent chromium. Trivalent chromium occurs naturally, and in small amounts is an essential nutrient for humans. Hexavalent chromium and chromium are generally produced by industry. Hexavalent chromium rarely occurs in nature. It is very toxic and is used in chrome plating, in manufacturing dyes and pigments, leather tanning and wood preserving.

Exposure

Individuals who work in industries that process or use chromium compounds can be exposed to higher than normal levels of chromium. An estimated 305,000 workers in the United States are exposed occupationally. Those industries include stainless steel welding, chromate production, chrome platers, chrome pigment manufactures, painters, battery makers, printers, candle makers, and cement makers.

People who live near industrial facilities that use or manufacture hexavalent chromium, cement plants, or landfills with wastes that contain chromium may also be exposed to higher levels of chromium than the general population. Busy

roadways that generate vehicle exhaust and cement particles may also increase exposure for near-by residents. Tobacco products also contain chromium.

There are three routes of exposure for hexavalent chromium, inhalation of airborne particles, ingestion, and to a much lesser extent, through the skin. For the general population, the most common route of exposure is by eating foods containing hexavalent chromium. Only very small amounts of hexavalent chromium can enter the body through the skin unless the skin is damaged.

Toxicological Effects

Occupations that lead to exposure by inhalation to hexavalent chromium, such as chromate and chromate pigment production and chrome plating, are associated with respiratory disease and lung cancer. Nasal septum perforation and other respiratory effects have been reported among workers chronically exposed to hexavalent chromium compounds.

The Department of Health and Human Services and the International Agency for Research on Cancer has determined that the following hexavalent chromium compounds are carcinogenic in humans: calcium chromate, zinc chromate, strontium chromate, lead chromate as well as those compounds used in chromate production, chromate pigment production and chromium plating.

Oral exposure indicates that hexavalent chromium has the most impact on human blood-cell profiles and the gastrointestinal system. Nausea and vomiting were reported when hexavalent chromium dust was ingested. Oral ulcers, diarrhea, abdominal pain, indigestion, and vomiting resulted from drinking badly contaminated well water. However, no evidence of cancer has been found in mice following long-term exposure to hexavalent chromium in drinking water. Reproductive effects have not been reported in humans, but oral exposure to hexavalent chromium caused severe reproductive and developmental effects in mice.

**Effects on the Endocrine System**

Over the last fifteen to twenty years, a growing body of research has uncovered the effects of a number of chemicals on the immune, endocrine and reproductive systems of animals and humans. Frequently referred to as endocrine disrupters or hormone mimics, these chemicals mimic the effects of naturally produced hormones in the body and disrupt or interfere with normal development of the nervous, immune, endocrine, or reproductive systems.

In addition, early in-vitro exposure to these hormone copy-cats may confuse or inhibit the development of a male fetus. Studies in Europe show an increase in the incidence of undescended testicles in newborn males and an increase in the rate of testicular cancer in young men. The results seen in young men may be linked to

exposure from their mothers. Analysis of data from studies of over 14,900 men also indicates a drop in sperm density and number.

The connection between the research being conducted on endocrine disrupters and the Toxics statute is that lead, cadmium and mercury are on the list of suspected endocrine disrupters.

In July 1991, a multidisciplinary group of scientist came together to discuss the prevalence and effect of endocrine disrupting chemicals. The group represented expertise in a wide variety of fields. The group was to integrate and evaluate the findings from diverse research done on this topic, to identify the conclusions that could be drawn with confidence from existing data, and establish a research agenda for uncertainties remaining in the field. To quote the consensus statements of the participants at the workshop:

> "We are certain of the following:
> 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; behavioral abnormalities in birds; demasculinization and feminization of male fish, birds and mammals; defeminization and masculinization of female fish, and birds, and compromised immune systems in birds and mammals."

Further:

> "The patterns of effects vary among species and among compounds. Four general points can nonetheless be made: 1) the chemicals of concern may have entirely different effects on the embryo, fetus or perinatal organism than on the adult; 2) the effects are most often manifested in the offspring, not in the exposed parent; 3) the timing of exposure in the developing organism is crucial in determining its character and future potential; and 4) although critical exposure occurs during embryonic development, obvious manifestations may not occur until maturity." (Consensus statement from the work session on Chemically-Induced Alterations in Sexual Development: The Wildlife/Human Connection, 1991. See Appendix 5 for the complete statement of the work group and list of participants).

**Pollution Prevention**

One of the most important aspects of the Toxics statute (and the Toxics in Packaging statute) is the strong pollution prevention requirements written into the law. Unlike disposal bans, and traditional regulatory controls which set contamination and leaching levels, this statute moves the regulatory focus

*So surely it is time to ask: do we really want to continue our attempts to manage persistent toxic substances, or, to the extent possible, do we want to begin the process of eliminating such oneous substances in the first place?*

*Gordon Durnil: The Making Of A Conservative Environmentalist*

upstream to the manufacturers who have control of the formulation of the regulated products. This is a much different approach than trying to control or remediate the fate of the metals at the disposal "end-of-the-pipe."

This is a new approach for the state of Minnesota as well as on a national level in the United States, although not as novel in other industrialized nations, particularly in Europe. Sweden has banned the use of mercury in electrical components and measurement instruments. The Swedish national chemical inspecterate, the Kemikalieinspektionen (Keml) is preparing regulations to ban the use of high mercury-content fluorescent light bulbs, and to ultimately phase out the use of mercury completely by 2000 (Eva Gustavsson, Keml, E-Mail communication). There is much to learn in formulating and implementing this type of policy change, but as a state, Minnesota and the MPCA have a great deal of experience with the other types of environmental protection tools that have been used over the years. This experience has proven that the costs to the state, counties and ultimately the tax payer of the end-of-the-pipe approach are always tremendous. One of the basic tenants of pollution prevention is that the end of the pipe is the most expensive place to control pollution.

**Fate of the Four Regulated Metals in the Solid Waste Management System**

***Landfills***

More than half of the solid waste, including demolition, construction and industrial waste, generated in Minnesota is landfilled. One of the byproducts of landfilling is leachate. Leachate is produced as water from rain or melted snow percolates through the waste. It contains particles, metals and chemicals which are picked up from the waste. All municipal solid waste (MSW) and most industrial landfills have liners which contain the leachate, and collection systems which collect and pump the leachate out of the landfill.

*All paint manufacturers have the ability to make lead-free paints. Because of the cost impact, (two to three times the cost for lead-free) the demand for lead-free based paints by end users has been minimal.*

***An Automotive Refinish Division***

The leachate must then be disposed of. In some communities the leachate is trucked to the local waste water treatment facility for treatment and eventual discharge. The sludge from waste waster treatment facilities is then land spread on nearby fields. Some landfills must pay a strength charge to the waste water treatment plants, the more contaminated the leachate, the greater the cost of disposal. The strength of the leachate can be an operational problem for smaller treatment facilities which have to incorporate the leachate slowly in order not to overwhelm the system. In essence, the leachate is diluted by the other waste water prior to treatment. Landfill gas is generated as materials decompose. The constituents of the waste determine the composition of the gas. Mercury because its volatilizes at low temperatures has been detected in landfill gas.

In some communities, trucking large volumes of leachate may not be practical or the distance to the nearest treatment facility may be too great. Another relatively new disposal method for leachate is land application. There are currently eight

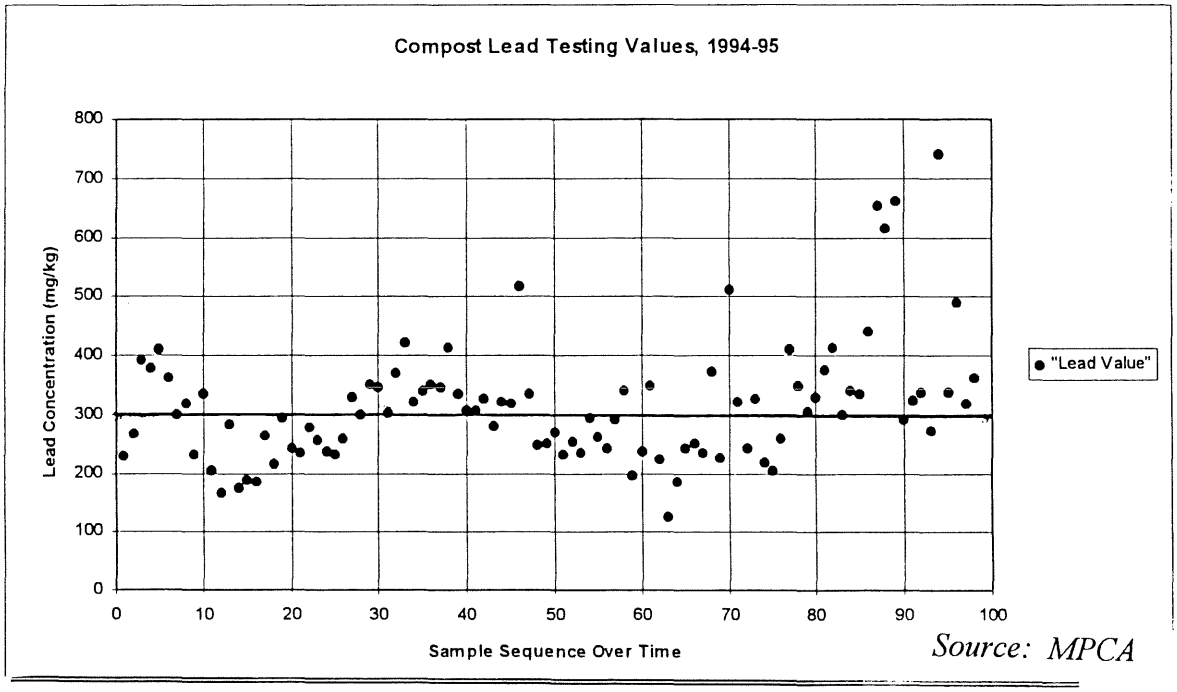
land application systems in Minnesota. Some sort of pre-treatment of leachate such as a pond system or mechanical pre-treatment is required before it can be land applied. The leachate is spray irrigated over a number of sites which have suitable soils, are a sufficient distance from water supply wells and have enough separation from ground water. Eventually the limits on the amount of metals and salts the soils can hold is reached, and another site must be selected. Since the metals are inorganics and are not broken down, they may be taken up by plants in the field where the leachate is applied, or stick to the soil particles, but they do not disappear.

***Compost Facilities***

The MSW compost facilities in Minnesota have, at times, had difficulty selling or even giving away the finished compost. Sometimes this has been because of operational difficulties, but frequently the problem has been that the level of the regulated metals has pushed the compost into the restricted use, Class II classification. Very little, if any, of the MSW compost produced in the state has been Class I compost. The solid waste rules pertaining to compost were recently revised to more closely mirror risk-based federal regulations, but the standards, particularly for lead, will still prove problematic for facility operators. The contamination of the compost by heavy metals has been costly for facility operators.

The graph below plots the levels of lead for approximately 100 samples taken during 1994 and 1995 at a Minnesota compost facility. The lead threshold for Class II, restricted use compost is 300 milligrams per kilogram under current rules (milligram per kilogram translates into parts per million). Approximately half of the samples were above 300 mg/kg level.

**Figure 2: Lead Values In Compost For Samples Taken In 1994-95**




*Source: MPCA*

### *Incineration*

Metals which become part of the matrix of the materials they are used in, and which under normal landfill conditions might not leach in a landfill, may be released to the environment when burned in an incinerator. Of the products effected by the Toxics statute, this is particularly true with plastics. Heavy metals cannot be destroyed in an incinerator. They must exit or accumulate within the unit. Most of the metals will remain in the bottom ash, a portion become gases and exit with the flue gases. The metals may attach themselves to the particulate matter in the flue gases and some will be captured in the flue gas cleaning equipment (Jackson, 1993).

The type of air pollution control systems used by the facility also affects the efficiency of removal of heavy metals from flue gasses. Electrostatic precipitator (ESP's) use a series of high voltage discharges to create negatively charged ions to attract the positively charged fly ash particles. Removal efficiency for cadmium ranged from 76 percent to 96.5 percent in facilities in Minnesota for which there is data available. Chromium ranged from 67 percent to 96.1 percent and lead ranged from 74.5 percent to 99.5 percent. Acid gas scrubbers add efficiency to an air pollution control system as well. In general, ESP's are not as efficient at removing ash particles as a fabric filter in combination with a spray drier or dry sorbent injection system. Efficiencies for those generally range from 99 percent for lead, and cadmium, to 90 percent to 99 percent for chromium (Jackson, 1993).

Control of mercury during incineration is the exception. Most metals condense to form solid particles as flue gas is cooled so that they can be collected as particulate matter. Mercuric chloride and elemental mercury are released during incineration of MSW (Teller, 1993), most of it being mercuric chloride (Kilgroe, 1996). Both elemental mercury and mercuric chloride are vapors at typical flue gas cleaning control device operating temperatures (285 Fahrenheit to 575 Fahrenheit). Because MSW facilities must operate their ESPs at temperatures where mercury remains as a gas, ESP's are especially inefficient at removing mercury, in some cases not removing any. Further, even waste combustors with acid gas scrubbing may not capture mercury if there is not enough carbon inherent in the particulate matter that is captured in the control devices.

