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VRD 0002018883

VISTA

Interoffice Communication

To: T. Grumbles

From: D. Penney

Date: July 12, 1993

Subject: **IARC REEVALUATION OF ETHYLENE**

The review of ethylene by the International Agency for Research on Cancer (IARC) is not based on any studies showing ethylene produces cancer in animals or humans. In fact, the opposite is true; an animal carcinogenicity study of ethylene conducted as part of the National Toxicology Program was negative (i.e., no evidence of cancer).

IARC's interest in reevaluating ethylene is based on the results of a metabolism study conducted in humans. This study found that when humans breathe ethylene, a small amount ($\simeq 2\%$) is converted in the body to EO. The conversion of ethylene to EO has also been demonstrated in animals. It is the conversion to EO, an animal carcinogen, which has raised concerns about ethylene.

Historically, IARC has not considered metabolism studies in its chemical reviews. However, IARC has recently been moving in this direction. Ethylene is amongst the first chemicals to be evaluated by IARC on this basis.

As you know, CMA is considering the sponsorship of studies to investigate the risks of ethylene's conversion to EO. It is anticipated that these studies will show that the small amount of EO that gets produced from ethylene is not enough to cause cancer. CMA's plan is to have as much of this data available as possible in time for IARC's review.

Dave Penney

cc: V. Messick - Houston

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CMA, GENERAL

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VRD 0002018885

SHHP

D. Penney - Vista

CMA

CHEMICAL MANUFACTURERS ASSOCIATION

cc: S. Hookanson
C. Schröder - Condea
Orig to D. Penney

July 19, 1994

To: Phthalate Esters Panel/ERTG/TRTG

Re: Swedish Ban of PVC

David Cadogan has just sent me the English translation of the "Recycling Delegation's" review of PVC on Behalf of the Swedish Government. I will send you anything new as I receive it.

As always, if you have any questions please do not hesitate to call me at (202) 887-1207.

Marian

Marian K. Stanley
Manager
Phthalate Esters Panel

2501 M Street, NW, Washington, DC 20037 Telephone 202-887-1100 Fax 202-887-1237

ECPI EUROPEAN COUNCIL FOR PLASTICISERS & INTERMEDIATES

A SECTOR GROUP OF CEFIC

DC/ab/471/940705.28

Addressees : Messrs. Angaroni - Dörrler - Lafora Comas - Koch - Thompson - Schreyer - Muniz - Krubner - Langer - Van Orden - Royer - Succi - Harris - Staley - De Lemos Pinto - Donnelly - Bruch - Kuhmann - Lösch - Moseley - Jansseune - Forslund - Leroy - Solano - Lopez Quintanilla - McKendrick - Moeschel - Vanden Burre - Deuvaert

cc: Technical Committee Members
Toxicology Working Group Members
Environment Working Group Members

Brussels, 5 July 1994

Dear Colleague,

THE "RECYCLING DELEGATION'S" REVIEW OF PVC ON BEHALF OF THE SWEDISH GOVERNMENT

Please find attached an English translation of Chapters 15-17 of the above review together with a summary of events in Sweden since the report was issued.

Neste and Hydro Plast have managed to extend the time for industry comments on the report until 15 November, 1994.

In my meeting with Neste we discussed how we might gain the support of the plasticiser users and carry out some studies to enable a better response to the report.

Neste, together with Hydro Plast and funding from the Swedish Government, will carry out measurements of the levels of phthalates in the environment at locations across Sweden. This should put the earlier, rather localised, hot spot measurements into perspective. We will ask ECETOC to carry out modelling of the Swedish environment to be used in conjunction with the analytical measurements.

In addition, the ECPI Environmental Working Group should consider possible ways of measuring the actual loss of plasticisers from outdoor articles such as roofing sheet to refine our current "worst case" estimates.

I would ask you all to consider the attached document carefully. It may seem an extreme Swedish situation at present but it could easily spread to the rest of Europe via the activities of the green lobby. I would be most grateful for your urgent comments on the proposed actions and suggestions for an action plan.

Yours sincerely,

David F. Cadogan.

D.F. CADOGAN
Technical Coordinator ECPI

NESTE
Chemicals

Re. Possible Swedish phase out of plastizised PVC.

June 8 , 1994. A report was presented by the Swedish Recycling Delegation
The recommendation to the Ministry of Environment and Energy is to limit the use of plastizised PVC and take steps to reach a complete phase out by year 2000.

June 13 ,1994. A delegation from the Swedish Association of Chemical Industry and the Swedish Association of Industry had a meeting on the Ministry of Environment and Energy. The ministry informed that the proposal will be sent out to the parties for consideration shortly.
The time for consideration was proposed to 2 months.
The Industry protested and demanded that the time to respond should be extended to the year end.
The Ministry asked for cooperation and constructive thinking from the Industry.