The best combination for effective mercury capture appears to be operating the control devices at low temperatures and maintaining a high level of carbon in the fly ash. This can be done by retrofitting incinerators with equipment that reduces flue gas temperatures, and injecting activated carbon into the cool flue gas stream. Activated carbon injection can remove at least 85 percent of mercury in the flue gas, and at some facilities can remove greater than 95 percent of the flue gas mercury (Kilgroe, 1996; Kane and Nebel, 1995).

MSW incinerators in 1990 emitted an estimated 1,497 pounds of mercury in Minnesota or 19 percent of the total emissions (White and Jackson, 1992). Minnesota MSW incinerators are required to retrofit their facilities by mid-2000 to incorporate temperature control and activated carbon injection to comply with state and federal rules. Once this equipment is operating, mercury emissions are expected to be below 553 pounds per year.

**Other Pollution Prevention Activities Related to the Regulated Metals**

The Toxics statute is one element of the state's program to reduce emissions of heavy metals and other priority toxins. More and more the focus is shifting to 'front-end' efforts. Below is a brief description of a few other MPCA programs involving one or more of the four heavy metals.

***Minnesota Environmental Partnership Agreement***
Reduction of persistent toxins is one of the priorities identified in the Minnesota Environmental Partnership Agreement between the MPCA and the EPA. The Environmental Partnership Agreement sets out a work plan for the MPCA and EPA for the current federal fiscal year. Activities laid out under this priority include identifying opportunities for educating consumers in targeted toxics in products. Other divisions within the MPCA and other states would be involved in this effort. Facility inspections are to be directed to the targeted toxics.

***The Lake Superior Initiative***
To reduce potential impacts of hazardous waste pollution in the Minnesota portion of the Lake Superior Drainage Basin and to experiment with outreach and assistance strategies, the MPCA created the Lake Superior Basin Hazardous Waste Initiative (Initiative). Through innovative use of customer research, partnerships and outreach, the Initiative has been effective in reducing hazardous waste, and improving waste management and has become a recognized national model. Mercury and polychlorinated biphenyls (PCB) containing waste collection was a high priority. The Initiative used advisory groups, focus groups and trade associations to work with generators, mostly small businesses. Particular effort was focused on print shops, auto body paint suppliers and auto repair shops. The Chamber of Commerce and the University of Minnesota, Duluth were also involved.

***Bi-National Agreement***
The MPCA along with state, federal, Canadian, city, Tribal, industry, Chambers of Commerce and environmental partners have been working on a zero discharge policy for the Great Lakes region. Signed into law in 1991, by Governor Carlson, the agreement identifies nine chemicals of concern, including mercury, and eventually prohibits discharge of any of these priority toxins into the Great Lakes or lake basin.

### *Comprehensive Mercury Reduction Strategy*

The MPCA was recently awarded a grant by the EPA to develop a comprehensive strategy for mercury reduction. The MPCA plans to design a comprehensive program to reduce mercury pollution with the help of industry, local governments, environmentalists and citizens. Once developed, the plan must be comprehensive in addressing all sources of mercury and transferable so that it can be used as a model elsewhere.

*All of the frits which we produce today are lead and cadmium free. The new frits seem to be equal or better than the frits they replaced. Though, in some cases, the price is higher.*

*An Enamel Company*

A number of possible strategies have been proposed to reduce the amount of mercury in solid waste:

- fees on mercury used;
- a levy on each pound of mercury released into the environment; and
- special collection systems for mercury-containing products.

Possible approaches include deposit and refund, product manufacturer "take-back" programs (like Honeywell Inc. does with their thermostats), or special household hazardous waste collections. Other possibilities include bans, prohibitions on the sale of mercury-containing products, and a limit or cap on the total amount of mercury released to the environment in Minnesota from all quantifiable sources. Another idea which will be explored over the course of the grant is lowering the cap as necessary over time, allowing facilities to buy and sell allowances in a manner similar to the federal acid rain program.

*The direct costs discussed above could thus be considered costs of compliance with the Minnesota standards alone; however, it is more realistic to consider them as an investment in future product planning as part of our product stewardship commitments and as a proactive response to possible future regulations on heavy-metal content in other jurisdictions.*

*An Automotive Refinishing Company*

### *TRACE Intra-Agency Work Group*

The Toxics Risk Assessment and Contamination Evaluation Committee was formed in 1995 to identify chemical pollutants of greatest risk to human health and the environment and to evaluate whether, and to what extent, they are regulated by the MPCA. In conducting this analysis, a special emphasis will be placed on persistent, bioaccumulative substances. The group has compiled current information available on the chemicals of concern and will be prioritizing those chemicals.

## Business Innovation

It is possible to look at the Toxics statute from a different angle, rather than just what the Toxics statute prohibits and how it seeks to protect human health and the environment. There are those studying and writing in the area of business theory who argue that the right kind of environmental or safety regulation can stimulate innovation, and compliant companies become early-movers on potential markets elsewhere.

A recent article in the Harvard Business Review criticized the notion that there is an inherent trade-off between environmental protection and economic competitiveness. The authors looked at the role the right kind of environmental

regulation can play in innovation. They argue that pollution, a waste or release of any kind, is an inefficiency in the company's system. Pollution's hidden costs - wasted resources and effort - are buried throughout a product's life cycle (Porter and Van der Lind, 1995).

*It is currently felt that the Minnesota requirements are more stringent than known federal statutes but, success in meeting the Minnesota statutes coupled with universal acceptance, would allow ready translation to worldwide markets.*

***A Paint Manufacturer***

Pollution prevention is a first step, and as well as reducing waste disposal cost, the other benefit of preventing pollution is conservation of resources. While it would seem that any company would be motivated to do this without any pressure from government in the form of regulations, this is based on a false assumption. The assumption is that all money-saving innovations have already been found, and that all managers have complete knowledge needed to make those innovations or that the company promotes those innovations. Certainly some companies do innovate in advance of regulations; however, in many companies the barriers to change are numerous (Porter, 1990).

This is why, the argument goes, the right kind of environmental regulation can provide outside pressure to overcome organizational inertia and foster creative thinking. These regulations should focus on outcomes not technologies. Setting the standard and allowing them to figure out how to reach it, instead of telling a business how to comply, promotes innovation rather than implying that one technology is best, and discouraging innovation. Regulations should regulate as close to the end user as practical, while encouraging upstream solutions, allowing more flexibility for innovation in the end product. An ample, but well defined phase in period will allow companies to develop innovative resource-saving technologies rather than force them to implement expensive solutions hastily. Market incentives such as pollution charges, draw attention to resource inefficiencies. The regulation and the attendant regulatory process needs to be stable and predictable so companies can effectively use a phase-in period to tackle basic process changes rather than hedging against the next twist or turn in philosophy (Porter and Van der Lind, 1995).

*Recyclers can readily supply zincs with less than 600 ppm lead . . . compliance with the Toxics statute will only serve to steer manufacturers away from the sources that are actively recycling this valuable natural resource in favor of mining, which as you may know, is not necessarily the most environmentally friendly activity. It is therefore my opinion that this statute is less "earth friendly" than may appear on the surface.*

***A Pigment Manufacturer***

The Toxics statute meets some, but not all of the above criteria for regulations that stimulate innovations in the various industries affected by the Toxics statute. The Toxics statute sets the benchmark or regulatory level (100 ppm and no intentional introduction) without specifying to industry how compliance is to be achieved. A phase-in period of three years was originally set in 1991. The three year period was extended to 1998, allowing for a seven year phase-in. Whether this is a sufficiently long period seems to depend on the industry regulated. For some industries the Toxics statute regulates the end product, for others it is an ingredient. The Toxics statute does look to solutions upstream. For those companies for whom one of the regulated products is an ingredient, they have been looking to their suppliers for products which will meet the statutory requirements.

The current Toxics statute does not incorporate any market incentives such as pollution charges or state purchasing requirements which might act as incentives to

change formulations. The Toxics statute has not been stable or predictable. The almost annual changes to the Toxics statute and the uncertainty that has surrounded it for the last several years has led at least one manufacturer to sit and wait before making capital investments in changes to his process. Others have seen the Minnesota Toxics statute as the first of other possible regulations coming from other states or perhaps even at the federal level. For some affected industries, they are too far downstream to be able to affect change to the products they use in their manufacturing process.

*The final product has very little hexavalent chromium; in fact, there have been recent studies which have revealed that properly processed treated wood has a hexavalent chromium content that is actually not detectable (only trace levels), but is certainly below 100 ppm.*

This area of innovation-friendly regulation is worth exploring further when considering changes to the Toxics in Products statute. Involving the affected industries in setting standards and timelines and developing greater technical expertise on the part of MPCA staff charged with implementing the Toxics statute, are just two areas where improvements are readily possible.

## Flaws in the Current Legislation

*The Minnesota law's impact cannot be reasonably measured in the same cost terms, (as applicable federal statutes) because the Toxics statute is not targeted at eliminating specific definable hazards, but rather it is structured as an indiscriminate ban of chemicals erroneously presumed to be inherently and uncontrollably hazardous. We believe that this is the basic fallacy in the subject statute.*

***An Industry Trade Association***

One of the major flaws in the legislation as it is written is that in many cases it only regulates the ingredients in a manufacturing process, not the final product. This leads to a loophole in that the products containing the regulated metals can be made elsewhere and shipped in-state. In those cases, the Toxics statute acts as a major disincentive to those businesses that use the regulated products and could force them to relocate into neighboring states that do not have similar restrictions. In addition, many of the consumer goods which contain the regulated metals eventually end up in the waste stream and nothing has been gained in terms of toxicity reduction.

While 18 states have passed the Toxics in Packaging statute, Minnesota is the only state which has gone beyond packaging to comprehensively regulate other applications of inks, dyes, paints, pigments and fungicide containing the regulated metals. Because Minnesota is currently the only state with an eventual ban on the use of these metal-containing products, the state becomes an island. This provides an incentive for some companies to move to other nearby states. For those companies that do not move out of state, they may be forced to use more expensive ingredients, making their products less competitive in national and local markets. In some cases there may be a commercially available alternative, but it does not perform as well, making the manufactured product less competitive.

There may be other savings such as lower hazardous waste disposal costs, or OSHA compliance costs which might off-set the increased materials costs. However, unless the manufacturing facility completely switches over and eliminates all of the use of the heavy metals, no OSHA compliance savings will be realized.

The Toxics statute regulates just part of the total use of the four metals. Mercury is also used in electric switches, batteries, and some medical products. Cadmium is used in batteries, cigarettes and in plastics other than as a pigment. Lead is used in batteries as well, and in ammunition and electronics. Hexavalent chromium is found in cement, and is used in chrome plating and leather tanning. While collection programs or disposal bans have been put in place for some of the items in which these metals are used (end-of-the-pipe), the state does not otherwise comprehensively regulate the total use of these four metals.

In addition to regulating only a portion of the use of the four heavy metals, the law ignores the other heavy metals. There are eight heavy metals regulated as hazardous wastes under federal law, the Resource Conservation and Recovery Act (RCRA). The MPCA requires landfills to analyze ground water samples from monitoring wells for ten metals of concern. While the four metals regulated by the Toxics statute were chosen because of the tremendous body of research which has been done on them and their effect, the negative effects of the other heavy metals like arsenic, for example, are also well known.

## Information Gathered From the 1996 Progress Reports

Subdivision 2 (e) of the Toxics statute, requires each manufacturer which has been granted an exemption, to report by July 1, 1996, on progress made toward compliance. On May 1, 1996, a letter with a questionnaire was sent to all the manufacturers and Minnesota users who had applied for an exemption to facilitate their reporting. The questionnaire was divided into two parts, the required questions and optional questions (see Appendix 6).

In addition to the progress made, the manufacturers were required to report the date compliance was, or is anticipated to be, achieved and how compliance was achieved. If compliance can not be achieved by July 1, 1998, the questionnaire asked for a technical explanation of why not, whether compliance could be achieved with more time and whether there were any health or safety factors which should be considered. The questions were essentially the same for the Minnesota users who applied for an exemption. They were asked for a description of progress made toward finding a substitute and the actual or anticipated date of compliance.

Because of the many issues that have arisen since the exemptions were originally granted, six optional questions were included in the questionnaire. The manufacturers and users were not required to answer them but were strongly encouraged to do so. The optional questions were designed to help provide the MPCA with additional information on other pollution prevention activities the companies were involved in, including International Standards Organization (ISO) 14000, costs, benefits and what the differences were between federal standards and the Minnesota Toxics statute.

***Responses***

Of the 85 reports due to the MPCA (82 companies, 3 trade association), 55 companies and trade associations provided timely reports or informed the MPCA of mergers or other change of status. Thirty companies were sent a reminder letter on August 2, 1996, if they had not responded in any way. Finally on September 20, 1996, six forgivable administrative penalty orders were sent out to the remaining companies which had still not replied. Of all those who replied, 49 companies responded to all of the optional questions for at least part of the company, the remainder submitted answers only to the required questions.

The National Paint and Coatings Association (NPCA) requested a blanket exemption for the incidental presence of any of the four heavy metals, for their entire membership for all products their members produced, since the manufacturers were not sure which products might contain an incidental presence of one of the regulated metals over the 100 ppm threshold. Since 1994, the NPCA and their members have worked hard to determine that none of the paints produced by their members should exceed the 100 ppm incidental presence threshold.

***MPCA Data Summary Efforts***

A data base was developed, using the Microsoft EXCEL program, with separate cells for each of the pieces of information provided in the original exemption requests, and the subsequent progress reports. Every effort was made to match the original item in the exemption request with information in the progress report as to whether that item is, or will be, in compliance by July 1,1998. There were a number of inconsistencies in the original requests and the progress reports and complete matching was not always possible. For example, some of the product lines of a company bought out by another were transferred and renamed, others were dropped. It was difficult even for the companies involved to track exactly what had happened to each product line. In other cases, an exemption request was made for hundreds of products which were not specifically identified.

**Summary of Information Obtained**

The MPCA received reports on a total of approximately 2000 products, either individually or as product lines. In several instances a company was represented in the data base on a single line, but the single entry represented dozens or even hundreds of products.

As the data was entered into the data base, each product was assigned to one of the statutory categories. It is important to note that in some cases, the distinction between these product categories was not clear and assigning them to a category was somewhat arbitrary. As shown in the table below, paints and pigments are the products which most commonly contain one of the listed metals.

**Figure 3: Number of Products in Each of the Regulated Categories**

Statutory Category

| I | D | P | Pm | F |
|---|---|---|---|---|
| *Inks* | *Dyes* | *Paints* | *Pigments* | *Fungicides* |
| 124 | 1 | 939 | 930 | 1 |

*Metal Use*

The exempted products or product lines were analyzed for metal use. The table below shows the frequency of the metals as an ingredient in one of the exempted products. According to the information provided by the exempted companies, over half of the products contain two or more of the regulated metals.

**Figure 4: Regulated Metal Used**

| Pb | Cd | Hg | Pb/Cr | Hex/Cr |
|---|---|---|---|---|
| *Lead* | *Cadmium* | *Mercury* | *Lead Chromate* | *Hex/Chromium* |
| 1,123 | 719 | 187 | 458 | 1,007 |

*Compliance Status*

The companies were required to inform the MPCA of the compliance status of each of the products for which an exemption was requested. Again, each of the products or product lines were assigned a status. If it seemed doubtful that a product would be in compliance by July 1, 1998, the product was assigned to the "No" category. If the product would be in compliance only by the cease of sale of the product in Minnesota, the product was assigned to the "No" category. It is important to note that the numbers may represent single products or product lines, and that special circumstances such as the blanket request from the National Paint and Coatings Association are not included in these numbers.

**Figure 5: Number of Products or Product Lines in Compliance**

| Yes | Will Be | No | Uncertain |
|---|---|---|---|
| 405 | 205 | 1,382 | 3 |

The number of uses for the regulated products is huge. For the purposes of categorizing, some product uses which seemed to be similar were grouped together under the headings listed below. In addition, the uses were further broken down by which products are in compliance now, would be by 1998, or will not be in compliance. Organizing the information this way helps identify industries or uses where compliance seems unlikely by 1998, or where the industry seems to be in or moving towards compliance.

**Figure 6: Use of Regulated Items and Compliance Status**

Compliance Status

| *Use of Regulated Item* | *YES* | *NO* | *WILL BE* | *UNCERTAIN* |
|---|---|---|---|---|
| | | | | |
| Screen Printing | 4 | 94 | 13 | |
| Military Use | 8 | 77 | | |
| Automotive | 279 | 467 | 20 | 1 |
| Transportation/Safety | | 75 | 1 | |
| Building Products | 17 | 40 | 49 | |
| Aircraft/Aerospace | 11 | 249 | 2 | |
| Vinyl | 9 | 41 | | |
| Plastics/Rubber | 94 | 102 | 53 | |
| Ceramics | | 142 | | |
| Paint | 7 | 22 | 6 | |
| Enamels | 185 | 35 | 5 | |
| Quick Dry Enamels | | 8 | | |
| Galvanized Coatings | 1 | 2 | | |
| Hydrofluoric Acid Paint Detecting | | 1 | | |
| Pastes and Gelcoates | 1 | 39 | 1 | |
| Permanent Marking Inks | | 28 | | |
| Sign Paints | 7 | 91 | 45 | |
| Colorants | 83 | 78 | 8 | |
| Manufacturer of Electric Signs | | 2 | | |
| Bowling Lane Coatings | 3 | | 3 | |
| Gas Pipe Coloring System | | | 1 | |
| Construction | 1 | | | |
| Sprayon Products | | 11 | | |
| Reaction Rinse | | 1 | | |
| Farm Equipment | | 23 | | |
| CCA Wood Preservative | | 1 | | |
| Coatings | | 16 | | |
| Lead Drier | | | | |
| Thick Film Pastes | | 1 | | |
| **Totals** | **710** | **1646** | **207** | **1** |

* Totals in this table are larger than in the Compliance Status table because some products have more than one use.

### *Technical Reasons For Non-Compliance*

The technical reasons for non-compliance were tallied up and are presented in the table below to give an idea of the most often cited reasons for the metals' presence in the regulated products. Reasons having to do with color, brightness, matching, or durability accounted for 831 times non-compliance was cited. Required use under a military specification was cited 31 times.

**Figure 7: Technical Reasons Sited for Non-Compliance**

| *Technical Reason* | *Number of Times Cited* |
|---|---|
| Opacity/Hiding Ability | 557 |
| Anti-Corrosive Properties | 477 |
| Bright Colors/Performance/Strength | 442 |
| Heat Resistance | 329 |
| Color Match | 298 |
| Adhesion Promotion | 214 |
| Weather Resistance | 205 |
| Less Expensive | 155 |
| Incidental Presence | 147 |
| Environmental Stability | 132 |
| Temperature Stability | 129 |
| Lead Dryers | 125 |
| Chemical Durability/Stability | 119 |
| Color Durability | 75 |
| Incompatibility of Organic Pigment and Solvents | 58 |
| Light Stability | 45 |
| Military Specification | 31 |
| Integral Part of the Crystal Structure | 25 |
| Clean Colors | 16 |
| High Gloss | 16 |
| Customer Requirements | 10 |
| Acts as Flux | 9 |
| Prevents Product Viscosity | 8 |
| Necessary in Order to Lower VOC Use | 8 |
| Provides Lubrication | 7 |
| Provides Correct Thermal Expansion | 2 |
| Dip Tank Stability | 1 |
| State Requirements | 1 |
| Necessary to Fix Compound in Wood | 1 |

## Optional Questions

The optional questions asked about involvement in ISO 14000, and about other pollution prevention activities the company had undertaken. The third optional question was an attempt to quantify the practical effect of the Toxics statute to date by soliciting the amount of the four metals avoided. Questions on the direct and indirect costs and savings associated with compliance with the Toxics statute were asked, and finally, a question on the differences between the Toxics statute and federal standards was included.

*". . . zinc dust of less than 600 ppm lead can be produced on a continuous bases using secondary metal. The only way to produce zinc dust with less than 100 ppm lead is to use electrolytic grade zinc metal as the feed stock. This is both expensive (some $0.05 per pound more cost) (the cost is important when we are bidding against other vendors who may be using the high lead content zinc dust) and eliminates the use of millions of pounds of secondary metal which then has no other beneficial use.*

***Pigment Manufacturer***

ISO 14000 is a set of standards developed by the International Organization for Standards. The ISO 14000 series is a set of process standards for all aspects of environmental management, they are not performance standards. ISO 14000 standards require that organizations establish and maintain procedures related to the environmental aspects of goods and services that they use, and communicate these requirements to their suppliers and contractors. Certification is done by a third party.

In some respects, ISO 14000 is a response to a proliferation of different environmental standards, both voluntary and mandated. Consistent standards and recognition of those standards internationally, prevents duplication and added compliance expense for multinational companies and their suppliers. Of the 47 companies which answered this question, 23 said they were not considering it, 21 indicated they were considering it, two were actively pursuing certification, and one company felt confident that they would achieve certification in 1997.

In addition, 27 companies indicated that they were involved in other pollution prevention activities. Some pollution prevention programs were industry initiatives like Responsible Care®, in the paint industry. Fourteen companies responded that they were not actively involved in a pollution prevention program.

A number of companies responded to the questions on direct and indirect costs of compliance with the Toxics statute. The information provided; however, was stated in general terms with few, if any, specifics. Generally companies indicated that there had been additional costs associated with compliance with the Toxics statute. Of those, several went on to say that it might give them a competitive advantage. Others felt that higher costs would be realized when they had to comply with the statutory deadline of July 1, 1998.

Fewer companies responded to the question about direct and indirect savings. Again, it seemed that few companies broke out costs and savings in terms of reduction of the use of heavy metals. One company responded that until they could completely eliminate the use of heavy metals from their workplace, they

would not realize any savings in terms of compliance with the standards set by the OSHA for workplaces which use heavy metals.

Of the companies that replied to the question about the differences between federal standards and the Toxics statute, most said the Minnesota Toxics statute was more stringent. A number of them pointed out that federal standards tended to regulate emissions or set leaching limits, while Minnesota Toxics statute restricted use of the metals. Several likened it to the Toxics in Packaging statute in terms of how the metals were regulated.

**Environmental Outcome**

In one of the optional questions, companies were asked to attempt to quantify the amount of metals avoided for those products which were in compliance with the Toxics statute in 1995. In other words, for those products which were originally exempted, but were now in compliance, could the amount of the four heavy metals avoided be quantified in some way? The purpose of this question was to attempt to quantify the environmental benefits of the Toxics statute for a one-year time period. Most of the companies could not answer that question with specific numbers, 12 companies gave an estimate.

Of the 12 companies which gave an estimate, a range of approximately 44,812 to 56,850 pounds of heavy metals were avoided in 1995. In addition, MPCA staff, with the assistance of Minnesota Department of Transportation (MNDOT) staff estimated that an additional 111,690 pounds of lead and 28,058 pounds of chromium were avoided in 1995 by using non-metal containing highway striping paint on Minnesota roads. **The total amount of metals avoided due to the Toxics statute is 184,560 to 196,598 pounds in 1995.**

**Areas Where Compliance Seems Technically Unlikely By 1998**

The most often cited reasons for non-compliance with the Toxics statute was that even after years of research there is still no alternative. In other cases, there are substitutes but they are inferior in performance or are much more expensive, or both. Use of one of the regulated metals is sometimes required by military specification.

*Military Specifications*

In general, there has been movement away from use of lead and hexavalent chromium by the military in their materials specifications and several have been changed in the last two years. The Department of Defense will be examining specifications during 1997 for opportunities for reductions in their use of various heavy metals. For example, South West Research has proposed a three phased implementation plan to eliminate chrome primers on C-17 Aircraft. They are also experimenting with a barrier coat of paint to cover and protect the heavy metal

primer that is used on the aircraft. This ensures that the heavy metal primer remains intact and thus eliminates the need to blast off an old paint (primer) coat. They also plan to test a chrome free primer (Dan Bernard, personal communication). MPCA staff was contacted in 1995 by Jim Swenson at the Department of Defense who wanted to use Minnesota's Toxics in Products statute as additional rationale for changing military specifications to reduce metals use.

Even with all the work being done to reduce or eliminate heavy metal use in this area, there will be some uses of hexavalent chromium for which it will be difficult to find substitutes for. It is the oxidizing characteristic that is desired in the paint or primer to prevent corrosion. Some applications are such that the tolerance for corrosion is specified at zero. In order to deviate from the specification, a substitute formulation must be submitted to the military for testing and certification. That process can take years.

***Avionics Industry***

In similar applications, although not specifically military use, there may be safety considerations that may outweigh the environmental concerns. Commercial airlines frequently use military aviation, or similar specifications for manufacture and maintenance of their planes. Again, the tolerance for corrosion is at or near zero. A quote from the progress report submitted by Lockheed is particularly illustrative:

"The product in use was chosen for its unique properties of corrosion protection while remaining flexible. The radar altimeter antenna protected by this product contains flexible ferrous material that must be protected from corrosion. . . . . The antenna installation is immediately in front of the jet engine inlet and must be protected to prevent the material from corroding, coming off and being ingested into the jet engine. Thus far, no suitable substitute product has been located which combines these unique properties. . . . Ingestion of foreign particles into the jet engine could produce serious problems for the engine, the aircraft, and the flight crew."

*Compliance is not dependent upon substitution or replacement of one or more components; rather, compliance is dependent upon developing an entirely new product chemistry which will yield chromium-free coatings with similar properties.*

Honeywell uses one to two gallons of this strontium chromate-containing paint per year for use on antenna parts supplied to Lockheed Martin.

***A Paint Manufacturer***

From all the information gathered by MPCA staff, there does not appear to be substitutes in this area of corrosion protection which have the same characteristics. Both the military and the avionics industries are working on substitutes for hexavalent chromium. There is at least one joint project involving the National Aeronautics and Space Administration (NASA), the Navy, three universities, and a paint manufacturer to find a substitute for strontium chromate as well as other species of hexavalent chromium. Cooperative ventures involving several paint manufacturers in Europe are working to find substitutes.

This type of research is highly speculative and the alternative developed may be completely different from a coating. A breakthrough may take years and commercial availability may then be several years beyond that.