In a separate meeting the Industry representatives discussed and agreed on how to organize the work to get a united response from the industry to the Ministry.

June 27,1994. A delegation from the industrial parties had a meeting on the Ministry of Industry giving the view from the Industry on the work of the Delegation where the unfortunate mixture of political and factual statements in their report and press release has already caused disturbances in the market.

Stressed the importance of allowing enough time for the Industry to work out their comments on the proposal which will be sent out for consideration.

The Deputy of the Ministry promised to involve himself in the process and to make contacts with the Ministry of Environment.

Future Neste Oxo has following plans for the near future:

Project to measure background concentrations of phthalates in aquatic environment like lake water, sediments and soil. The project is shared with Hydro Plast and is performed in cooperation with the Inspectorate of Chemicals and the Swedish Environmental Protection Agency.

Involvement of customers

Private talks with Presidents of customer companies and competitors Swedish affiliates. Made by President of Neste Oxo.

NESTE
Chemicals

Meeting with Dr. Cadogan to get CEFIC:s views and support.

Meeting with customers business and technical representatives to explain Neste Oxo:s position to defend DEHP and why.
Mobilize support from the customers.

Contact with international competitors .

GW 28.06.94

PVC
- a plan for the avoidance of environmental effects

Chapters 15-17

SOU 1994:
"Kretsloppsdelegationens" (The Recycling Delegation's) Review of PVC on behalf of the Government

15 Overall Finding

15.1 Production of PVC raw materials

There are three production methods for the production of chlorine. The two Swedish chlorine manufacturers which manufacture chlorine for the production of PVC use a method which has several recognised environmental problems. The manufacture of chlorine uses an amalgam method which is a mercury process. During the production of chlorine it is mostly the loss of mercury to the air and the consumption of energy which are, according to "Naturvårdsverket" (National Environmental Protection Board), are the most trying factors. Chlororganic compounds are also released.

The use of mercury for chlorine production shall, according to Sweden's acceptance of an international agreement "Nordsjönkonferensen" (North Sea Conference), be phased out by the year 2010. The manufacturers have the prospect of using the amalgam method for a further 16 years. None of the manufacturers have, as yet, applied for a change-over to another method, nor has anything, other than testing, been carried out.

The production of chlorine for the manufacture of PVC is not included in the reappraisal according to "Miljöskyddslagen" (The Environmental Protection Law) which is planned for PVC manufacture installations.

The production of PVC raw materials is from chlorine gas and ethane via a production stage dichloroethane (EDC) and vinylchloride (VCM). The production of PVC raw materials takes place at one site in Sweden. Approximately 40 percent of their production of PVC raw materials is used within the country and the rest is exported. Of the Swedish consumption 60 percent is imported, mostly from Germany (30%), Norway (10%) and Finland (10%).

Several of the light and heavy waste products are strongly contaminated with dioxins and other unwanted chlor-organic compounds. Hazardous waste in the form of dichloroethane and vinylchloride tar are produced during manufacture. The waste is either destroyed in the company's own waste disposal installation, stored or exported for combustion in a VCM factory in Holland. The release of

chlor-organic compounds to water beyond the waste water treatment plant to which the production site is connected , according to The National Environmental Protection Board, is not negligible and possible measures should be investigated further. Diffuse pollution in the form of chlor-organic compounds also occurs from production sites.

Approximately 70 percent of all chlorine which is used in Sweden goes directly to dichloroethane production, which is a step in the production of PVC. Of the total amount of dichloroethane produced in Sweden half is used in the next stage in the production of PVC.

In "Kemikalieinpektionens" (The Chemical Inspectorate) "Solnedgångsprojekt" (Sunset Project) the chlorine compounds used or created during the production of PVC were studied. Noted among the chlorine compounds which are used in Sweden were the components related to PVC production together with previously regulated chlorine compounds, partly because they exist in large amounts and partly because they are associated with negative effects on health and the environment.

A planned reappraisal (following the 10 year-rule) of the Swedish installations for the production of PVC raw materials, is expected to take place in the Autumn of 1994. The National Environmental Protection Board are now preparing the commission and believe that, within the framework according to the Environmental Protection Law, one can bring about the further measures for environmental protection which are necessary.

The Recycling Delegation make their findings against the background that "Naturverkets" (The Department of the Environment) statement on environmental problems at the installation which produces PVC in Sweden is not conclusively significant for an overall judgement of PVC

15.2 Additives

Additives are always added to PVC. Which additives and which amounts depends on the required properties of the material. PVC always requires, however, the addition of stabilisers.