*Compliance with the Toxics statute, as applied to products containing cadmium based pigments, will have significant direct and indirect costs for industry and for the consumer. By mandating the use of substitutes for cadmium-based pigments, the Toxics statute forces pigments users to sacrifice cost, performance, or both. Industry will undoubtedly pass these compliance costs on to the consumer.*

***A Chemical Company - Colors and Silica***

### *Plastics Industry*

The plastics industry is another area where, in total, compliance seems unlikely by July 1, 1998. Lead, cadmium, and to a lesser extent, mercury have a number of uses in plastics besides pigmentation. They are used as stabilizers to prevent the degradation of the resins during processing or to extend the life of the final products by enhancing specific physical properties. Cadmium particularly, is used to enhance stability for plastics exposed to ultra violet light. They may also be used as lubricants and heat conductors during the molding operation to give uniform flow without producing weld lines, stress cracks or burning the plastic (American Plastics Council (APC), presentation June 17, 1994).

Extensive work is being done in the polyvinyl chloride (PVC) industry to replace certain cadmium based stabilizers with non-cadmium containing stabilizers. Substitutes are available but do not have a substantial history of performance. There are still some technical problems that need to be overcome and the replacements may be more costly (APC 1994).

Lead and lead compounds such as lead oxide are used as a stabilizer for PVC electrical insulation and cable housings and to provide water resistance for synthetic rubber. Lead oxide is used as part of the cure system to help give high elastic tensile strength. In this form, these rubber items are used where heat resistance is necessary for power transmission belts and automotive hoses (APC, 1994).

As well as being used as a stabilizer, cadmium is used to produce bright yellow, orange, red, and maroon colors. As a pigment, it has good opacity and is very color-fast. In some applications, organic yellow pigments do not have the same heat stability, and will turn brown. The organic pigments do not provide the same color palette and may cost more.

Lead, usually in the form of lead chromate, is used as a pigment as well. It also provides good opacity, light stability, and has high heat resistance. The substitutes are not considered as durable and some of the colors cannot be matched. One company reported greater success in lowering or eliminating the amount of lead chromate used in custom color blends. Non-metal containing pigments could be blended with increasingly smaller amounts of metal-containing pigments and commercially acceptable color matches could be achieved. However, their Minnesota customers all used single pigment dispersion systems, not the blends.

What was evident from the progress reports was that the uses of heavy-metal containing pigments in plastics industry were widespread and that the requirements

*In plastics applications, the heat stability reduces off-specification production, and allows formulators to rework scrap, thus reducing solid waste generation. In both applications, energy consumption is reduced by using the easy-to-disperse cadmiums. The stability of cadmium-based pigments also enhances the durability and service life of the end products, further reducing the volume of solid waste. By mandating the use of substitutes for cadmium-based pigments, these environmental benefits are lost.*

***A Plastics Manufacturer***

of the industry are hugely varied. Some plastic parts manufacturing companies do not use metal-containing pigments for any of their applications (see Anchor Plastics case study). Others have very precise color match requirements and cannot be limited in palette (such as the work RTP Corporation does). Because of the variability of the uses and technical requirements of the industry as a whole, the pieces of information provided in the progress reports do not present a complete enough picture to be able to determine the technical feasibility of compliance by 1998 in all cases.

***Glass and Ceramic Decoration***

One of the most technically difficult issues raised by the Toxics statute has been that of the use of lead and cadmium in glass and ceramic glazes. Because of the high firing temperatures of glass and ceramics, lead is used in the glaze so that the glaze expands at the same rate as the substrate it is applied to. In addition, lead and cadmium are used as colorants. According to local ceramic decorators and members of the Glass and Ceramic Decorators trade association, achieving a true red color is not possible without the use of lead.

Experts from New York State College of Ceramics at Alfred University maintain that once fired onto a glass or ceramic substrate, the glaze becomes part of the substrate. They also acknowledged that everything eventually leaches. Cadmium for example will leach, particularly in an alkaline environment. Dr. Stanley Barnette from the Center for Pollution Prevention in Rhode Island did not feel that the Toxicity Characteristic Leaching Procedure (TCLP) is stringent enough to determine the leaching potential outside of landfill environment. However, he had no suggestions for alternative testing methods.

The question of the fate of the metals in an incinerator is less clear. Dr. Arun Varshneya explained that at temperatures between 1500 Fahrenheit and 1800 Fahrenheit that glass will soften and that the enamels used on them are less durable than the glass. He could not predict what would happen to the enamels in a typical incinerator because of the many variables, such as temperature, types of incinerators and time spent on the incinerator bed. In addition, there is the question of how the ash is affected and managed.

One cosmetics company believes they have developed a substitute process for applying decoration to glass and ceramics. They have been using their new technology for over two years. They feel they have a full palette of colors to offer and that the new technology is less expensive and faster than traditional ceramic methods. The process uses ultraviolet light rather than heat curing, thus eliminating the need for using ovens. They have been granted a patent on the process and presented it to the industry at a trade show in the fall of 1996. Company officials are very excited about this new process and are working hard to gain industry acceptance.

There was; however, quite a bit of skepticism on the part of those who produce glass packaging and glazed ceramic ware, about the new process and whether it would actually perform as well as the lead-containing glazes. There was also concern about the expense of buying the new technology and switching over to a new process. More time is needed to determine the workability of the new system, but the new technology seems very promising.

## Future Implementation of the Toxics Statute

In analyzing the information submitted by the companies with exemptions, the exempted products generally fell into one of the three categories listed below:

*The problem is persistent toxins is global, but it is a problem that will be solved by your own actions in your own community. So get involved. Make some noise. Kick up some dust. Be optimistic. Know that your concerns, your words, your actions, do matter. And one last word for my conservative colleagues: we should be leading this parade*

*Gordon Durnil: The Making Of A Conservative Environmentalist!*

**A) P2 Now:** This category consists of those who should be in compliance by July 1, 1998. Included in this group are those who are currently in compliance or have indicated they will be by July 1, 1998. Those manufacturers and users in this category are self-selected; their progress reports certify they will be in compliance by July 1,1998.

The products in this category should, in our view, comply with the current deadline of 1998. In all cases where the businesses have successfully switched to alternatives, or will be able to do so by July 1, 1998, they should be encouraged to go forward in their efforts in toxicity reduction. Many of these businesses have made investments of time, money and capital to convert their processes. Holding them to the statutory requirement lends certainty to the future and makes future business decisions based on the Toxics statute more clear.

**B) Needs more time to come into compliance:** This category consists of those who are still actively seeking alternatives but will not be able to make the July 1,1998, deadline. Some companies have informed MPCA staff that they need more time, sometimes significantly more time in order to comply. In some cases there may be an alternative on the horizon, in other cases it is not clear that an alternative will be found any time soon.

Placement in the second group was based again, on self-selection. The companies provided information indicating that there may be commercially available alternatives but they have drawbacks or do not work in all applications. In some cases the alternatives have not yet been readily accepted in the industry or they are not yet a proven technology. In some cases the industry is honestly, actively, working on substitutes, but are very unlikely to have one by July 1, 1998.

**C) Should be exempted from the Toxics statute:** The products in this category are those for which the MPCA believes there are overriding health or safety considerations, as reported in the progress reports.

There were two specific criteria for placement in the third group; other health or safety considerations or use of one of the regulated metals is currently required by military specifications. In addition, it is unlikely that the items these primers or paints are used on, would end up in the solid waste stream.

1) Aircraft primers and paints containing hexavalent chromium for corrosion protection: As described on page 21, the metals are used to prevent corrosion on critical parts, and their use becomes a safety issue. Metal airplane parts are also unlikely to end up in the solid waste stream.

2) Tamper proof seals used on aircraft: A colored sealant is used by the industry to mark and seal critical bolts, nuts and screws in aircraft to protect against tampering. Likewise, uses of a hexavalent chromium-containing paint to indicate if the airplane part has been tampered with, would be exempted.

3) Products which contain one of the regulated metals because its use is specified by the Department of Defense: As discussed on page 21, the military is slowly changing its specifications to eliminate heavy metals where possible. The MPCA will write a letter to the Department of Defense and attempt to influence them to examine their use of heavy metals in situations where they have not yet done so.

4) Railroad joint primer: A heavy metal-containing adhesive primer is used to prevent corrosion and ensure proper bonding of the composite materials and the rail. The joints allow railroad crossing semaphores to be activated by the approaching train to warn crossing traffic.

## Recommendations

Because of the complexity of the many issues surrounding this Toxics statute, a number of industries and trade associations asked for an opportunity for input as the MPCA was drafting the report. Representatives from the Minnesota Chamber of Commerce, 3M, Northwest Airlines and the American Wood Preservers Institute asked to meet with MPCA staff and members of the Commissioner's office. The MPCA also solicited comments from the Environmental Health Association, various environmental groups, other state agencies, counties and those representing the resource recovery industry. Members of this unofficial "toxics work group" of interested parties met a number of times with MPCA staff and members of the Commissioner's office as a large group, and in smaller groups. Draft copies of this report were presented along with summaries of the information collected from the manufacturers. As a result of these discussions, a number of administrative options were proposed, refined, rejected, proposed and refined some more.

Discussions are still ongoing as of the date of this report. The hope is that a consensus proposal can be crafted for future administration of this Toxics statute.

Much of the discussion has revolved around what to do with those who cannot comply with the July 1, 1998, deadline. However, MPCA staff is also sensitive to the fact that the information in the progress reports needs to be summarized and presented to the legislature. Therefore, the MPCA will issue an addendum to this report with the final recommendations of the group if consensus can be reached or with final recommendations from the MPCA. The addendum will be forth coming.

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# CASE STUDIES:

## ANCHOR TOOL AND PLASTIC, INC.

## EDCO PRODUCTS, INC.

## HIRSHFIELD'S PAINT MANUFACTURING, INC.

## HIGHWAY STRIPING PAINT

# Case Studies

**Anchor Tool and Plastics, Inc.**
**8109 Lewis Road**
**Golden Valley, Minnesota**
**Ron Rogers, President**

Anchor Tool and Plastics does injection molding of a wide variety of plastic items. Ron Rogers' company sells an advanced technology and capability, they are not a low end bidder. Anchor uses no heavy metals in their shop, partly for health and environmental reasons and partly because of the type of things they make. Their molding methods are different from blow molding although the pigment issues are the same for both types of molders.

Ron Rogers divides the use of plastics into four main areas, automotive, packaging, consumer goods, and durable goods. Automotive manufacturing is a big segment of the plastic industry. More and more car parts are made of plastic, and about 14 million vehicles are made each year in the U.S. Color is very important in the auto world. Parts may be made in several different plants around the country and they must match exactly (except for parts that are under the hood). Many car parts are manufactured in Minnesota but most are shipped out to assembly plants elsewhere.

Packaging is a large volume market for plastics and a major constituent of the waste stream. Low cost is a primary consideration in designing packaging. Color decisions are based on marketing and, to a lesser extent, on cost. Packaging tends to be manufactured close to where it will be used because transporting it long distances does not make sense. Any heavy metal use in packaging would be prohibited by the Toxics in Packaging statute.

Consumer goods are a little more permanent, things like toys, plastic goods, dishes, tools, casings, etc. The color of these objects are sometimes based on marketing decisions and recycled only to a limited extent. These are generally produced locally.

Durable goods are the objects that are slow to get into the waste stream. Pipe is a big part of this category along with appliances, furniture and building parts. Pipes are colored specific colors for recognition purposes, i.e., gas pipes are yellow. Theoretically they could be any color, but yellow is the industry standard.

The amount of pigment that must be used depends on the grade of plastic, what it is being used for, and the color that must be achieved. Water clear plastic is clear enough to read through. Translucent plastics vary from the color of milk jugs to industrial grades which are a muddy color. The industrial grades require more pigment to color them, but may be made into something where the color is less essential.

Red is a very hard color to achieve and requires the use of lots of pigment. It is also one of the most expensive colors because of the cadmium content. Ron believes that many of the technical difficulties of achieving the bright reds without using heavy metals have been solved but there are still some problems. Some colors are easy to achieve. Black requires only one to two percent carbon to make any grade of plastic black.

There are several ways Anchor's plastic can be colored. It can come to the facility that way, having been pre-colored to very precise specifications. It takes six to eight weeks to get a pre-colored order and there is a minimum amount that must be ordered, but for some applications, this method works best. Those orders come with a Material Safety Data Sheet (MSDS) listing the contents of the plastic. Anchor does not do any testing of their supplies. They rely on the suppliers to tell them what is in the plastic and colorant.

Blenders, like RTP Company in Winona, Minnesota create specialty plastics by taking generic material and adding fiber glass, filler, or whatever is needed. The special blends come from the blender with an MSDS and a list of added materials. Anchor uses a blender for small batches when they do not want to mix it themselves, for very specialized orders.

The third way plastic is colored is with color concentrate. Anchor gets much of its concentrate from Reed Spectrum. Reed Spectrum takes a base plastic, mixes in the powdered colorant and makes it into small pellets. The color concentrate pellets are mixed into a larger batch of plastic, melted together and then molded into products. The amount of concentrate used depends on the color and what is being colored.

Liquid concentrates can also be used to color feedstock. Liquids are not used much because of technical difficulties with getting the proper blend, and because they are difficult to handle. Whatever the coloring method, the ingredients that actually give the colorants their color are the same in all cases. So if a substitute for a particular color is found, everyone, regardless of their molding process should be able to use it.

Inventory control is one of the main reasons to use concentrates. Because concentrate is added in much smaller proportions to the generic plastic, it is much easier to store the smaller bags of concentrate and add it as needed, than to store the pre-colored feedstock. Anchor can mix batches of the size needed rather than trying to meet a minimum order for pre-colored materials.

Ron really believes that if the industry is given enough time and expends enough effort, they will be able to replace the heavy metals. The industry is at least part way there.

**EDCO Products, Inc.**
**845 Excelsior Avenue East**
**Hopkins, Minnesota 55323**
**Jock Edwards Vice President of Marketing**

Edco Products is a 50 year old manufacturer of prefinished metal building products, located in Hopkins, Minnesota. 'Coils' are large rolls of light gauge flat sheets of steel and aluminum. These coils are put on a coating line, uncoiled, cleaned, pretreated, primed, painted, cured and then recoiled. The painted coil is then processed into a variety of exterior building products such as siding, gutters and drain pipes, and architectural decorations. Their building products are marketed nationwide.

Coil coating is one of the most efficient and controlled painting methods used today. The pretreatment, primer and paint is applied only to the part of the strip which is used. Edco offers their products in about 54 different colors. The coatings are applied by a coating machine and cured at a temperature of 600 degrees Fahrenheit. All painted scrap metal or 'off spec' products are recycled. The drums which contain the paint are sent to a drum reconditioner for cleaning and reuse. Edco produces little hazardous waste. Since Edco uses standard colors, there is no need to dispose of any paint. Any left over paint is added to the next drum of the same color.

Edco uses a hexavalent chromium primer on the coil. They use a lead-containing paint on the prepared metal surfaces, and one of their product lines contains very low levels of cadmium for ultra violet light stability. There is no mercury in any of the products Edco uses.

Akzo Nobel is Edco's largest supplier of paints and primers. Akzo is the world's largest paint manufacturer and has taken a leadership position in the elimination of heavy metals from their coatings whenever doing so does not seriously compromise product performance and quality. Special permission to use hexavalent chromium must be granted by corporate headquarters, and is granted only in the case where quality would otherwise be compromised. Cadmium pigments are forbidden for use in Akzo products because of the difficulty and expense of proper handling. Mercury is not intentionally added to any of its products.

Akzo has developed lead-free formulations for most of the products they sell to Edco. However, some colors cannot be matched using the lead-free formulations. Akzo representatives have stated that the alternative will have some shortcomings. Certain physical properties as well as durability will be compromised. This will result in reducing the life cycle of Edco's products. Edco representatives believe that using such inferior coatings would compromise the product quality resulting in an overall negative effect on the environment by necessitating the surface preparation and repainting, in the field, of

previously maintenance-free materials. Additionally, this would put Edco at a competitive disadvantage in the marketplace, as their competitors in other states can continue to manufacture products utilizing current coating formulations.

Akzo uses cadmium in very small amounts as a stabilizer in its polyvinyl chloride (PVC) coatings. PVC polymers are inherently tough and chemical-resistant, they are; however, very unstable in the presence of ultraviolet light without the addition of stabilizers. A combination of cadmium, barium, and zinc is the best stabilizer currently available. Akzo has an ongoing program directed at finding an acceptable substitute to cadmium-based stabilizers. If Akzo does not have a substitute by July 1, 1998, they will be forced to withdraw this product from the Minnesota marketplace.

Representatives from Akzo believe replacement of hexavalent chromium in coatings used on exterior metal products will be extremely difficult. That particular valent state of chromium possesses unique corrosion-inhibiting properties. Research has been on-going for over twenty years, and Akzo efforts have been intensive and global. Projects are underway with National Aeronautics and Space Administration, the U.S. Navy,
Los Alamos National Laboratory, and three major universities as well as weathering and field trials being done in Europe and the U.S. Research was begun by Akzo prior to passage of the Toxics statute. Akzo representatives believe that Minnesota's ban may be the first of several and that other states are contemplating similar legislation. Despite all the research; however, it may be years before a commercially available alternative comes to market.

Edco officials are very concerned about the impact that the legislation would have on their ability to continue to compete with companies manufacturing similar products in other states. If the quality of Edco's products is in any way compromised, their customers would have no recourse but to look to Edco's competitors for products suitable for use on the exterior environment.

**Hirshfield's Paint Manufacturing Inc.**
**4450 Lyndale Avenue North**
**Minneapolis, Minnesota 55412**
**Mark Uglem, Executive Vice President**

Hirshfield's is a fourth generation family-owned paint manufacturing company in Minnesota. They primarily make residential and building paints, primers and sealant.
Mark Uglem, Executive Vice President, says the paint industry is largely made up of up two groups; trade paints (architectural) and industrial manufacturers. Paint is not as big an industry in Minnesota as it was years ago, there is only a small community of paint companies remaining. Valspar Paints, for example, does not manufacture paint in Minnesota anymore. There has been much consolidation in the paint industry nationally as well, there are about 700 paint companies in the U.S.

Hirshfield's does not and never has used any heavy metals in their formulations. Mark thinks that, at least for the types of paint that Hershfield's manufactures, if the paint is correctly formulated, there should be no need for heavy metals in it. However, some industrial applications such as car touch-up paints or certain types of specialized-use paints with high performance requirements such as anti-corrosion might be exceptions.

Although most of their business is for residential paint, Hirshfield's has turned down jobs to formulate other types of paint if it went against the company's policy or code of ethics. Economics, environmental concern, and a desire to keep employees safe were the impetus to manufacture only lead-free and environmentally friendly paints. Hans Hirshfield, a member of the latest generation to work in the business, says the "backyard theory" is the reason that the company will turn down business that requires the use of heavy metals. His employees, his business, and much of his sales are in his back yard. Mark Uglem's son works in the plant. In addition, working with non-lead containing paints is cheaper for Hirshfield's in the long run. They do not have to comply with the OSHA workplace lead standard, they have a healthier environment for workers, and virtually no hazardous waste.

Making a batch of residential paint is similar to baking a cake. Hirshfield's has very precise recipes for each of their colors and formulations. Small amounts of pigments, and other ingredients are mixed with a base, other ingredients are added and the paint is then mixed again. It is then put in cans or five gallon buckets (usually used by contractors). Paint manufacturing companies rely on their suppliers, the raw material companies, to meet the manufacturer's very tight specifications. Hirshfield's paint chemist will look over the specification sheet or a certificate of analysis from the raw materials suppliers and will contact the appropriate people if something is wrong.

More and more paint companies, including Hirshfield's, are getting away from oil based paints. Hirshfield's has a goal of moving towards selling only latex within the next couple

of years. They have been developing paints that work better in northern climates and can withstand our harsh winters and dramatic changes in temperature. In more southern climates, mold and very strong sun light are bigger challenges. There are new formulations of latex paint which can be applied at temperatures below 50 degrees. These will be a great advantage to contractors and do-it-yourselfers because of the extended painting season.

Mark does not think the ban in the Toxics statute should be a problem for his company; however, he supports the 100 ppm limit in the Toxics statute as a necessary exemption for trace amounts of heavy metals sometimes found in pigments. They have found a successful market niche for themselves and have not found compliance with the Toxics statute to be a problem. Mark cautions that certain industrial manufacturers may feel differently; however, since the applications for their products are different.

**Highway Striping Paint**
**Minnesota Department of Transportation**

One of the types of paints affected by the Toxics statute are the paints used by the Minnesota Department of Transportation (MNDOT) on Minnesota roads. MNDOT uses white and yellow paints to stripe center lines, lines along the side of the road, and curbs. Similar paint is used (not necessarily by MNDOT) to stripe parking lots and curbs. All paint used on MNDOT projects, even by those who contract to do road work, must meet the specifications established by MNDOT. A contract with a paint manufacturer is established annually by MNDOT for purchase of paint which meets their specifications. The counties and other units of government are also allowed to purchase paint under this contract.

Highway striping paints fall under the Toxics statute because some contain lead and hexavalent chromium in the form of lead chromate. White highway paint used in Minnesota does NOT contain any heavy metals, and has not since 1990. Yellow paint contains, in some cases, relatively high levels of lead chromate, around seven percent by weight. The yellow paint that MNDOT purchased in 1993 contained a total of 97,240 pounds of lead and 24,423 pounds of chromium.

The latex and alkyd paints used in 1993 contained 0.641 pounds of lead per gallon and 0.161 pounds of chromium. It takes an average of 16.5 gallons of paint to stripe one mile of highway. Thus, the alkyd and latex paints used equaled approximately 10.7 pounds of lead and 2.7 pounds of chromium per highway mile. In 1993, epoxy paint when placed, had 1.7 pounds of lead and 0.43 pounds of chromium per gallon. Multiplied by the application rate of 16.5 gallons per mile, the epoxy used in 1993 equaled 28.1 pounds of lead and 7.1 pounds of chromium per highway mile.

In January 1994, in anticipation of the effective date of the Toxics statute, MNDOT changed their specifications to prohibit the use of lead or chromium in any of their pavement markings. There are three products MNDOT uses for striping; alkyd paint, latex paint and an epoxy paint. Epoxy paint is used primarily by contractors working on MNDOT jobs, latex and alkyd paints are used by both MNDOT crews and contractors. During 1994, MNDOT experienced some quality problems as vendors worked on some of the technical difficulties. By 1995, the products used by MNDOT crews had improved to the point where the trade-off for quality and increased cost were acceptable to them. Problems with the lead chromate-free epoxy seemed to have been worked out by the end of the 1995 construction season when a new version of a metal-free paint was substituted. (Overview of MNDOT's Traffic Marking Materials, March 1996 fact sheet.)

The metal-free paints are more expensive, in general, than the metal-containing paints, sometimes significantly more expensive. Exactly how much more expensive is difficult to calculate because of the different types of paint, differing costs associated with application of the paint and the difficulty of figuring in the hazardous waste handling costs for metal-

containing paint. Although the metal-free paints are more expensive, MNDOT does not view the cost of the metal-free paints as a deterrent to their use. (March 1996 fact sheet.)

The more significant issue is the decreased brightness of the metal-free yellow paints. Retroreflectivity is the paint's ability to reflect light back and is a technical measure of brightness. MNDOT has found that the new yellow paints are 16 to 33 percent less bright than the lead chromate paints. The yellow metal containing paints used prior to 1994 produced a retroreflectivity of between 200 and 220 mcd/m/lux (a measurement of night time visibility). The same measurement of the new organic pigments have not been as high and have been between 180 and 140 mcd/m/lux. The metal free yellow paints meet federal Department of Transportation standards but are not as bright.

It is interesting to note that in the area of using metal-free pavement markings, Minnesota is not alone. As part of a joint research project with MNDOT, MPCA staff contacted engineers and officials in other states and learned that the states of Maryland, Pennsylvania, Florida and parts of Wisconsin use metal free paints, and in some cases have been for years. In addition, the state of California has started a pilot project using metal-free paints and plans to completely convert over to metal-free paints by the year 2000, if not by the end of this year.

The experiences of the other states which have been using metal-free pavement markings has been varied. Maryland switched to metal-free, acrylic, water-borne paint in 1987-88 for striping and all transportation signs. There was an initial expense of converting over to the metal-free paint because the tanks and pipes on the painting truck must be made out of stainless steel rather than galvanized steel. Pat Murray, who writes specifications for the Maryland Department of Transportation, felt that the night time reflectivity of the paint is the same as when it contained lead. They have not experienced any significant problems and have saved money in the long run because of lower hazardous waste disposal costs. The cost of the metal-free paint has fallen over time and the Maryland Department of Transportation now pays $5.39 a gallon for yellow paint. (Ms. Pat Murray, Maryland DOT, personal communications, 6/25/96.)

The state of Florida has been using metal-free paint since 1994. They changed paints after a landfill the Florida Department of Transportation (DOT) had been using for disposal was listed as a SUPERFUND site. Frank Rey, chief chemist with Florida DOT said they initially had a problem with the time it takes their paint to dry (eight to ten minutes). They now use a paint that dries in less than two minutes. They have had some difficulty with the brightness of the paint. Florida DOT also uses a thermal plastic for striping, a material which would not be suitable for use on Minnesota roads because a snow plow could scrape up a whole strip. (Mr. Frank Rey, Florida DOT, personal communication, 7/21/96.)

Pennsylvania Department of Transportation (DOT) also switched to a metal-free paint in 1994. Their decision to switch was based more on the superior performance of the water-

borne acrylic paint and the OSHA compliance issues for DOT workers (protecting and testing workers) and the costs of hazardous waste disposal. There was also concern about the fate of the lead and hexavalent chromium which was ground off the roads when new paint was applied. Dave Kuniega from Pennsylvania DOT said they have had problems with the yellow color of the paint changing over time when it is exposed to sun light. They also have noticed some decrease in the reflectivity over time, although it still meets federal standards. The roads in Pennsylvania are subjected to much the same winter abuse as the roads in Minnesota, parts of Pennsylvania typically receive more than 160 inches of snow. (Mr. Dave Kuniega, Personal communication, 7/15/96.)

In 1994, the California Air Resources Board (ARB) and the California Department of Transportation (Caltrans) started a joint project to evaluate the use of traffic paints which did not contain lead and hexavalent chromium. An U.S. EPA grant for pollution prevention was used to help fund the project. The evaluation went so well that the phase out of the use of metal-containing paint should be completed in 1997. Caltrans and the ARB have stated that "use of the substitute paint will reduce public exposure to lead and to hexavalent chromium, one of the most potent carcinogens identified by the ARB as a toxic air contaminate." (ARB fact sheet, August, 1996.) Mark Watkins of the ARB acknowledges that the reformulated paints are more expensive. Costs have gone from about $5 per gallon to $6-$10 per gallon. He pointed out that some of that cost difference will be offset by lower hazardous waste disposal costs. According to Watkins, Minnesota's Toxics statute was the inspiration for entering into their agreement with Caltrans to eliminate metal-containing paints.
(Mr. Mark Watkins, ARB, Personal communications, September 2, 1996.)

The southwest corner of Wisconsin and eight counties along Lake Michigan, have been using metal-free highway paints since 1990. Wisconsin DOT is very decentralized so each district sets its own specifications. Bill Katheiser, the signing and pavement marking supervisor for District 2, says they have found that the metal-free paint is a lot more sensitive to weather and road conditions and the drying time is longer. The paint seals well and night visibility is good, although no reflectivity readings have been done. Their cost is $4.83 per gallon.
(Mr. Bill Katheiser, Wisconsin DOT, personal communications, 6/28/96.)

The Northeastern Association of State Highway and Transportation Officials concluded, based on testing done in Pennsylvania in 1994 and 1995, that performance of almost all of the waterborne, metal-free paints was superior to the solvent-borne paints for the duration of the official test period (two years). However, the retroreflectivity of the yellow paints was almost half that of the white paints. They also found that there was a wide color variation in the yellow products and field exposure caused distinct color changes on a number of the products tested. They also concluded that:

> "using waterborne paints requires greater care, more attention to detail and strict adherence to the manufacturer's recommendations by striping crews.

Green algae
Water flea
Fathead minnow
Lettuce
Frog eggs

Most sensitive

Least sensitive

* It is possible that the toxicity observed in some of the paints, particularly the latex, might result from intentional addition of biocides by paint manufacturers. Biocides may have been added so that molds, algae or other single celled organisms would not grow in the paint prior to use. We have no information on those types of additives to the paints tested.

* The paints were also analyzed for relative amounts of organic constituents which might potentially bioaccumulate in fish tissue. The number of constituents in each paint were measured, but not identified. The presence of a material which might bioaccumulate does not indicate whether or not the material would be harmful to an exposed organism.

Lead-containing alkyd paint
Non-lead alkyd paint
Non-lead epoxy
Non-lead latex

Most potentially bioaccumulative compounds

Least potentially bioaccumulative compounds

The interpretation above is still preliminary, based on the first half of the laboratory testing done. Yet the research done under this MOU has raised interesting questions, some of which staff hope to answer in the research to come. These tests do not address the issue of the eventual release of lead chromate to the environment by way of abrasion of the paint, or contact with solvents. Field tests scheduled to be run next year will hopefully provide some insight into some of those questions.

The decision about whether to require the use of metal-free paints will involve an evaluation of the short term toxicity verses potential long-term loading of heavy metals to the environment. Other factors such as worker safety should be considered as well. The industry is continuing to work on improving the retroreflectivity of the non-metal yellow striping paint because that remains an issue. However, it seems clear that the industry is moving away from metal-containing paints (Summary of Results 1994 Field and Laboratory Evaluations, page 10) and there are already five states which have switched to non-metal containing paints.

# APPENDIX 1

# MINN. STAT § 115A.9651,

# TOXICS IN SPECIFIED

# PRODUCTS

## 115A.9651 TOXICS IN SPECIFIED PRODUCTS; ENFORCEMENT.

**Subdivision 1. Prohibition.** (a) Except as provided in paragraph (d), no person may distribute for sale or use in this state any ink, dye, pigment, paint, or fungicide manufactured after September 1, 1994, into which lead, cadmium, mercury, or hexavalent chromium has been intentionally introduced.

(b) For the purposes of this subdivision, "intentionally introduce" means to deliberately use a metal listed in paragraph (a) as an element during manufacture or distribution of an item listed in paragraph (a). Intentional introduction does not include the incidental presence of any of the prohibited elements.

(c) The concentration of a listed metal in an item listed in paragraph (a) may not exceed 100 parts per million.

(d) The use of lead in substances utilized in marking road, street, highway, and bridge pavements is exempt from this subdivision until July 1, 1998.

**Subd. 2. Temporary exemption.** (a) An item listed in subdivision 1 is exempt from this section until July 1, 1998, if the manufacturer of the item submitted to the commissioner a written request for an exemption by August 1, 1994. The request must include at least:

(1) an explanation of why compliance is not technically feasible at the time of the request;

(2) how the manufacturer will comply by July 1, 1997; and

(3) the name, address, and telephone number of a person the commissioner can contact for further information.

(b) By September 1, 1994, a person who uses an item listed in subdivision 1, into which one of the listed metals has been intentionally introduced, may submit, on behalf of the manufacturer, a request for temporary exemption only if the manufacturer fails to submit an exemption request as provided in paragraph (a). The request must include:

(1) an explanation of why the person must continue to use the item and a discussion of potential alternatives;

(2) an explanation of why it is not technically feasible at the time of the request to formulate or manufacture the item without intentionally introducing a listed metal;

(3) that the person will seek alternatives to using the item by July 1, 1997, if it still contains an intentionally introduced listed metal; and

(4) the name, address, and telephone number of a person the commissioner can contact for further information.

(c) A person who submits a request for temporary exemption under paragraph (b) may submit a request for a temporary exemption after September 1, 1994, for an item that the person will use as an alternative to the item for which the request was originally made as long as the new item has a total concentration level of all the listed metals that is significantly less than in the original item. An exemption under this paragraph expires July 1, 1998, and the person who requests it must submit the progress description required in paragraph (e).

(d) By October 1, 1994, and annually thereafter if requests are received under paragraph (c), the commissioner shall submit to the legislative commission on waste management a list of manufacturers and persons that have requested an exemption under this subdivision and the items for which exemptions were sought, along with copies of the requests.

(e) By July 1, 1996, each manufacturer on the list shall submit to the commissioner a description of the progress the manufacturer has made toward compliance with subdivision 1, and the date compliance has been achieved or the date on or before July 1, 1998, by which the manufacturer anticipates achieving compliance. By July 1, 1996, each person who has requested an exemption under paragraph (b) or (c) shall submit to the commissioner:

(1) a description of progress made to eliminate the listed metal or metals from the item or progress made by the person to find a replacement item that does not contain an intentionally introduced listed metal; and

(2) the date or anticipated date the item is or will be free of intentionally introduced metals or the date the person has stopped or will stop using the item.

By October 1, 1996, the commissioner shall submit to the legislative commission a summary of the progress made by the manufacturers and other persons and any recommendations for appropriate legislative or other action to ensure that products are not distributed in the state after July 1, 1998, that violate subdivision 1.

**Subd. 3. Application; enforcement.** (a) This section does not apply to art supplies.

(b) This section may be enforced under sections 115.071 and 116.072. The attorney general or the commissioner of the agency shall coordinate enforcement of this section with the director of the office.

**HIST:** *1991 c 337 s 51; 1993 c 249 s 25; 1993 c 366 s 7; 1994 c 585 s 30; 1995 c 247 art 1 s 28; 1996 c 455 art 3 s 1; 1996*

# APPENDIX 2

# LIST OF COMPANIES

# CURRENTLY EXEMPTED

# UNDER MINN. STAT. § 115A.9651

## Companies Currently Exempted Under Minn. Stat. § 115A.9651

3M
AKZO Nobel Coatings, Inc.
American Porcelain Enamel Co.
American Standox, Inc.
Americhem, Inc.
BASF Corporation
Bruning Paint Company
Brunswick Bowling
Carboline Company
Cerdec Corporation
Coates Screen, Inc.
Cookson Matthey Ceramics, Inc.
Cookson Pigments
Courtaulds Aerospace
Coventry Coatings Corporation
Coz Corporation
CPF One Shot
Cudner & O'Conner Company
DEFT, Inc.
Dexter Corporation
Dominion Colour Corporation
E.I. DuPont deNemours & Co.
Elpaco Coating Company
Engelhard Corporation
Ferro Corporation
General Color & Chemical Co.
General Formulations
Glidden Research Center
Harwick Chemical Corporation
Henkel Corporation - Parker Amchem
Hentzen Coatings, Inc.
Horton-Earl Company
House of Kolor
Ink Dezyne International, Inc.
Interplastic Corporation
Johnson Mathey
Lilly Industries, Inc./Moline Paints
LNP Engineering Plastics, Inc.
Lockheed Forth Worth Company
M.A. Hanna Company
Mameco Paint, Inc.
Mar-Hyde Corporation
Mautz Paint Company
Morton Industrial Coatings
NAZ-DAR/KC
Neste Polyester, Inc.
Peacock Colors, Inc.
Penn Color, Inc.
Plast-kote Company, Inc.
PPG Industries, Inc.
Pratt & Lambert
RTP Company
Reed Spectram
Sartomer
SCM Chemicals
Sericol, Inc.
Sherwin Williams Company
Sierra Corporation
Spies Hecker, Inc.
T. J. Ronan Paint Corporation
Techmer PM
TNEMEC Company, Inc.
U.S. Paint Corporation
United Mineral & Chemical Corp
Uponor Aldyl Company
Valspar Corporation
Viking Paints, Inc.
Vogel Paint & Wax Company, Inc.
Wayne Pigment Corporation
Whitford, Corporation
Yenkin-Majestic Paint Corporation

### Users Exempt

Excel Metal Finishing Company
Gopher Sign Company
Honeywell, Inc.
McKechnie Plastic Components
Northland Aluminum Products, Inc.
United Defense LP

### Trade Associations

American Wood Preservers Institute for:
- Chemical Specialties, Inc.
- Hickson Corp.
- Osmose Wood Preserves

CPMA Color Pigments Mfg. Assoc., Inc. for:
- Appollo Colors, Inc.
- Arizona Oxides, Inc.
- Columbian Chemicals Company
- E.M. Industries, Inc.
- Harcros Pigments, Inc.
- Hoover Color Corp.
- Ishihara Corp. (USA)
- Kikuchi Color & Chemical Works, Inc.
- Mason Color & Chemical Works, Inc.
- Miles, Inc.
- New Riverside Ochre
- Shepherd Color Co.
- National Paint & Coating Association



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# APPENDIX 3

# PARTICIPANTS IN DRAFTING

# THE CONEG MODEL LEGISLATION,

# TOXICS IN PACKAGING

## Organizations That Negotiated Reduction of Metals in Packaging Legislation

The following industries, environmental groups, trade associations, consultants and government agencies were involved in negotiating the limits on cadmium, hexavalent chromium, lead and mercury in packaging, as well as the drafting of model legislation.

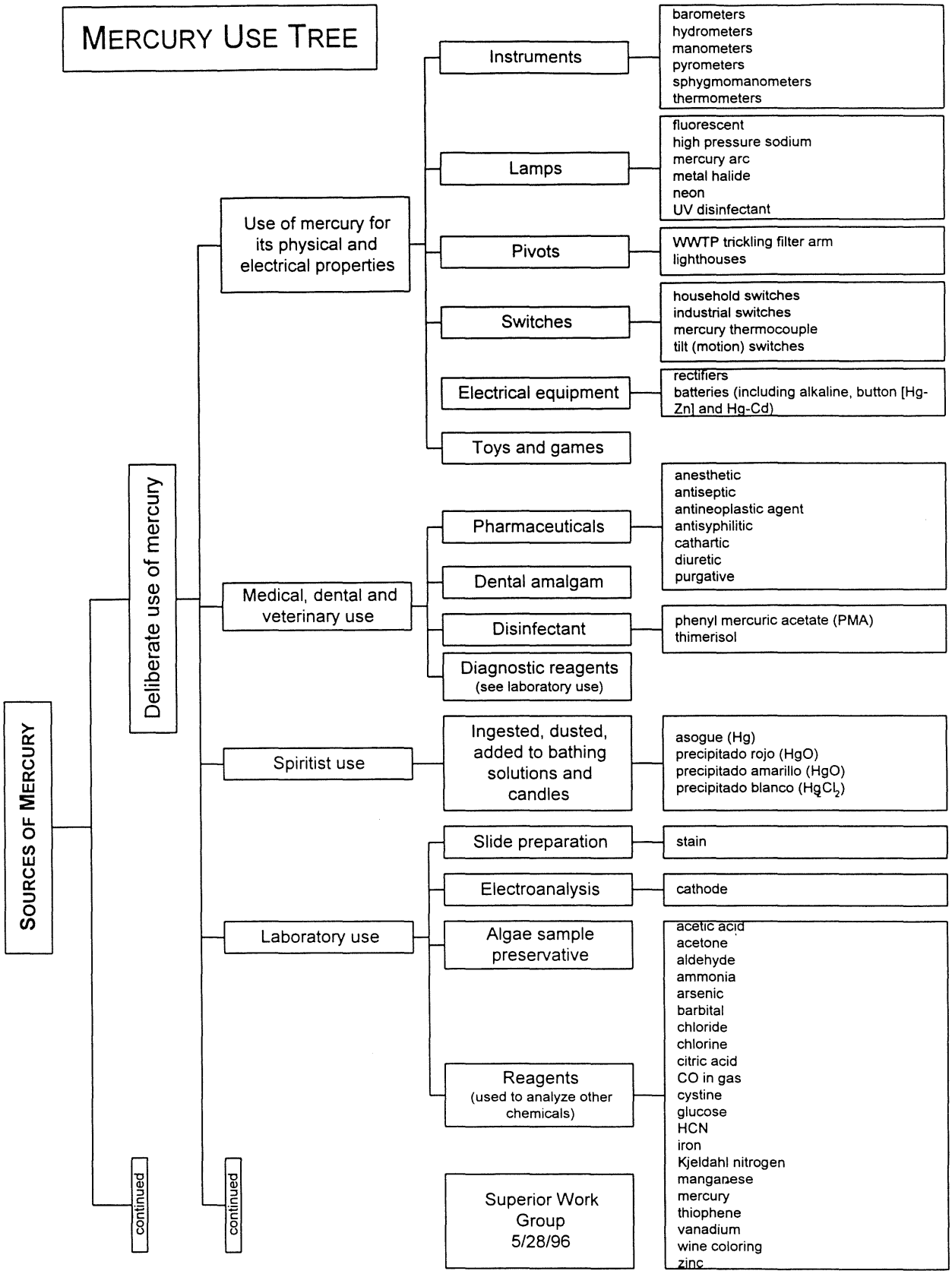
| Industries | Trade Association and Consultants |
|---|---|
| Alcoa | American Paper Institute |
| Allied Signal | American Plastics Council (formerly Council for Solid Waste Solutions) |
| American National Can | Food Marketing Institute |
| Bristol Meyers/Squib | Franklin and Associates |
| Campbell Soup | Glass Packaging Institute |
| Clorox | Grocers' Manufacturers Association |
| Continental Can | Septic Packaging Council |
| Digital Computer | Soap and Detergent Association |
| Dow Chemical | Steel Recycling Institute |
| General Mills | Tellus Foundation |
| Heinz | **Environmental Organizations** |
| James River Paper | Citizens for Responsible Waste Management |
| Johnson and Johnson | Conservation Foundation |
| Kodak | Conservation Law Foundation |
| McDonalds | Environmental Action Coalition |
| Mobil | Environmental Action Foundation |
| Oxidental Chemical | Environmental Defense Fund |
| Pepsi Cola | INFORM |
| Phillip Morris | National Audubon Society |
| Proctor and Gamble | National Resource Council of Maine |
| Scott Paper | National Resource Defense Council |
| Seagrams | New Jersey Alliance for Action |
| Sears | New Jersey for a Clean Tomorrow |
| Tam Brand (Tampax) | New York Public Interest Research Group |
| Wellman | Pennsylvania Resource Council |
| **Government Agencies** | Special Public Advisory Committee on the Environmental to Atlantic County Freeholders (New Jersey) |
| City of New York | Vermont Public Interest Research Group |
| Nine states in the Council of Northeastern Governors — Connecticut, Maine, New Hampshire, New Jersey, Rhode Island, Vermont, Pennsylvania, New York and Massachusetts. | **Other Organizations** |
| State of Minnesota | Cornell University |

# APPENDIX 4

# MERCURY TREE

# INDICATING SOURCES

# OF MERCURY IN THE ENVIRONMENT


MERCURY USE TREE
SOURCES OF MERCURY
Deliberate use of mercury
Use of mercury for its physical and electrical properties
Instruments
barometers
hydrometers
manometers
pyrometers
sphygmomanometers
thermometers
Lamps
fluorescent
high pressure sodium
mercury arc
metal halide
neon
UV disinfectant
Pivots
WWTP trickling filter arm
lighthouses
Switches
household switches
industrial switches
mercury thermocouple
tilt (motion) switches
Electrical equipment
rectifiers
batteries (including alkaline, button [Hg-Zn] and Hg-Cd)
Toys and games
Medical, dental and veterinary use
Pharmaceuticals
anesthetic
antiseptic
antineoplastic agent
antisyphilitic
cathartic
diuretic
purgative
Dental amalgam
Disinfectant
phenyl mercuric acetate (PMA)
thimerisol
Diagnostic reagents
(see laboratory use)
Spiritist use
Ingested, dusted, added to bathing solutions and candles
asogue (Hg)
precipitado rojo (HgO)
precipitado amarillo (HgO)
precipitado blanco ($HgCl_2$)
Laboratory use
Slide preparation
stain
Electroanalysis
cathode
Algae sample preservative
Reagents
(used to analyze other chemicals)
acetic acid
acetone
aldehyde
ammonia
arsenic
barbital
chloride
chlorine
citric acid
CO in gas
cystine
glucose
HCN
iron
Kjeldahl nitrogen
manganese
mercury
thiophene
vanadium
wine coloring
zinc
Superior Work Group
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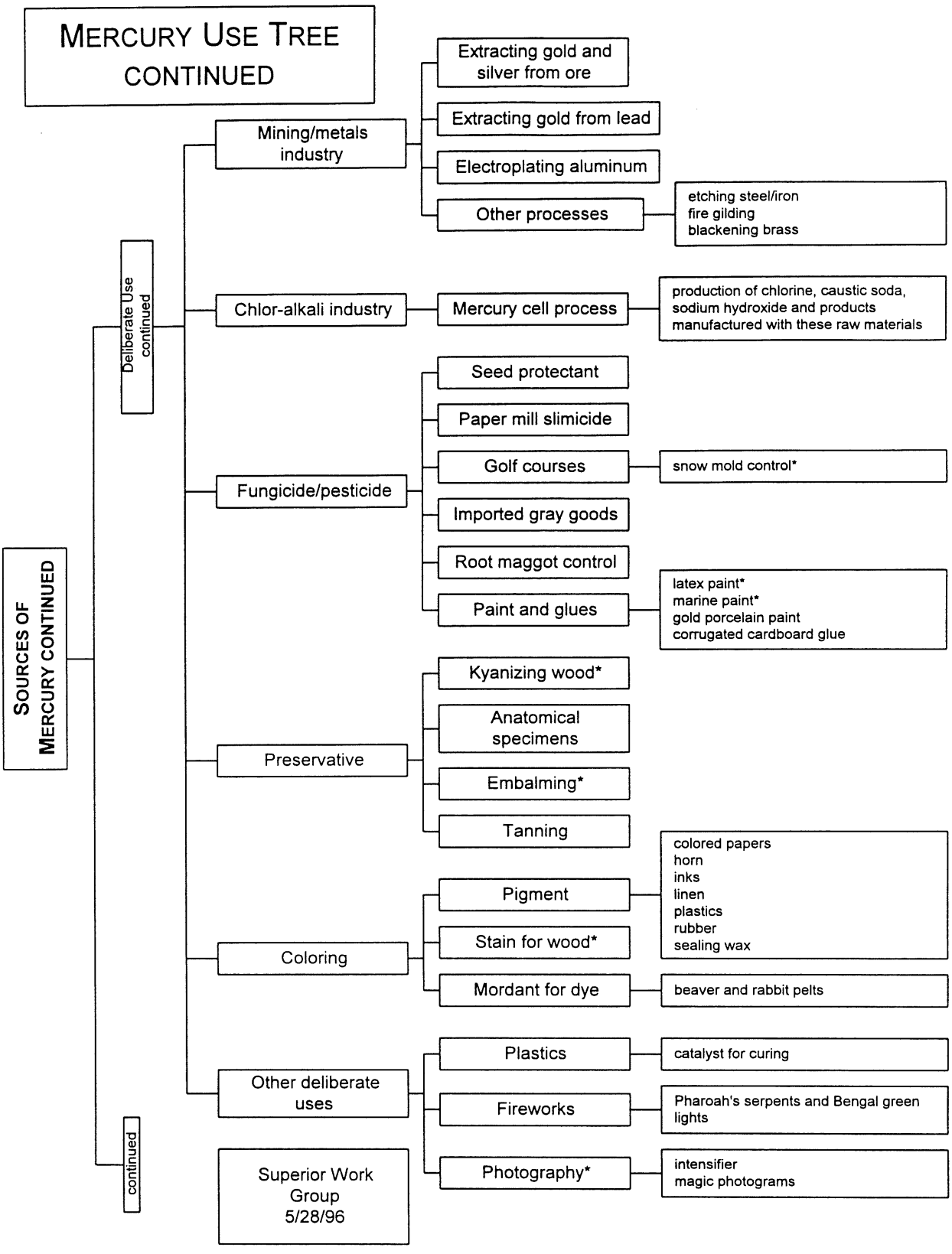
continued
continued


MERCURY USE TREE
CONTINUED
SOURCES OF MERCURY CONTINUED
Deliberate Use continued
continued
Mining/metals industry
Extracting gold and silver from ore
Extracting gold from lead
Electroplating aluminum
Other processes
etching steel/iron
fire gilding
blackening brass
Chlor-alkali industry
Mercury cell process
production of chlorine, caustic soda, sodium hydroxide and products manufactured with these raw materials
Fungicide/pesticide
Seed protectant
Paper mill slimicide
Golf courses
snow mold control*
Imported gray goods
Root maggot control
Paint and glues
latex paint*
marine paint*
gold porcelain paint
corrugated cardboard glue
Preservative
Kyanizing wood*
Anatomical specimens
Embalming*
Tanning
Coloring
Pigment
colored papers
horn
inks
linen
plastics
rubber
sealing wax
Stain for wood*
Mordant for dye
beaver and rabbit pelts
Other deliberate uses
Plastics
catalyst for curing
Fireworks
Pharoah's serpents and Bengal green lights
Photography*
intensifier
magic photograms
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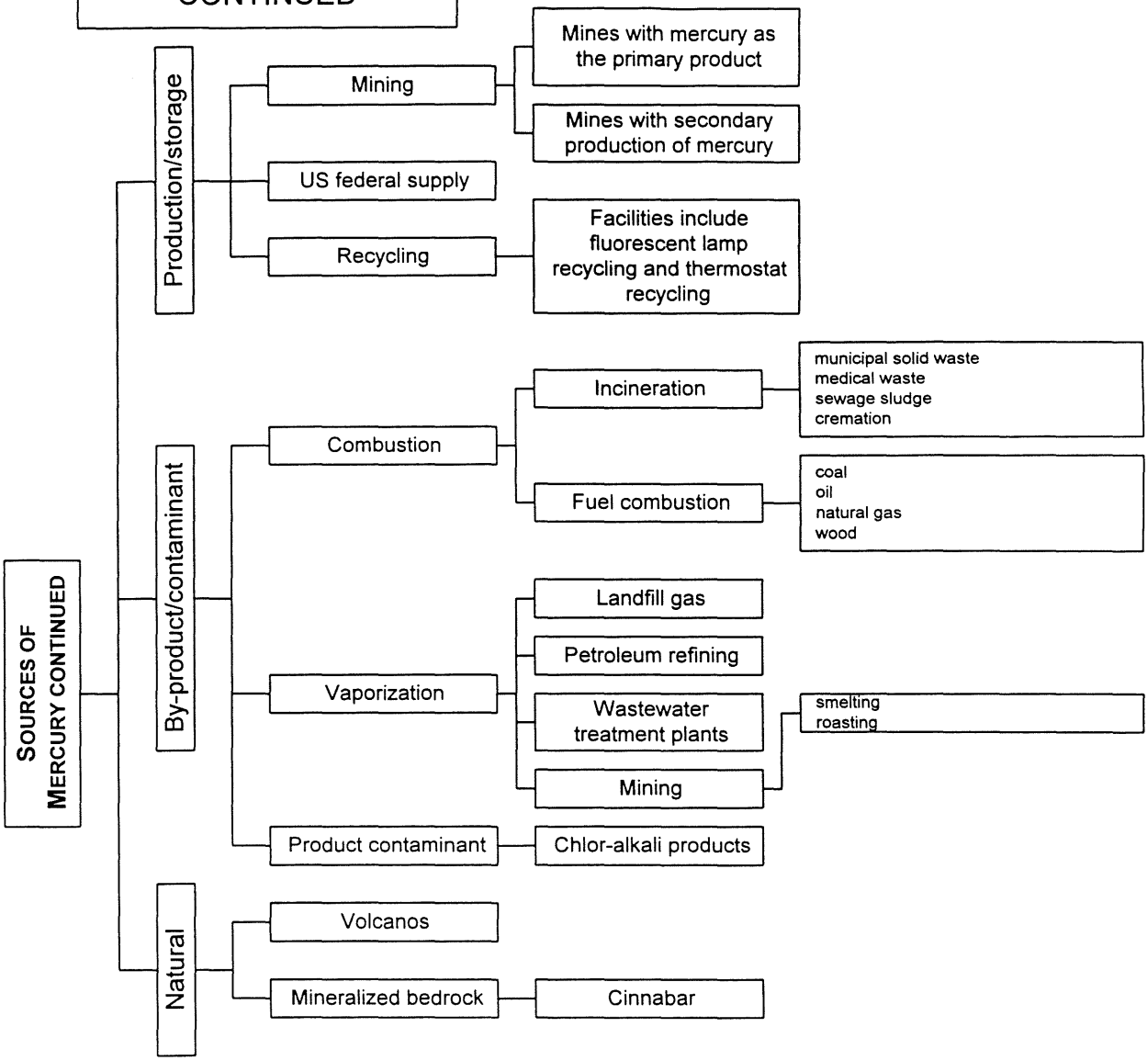
# MERCURY USE TREE CONTINUED




* = discontinued

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# APPENDIX 5

# CONSENSUS STATEMENT

# AND LIST OF

# PARTICIPANTS AT THE

# WORK SESSION ON

# ENDOCRINE DISRUPTERS

# STATEMENT FROM THE WORK SESSION ON

# CHEMICALLY-INDUCED ALTERATIONS IN SEXUAL DEVELOPMENT: THE WILDLIFE/HUMAN CONNECTION

## THE PROBLEM

Many compounds introduced into the environment by human activity are capable of disrupting the endocrine system of animals, including fish, wildlife, and humans. The consequences of such disruption can be profound because of the crucial role hormones play in controlling development. Because of the increasing and pervasive contamination of the environment by compounds capable of such activity, a multidisciplinary group of experts gathered in retreat at Wingspread, Racine, Wisconsin, 26-28 July 1991 to assess what is known about the issue. Participants included experts in the fields of anthropology, ecology, comparative endocrinology, histopathology, immunology, mammalogy, medicine, law, psychiatry, psychoneuroendocrinology, reproductive physiology, toxicology, wildlife management, tumor biology, and zoology.

The purposes of the meeting were:

1. to integrate and evaluate findings from the diverse research disciplines concerning the magnitude of the problem of endocrine disruptors in the environment;
2. to identify the conclusions that can be drawn with confidence from existing data; and
3. to establish a research agenda that would clarify uncertainties remaining in the field.

## CONSENSUS STATEMENT

The following consensus was reached by participants at the workshop.

1. *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.[1]

[1]Chemicals known to disrupt the endocrine system include: DDT and its degradation products, DEHP (di(2-ethylhexyl)phthalate), dicofol, HCB (hexachlorobenzene), kelthane, kepone, lindane and other hexachlorocyclohexane congeners, methoxychlor, octachlorostyrene, synthetic pyrethroids, triazine herbicides, EBDC fungicides, certain PCB congeners, 2,3,7,8-TCDD and other dioxins, 2,3,7,8-TCDF and

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

- The patterns of effects vary among species and among compounds. Four general points can nonetheless be made: (1) the chemicals of concern may have entirely different effects on the embryo, fetus, or perinatal organism than on the adult; (2) the effects are most often manifested in offspring, not in the exposed parent; (3) the timing of exposure in the developing organism is crucial in determining its character and future potential; and (4) although critical exposure occurs during embryonic development, obvious manifestations may not occur until maturity.

- Laboratory studies corroborate the abnormal sexual development observed in the field and provide biological mechanisms to explain the observations in wildlife.

- Humans have been affected by compounds of this nature, too. The effects of DES (diethylstilbestrol), a synthetic therapeutic agent, like many of the compounds mentioned above, are estrogenic. Daughters born to mothers who took DES now suffer increased rates of vaginal clear cell adenocarcinoma, various genital tract abnormalities, abnormal pregnancies, and some changes in immune responses. Both sons and daughters exposed *in utero* experience congenital anomalies of their reproductive system and reduced fertility. The effects seen in *in utero* DES-exposed humans parallel those found in contaminated wildlife and laboratory animals, suggesting that humans may be at risk to the same environmental hazards as wildlife.

2. *We estimate with confidence that:*

- Some of the developmental impairments reported in humans today are seen in adult offspring of parents exposed to synthetic hormone

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other furans, cadmium, lead, mercury, tributyltin and other organo-tin compounds, alkyl phenols (non-biodegradable detergents and anti-oxidants present in modified polystyrene and PVCs), styrene dimers and trimers, soy products, and laboratory animal and pet food products.

disruptors (agonists and antagonists) released in the environment. The concentrations of a number of synthetic sex hormone agonists and antagonists measured in the US human population today are well within the range and dosages at which effects are seen in wildlife populations. In fact, experimental results are being seen at the low end of current environmental concentrations.

- Unless the environmental load of synthetic hormone disruptors is abated and controlled, large scale dysfunction at the population level is possible. The scope and potential hazard to wildlife and humans are great because of the probability of repeated and/or constant exposure to numerous synthetic chemicals that are known to be endocrine disruptors.

- As attention is focused on this problem, more parallels in wildlife, laboratory, and human research will be revealed.

3. *Current models predict that:*

   - The mechanisms by which these compounds have their impact vary, but they share the general properties of (1) mimicking the effects of natural hormones by recognizing their binding sites; (2) antagonizing the effect of these hormones by blocking their interaction with their physiological binding sites; (3) reacting directly and indirectly with the hormone in question; (4) by altering the natural pattern of synthesis of hormones; or (5) altering hormone receptor levels.

   - Both exogenous (external source) and endogenous (internal source) androgens (male hormones) and estrogens (female hormones) can alter the development of brain function.

   - Any perturbation of the endocrine system of a developing organism may alter the development of that organism: typically these effects are irreversible. For example, many sex-related characteristics are determined hormonally during a window of time in the early stages of development and can be influenced by small changes in hormone balance. Evidence suggests that sex-related characteristics, once imprinted, may be irreversible.

   - Reproductive effects reported in wildlife should be of concern to humans dependent upon the same resources, e.g., contaminated fish. Food fish is a major pathway of exposure for birds. The avian (bird) model for organochlorine endocrine disruption is the best described to date. It also provides support for the wildlife/human connection because of similarities in the development of the avian and mammalian endocrine systems.

4. *There are many uncertainties in our predictions because:*

   - The nature and extent of the effects of exposure on humans are not well established. Information is limited concerning the disposition of these contaminants within humans, especially data on concentrations of contaminants in embryos. This is compounded by the lack of measurable endpoints (biologic markers of exposure and effect) and the lack of multi-generational exposure studies that simulate ambient concentrations.

   - While there are adequate quantitative data concerning reduction in reproductive success in wildlife, data are less robust concerning changes in behavior. The evidence, however, is sufficient to call for immediate efforts to fill these knowledge gaps.

   - The potencies of many synthetic estrogenic compounds relative to natural estrogens have not been established. This is important because contemporary blood concentrations of some of the compounds of concern exceed those of internally produced estrogens.

5. *Our judgment is that:*

   - Testing of products for regulatory purposes should be broadened to include hormonal activity *in vivo*. There is no substitute for animal studies for this aspect of testing.

   - Screening assays for androgenicity and estrogenicity are available for those compounds that have direct hormonal effects. Regulations should require screening all new products and by-products for hormonal activity. If the material tests positive, further testing for functional teratogenicity (loss of function rather than obvious gross birth defects) using multigenerational studies should be required. This should apply to all persistent, bioaccumulative products released in the past as well.

   - It is urgent to move reproductive effects and functional teratogenicity to the forefront when evaluating health risks. The cancer paradigm is insufficient because chemicals can cause severe health effects other than cancer.

   - A more comprehensive inventory of these compounds is needed as they move through commerce and are eventually released to the environment. This information must be made more accessible. Information such as this affords the opportunity to reduce exposure through containment and manipulation of food chains. Rather than

separately regulating contaminants in water, air, and land, regulatory agencies should focus on the ecosystem as a whole.

- Banning the production and use of persistent chemicals has not solved the exposure problem. New approaches are needed to reduce exposure to synthetic chemicals already in the environment and prevent the release of new products with similar characteristics.

- Impacts on wildlife and laboratory animals as a result of exposure to these contaminants are of such a profound and insidious nature that a major research initiative on humans must be undertaken.

- The scientific and public health communities' general lack of awareness concerning the presence of hormonally active environmental chemicals, functional teratogenicity, and the concept of transgenerational exposure must be addressed. Because functional deficits are not visible at birth and may not be fully manifested until adulthood, they are often missed by physicians, parents, and the regulatory community, and the causal agent is never identified.

6. *To improve our predictive capability:*

- More basic research in the field of developmental biology of hormonally responsive organs is needed. For example, the amount of specific endogenous hormones required to evoke a normal response must be established. Specific biologic markers of normal development per species, organ, and stage of development are needed. With this information, levels that elicit pathological changes can be established.

- Integrated cooperative research is needed to develop both wildlife and laboratory models for extrapolating risks to humans.

- The selection of a sentinel species at each trophic level in an ecosystem is needed for observing functional deficits, while at the same time describing the dynamics of a compound moving through the system.

- Measurable endpoints (biologic markers) as a result of exposure to exogenous endocrine disruptors are needed that include a range of effects at the molecular, cellular, organismal, and population levels. Molecular and cellular markers are important for the early monitoring of dysfunction. Normal levels and patterns of isoenzymes and hormones should be established.

- In mammals, exposure assessments are needed based on body burdens of a chemical that describe the concentration of a chemical

in an egg (ovum) which can be extrapolated to a dose of the chemical to the embryo, fetus, newborn, and adult. Hazard evaluations are needed that repeat in the laboratory what is being seen in the field. Subsequently, a gradient of doses for particular responses must be determined in the laboratory and then compared with exposure levels in wildlife populations.

- More descriptive field research is needed to explain the annual influx to areas of known pollution of migratory species that appear to maintain stable populations in spite of the relative vulnerability of their offspring.

- A reevaluation of the *in utero* DES-exposed population is required for a number of reasons. First, because the unregulated, large-volume releases of synthetic chemicals coincide with the use of DES, the results of the original DES studies may have been confounded by widespread exposure to other synthetic endocrine disruptors. Second, exposure to a hormone during fetal life may elevate responsiveness to the hormone during later life. As a result, the first wave of individuals exposed to DES *in utero* is just reaching the age where various cancers (vaginal, endometrial, breast, and prostatic) may start appearing if the individuals are at a greater risk because of perinatal exposure to estrogen-like compounds. A threshold for DES adverse effects is needed. Even the lowest recorded dose has given rise to vaginal adenocarcinoma. DES exposure of fetal humans may provide the most-severe-effect model in the investigation of the less potent effects from environmental estrogens. Thus, the biological endpoints determined in *in utero* DES-exposed offspring will lead the investigation in humans following possible ambient exposures.

- The effects of endocrine disruptors on longer-lived humans may not be as easily discerned as in shorter-lived laboratory or wildlife species. Therefore, early detection methods are needed to determine if human reproductive capability is declining. This is important from an individual level, as well as at the population level, because infertility is a subject of great concern and has psychological and economic impacts. Methods are now available to determine fertility rates in humans. New methods should involve more use of liver-enzyme-system activity screening, sperm counts, analyses of developmental abnormalities, and examination of histopathological lesions. These should be accompanied by more and better biomarkers of social and behavioral development, the use of multigenerational histories of individuals and their progeny, and congener-specific chemical analyses of reproductive tissues and products, including breast milk.

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From: Chemically Induced Alterations in Sexual and Functional Development: The Wildlife/Human Connection. Eds. T. Colborn and C. Clement. Princeton Scientific Publishing, Princeton, NJ 1992. Tel: 609-683-4750 or Fax: 609-683-0838

# APPENDIX 6

# QUESTIONNAIRE SENT TO MANUFACTURERS AND USERS WITH EXEMPTIONS UNDER MINN. STAT. § 115A.9651

## Information Required under Minn. Stat. § 115A.9651

1. How many of the exempted products are in compliance with the eventual ban on heavy metals? Which ones?

2. On what date was/will compliance be achieved for each of the exempted products? What changes were underway prior to 1991 (enactment of the statute)?

3. How was compliance achieved (e.g., reformulation, ceasing sale of the item in Minnesota, etc.)?

4. Of the products which will not be in compliance by 1998:

   Please give a technical explanation of why compliance has not been/will not be achieved?
   Could compliance be achieved with more time?
   Are there health and safety considerations which preclude substitution for the product?

### Optional Questions

**We strongly urge you to provide the information from the questions below. This information is not required by the statute but will greatly help us to present as complete a picture as possible about your industry, when we report to the Minnesota Legislature.**
**Please feel free to add any other additional information you think pertinent.**

1) Involvement in, and eventual certification under ISO 14000 indicates that a company has demonstrated an environmental commitment beyond compliance with applicable national and local laws. Is your company implementing or considering implementing ISO 14000 at this time?

2) Is your company involved in any other pollution prevention activities in regards to lead, mercury, cadmium and hexavalent chromium used in products? If so, please describe them. What prompted these activities (environmental commitment, cost of product, federal regulation, state law, etc.)?

3) Of the products which comply with the statute, can the amount of lead, mercury, cadmium or hexavalent chromium avoided, be quantified in some way (i.e., amount formerly in the product multiplied by the amount of product which has previously been sold in Minnesota)? If trade secrecy is an issue, amounts can be estimated or expressed in ranges.

4) What direct and indirect costs, if any, have been associated with compliance with this statute (i.e., administrative, additional research and development, market impact, product performance etc.)? From your perspective, what have the disadvantages of compliance been?

5) What direct and indirect savings, if any, have been associated with compliance with this statute (i.e., OSHA compliance insurance costs, hazardous waste disposal costs, market impact, product performance, etc.)? From your perspective, what have the advantages of compliance been?

6) How do the requirements of Minnesota's Toxics in Products statute differ from federal requirements, either statute or regulation? What are the additional costs, if any, of compliance with the Minnesota standards verses compliance with federal standards?