15.2.1 Plasticisers

To all flexible PVC, which in 1992 was more than half (52%) of the PVC - usage, plasticisers are added. Plasticisers in PVC leach out from the product over a period of time either during use, at landfills or from PVC buried in the ground, since they are not tightly bound to the polymer.

The Chemical Inspectorate has, during the Spring of 1994, within the framework of the plastic-additive project, carried out a risk assessment of plasticisers which are used in PVC. This it has shown that diesters (such as phthalates), triesters, phosphates and chloroparaffins are the plasticisers which are used for PVC. The dominant group of plasticisers are phthalates. Diethylkexylphthalate (DEHP) stands for the largest part (60%) of the total usage of plasticisers and is at the same time the most researched in terms of health and environmental effects.

DEHP is slowly degraded at low temperatures and especially under oxygenless conditions. DEHP can, therefore, accumulate in sediments. Studies carried out indicate, according to The Chemical Inspectorate, the risk for effects on sediment life forms and water-filtering organisms. DEHP can also bio-accumulate.

Other plasticisers, such as DINP, DIDP, TOTM, TEHP may be less easily degraded than DEHP. There are indications that DINP, DIDP can be somewhat more poisonous than DEHP.

DEHP is used as a plasticiser for, amongst other things, PVC products used for medical treatment such as PVC blood bags and PVC tubing. Exposure levels for people are, under certain medical treatments, near those levels which have shown to give effects in animal studies.

Emissions of plasticisers from PVC products are to air and water. The largest source of emission from products to air are, according to Chemical Inspectorate, PVC-coated metal sheet at a level of approximately 300 ton per year and PVC-coated fabric of the order of 100 ton per year. Emissions to air from flooring and wallpaper amount to approximately 2-3 ton per year. The release to water during cleaning is approximately ten times larger than the release to air. Measurements of sludge from communal waste water treatment plants show DEHP in all samples. Overall it is calculated that 30 tons of DEHP end up in sludge every year.

The annual precipitation from the air has been measured as 130 ton DEHP. There are too few studies about plasticiser content in leach water from landfills for any general conclusions about emissions from landfills to be drawn. According to a Government decision (prop. 1990/91:90, JoU:30, rskr. 1990/91:73) the use of phthalate shall be limited. The emission of the phthalate DEHP to the environment should, according to the Chemical Inspectorate, be reduced. Analysis of exposure shows that a large part of the emissions come from products and The Chemical Inspectorate's opinion is, therefore, that there should be an investigation into the possibility of reducing the use of DEHP in plastic.

The Reycling Delegation believe that since phthalates are used almost exclusively in PVC, the reduction should take place in PVC products. Aside from phthalates other diesters and triesters and phosphates have plasticising properties. The documentation which exists today is insufficient according to the Chemical Inspectorate. The information which does exist suggests, according to the Chemical Inspectorate, that however a change from DEHP to one of the other plasticisers which were investigated would probably not give any significant risk reduction, if any reduction at all.

Chloroparaffins shall be, according to a previous government decision (prop. 1990/91:90, JoU:30, reskr. 1990/91:73) phased out by the end of the year 2000. The short-chained highly chlorinated chloroparaffins, should be eliminated by 1994 at the latest. Highly chlorinated chloroparaffins are not used for PVC. Short-chained chloroparaffins which are used in PVC are already being reduced. The Recycling Delegation believe that the use of phthalates and chloroparaffins should be reduced, respectively phased out. The Recycling Delegation note that the government have previously made such a decision. The information which does exist suggests, according to Chemical Inspectorate, that however a change from DEHP to one of the other plasticisers which were investigated would probably not give any significant risk reduction, if any reduction at all.

15.2.2 Stabilisers

Stabilisers are added to all PVC to protect the material from decomposition, the largest group of stabilisers consists of lead compounds, the other stabiliser which are used for PVC are barium/zinc compounds, organic tin compounds and calcium/zinc compounds. Cadmium has previously been used as a stabiliser in

PVC but that use has now been prohibited in Sweden. Cadmium can, however, still exist in long-lived products which were produced before the prohibition, for example flooring. The use of lead shall be phased out mainly through voluntary measures according to a previous government decision and the use of organic tin compounds shall be restricted (prop. 1990/91:90, JoU:30, rskr. 1990/91:73). The environmentally harmful use of these organic tin compounds should be phased out as soon as possible. This decision applies to the overall use of these compounds, that is not only in connection with with PVC. The change-over to alternative stabilisers in PVC has, according to the Chemical Inspectorate, not yet been carried out on any great scale, neither for lead nor organic tin compounds.

Other stabilisers which today are used for PVC have an unknown effect on the environment.

The Recycling Delegation believe that the phasing out of lead and organic tin compounds in PVC should be intensified.

15.3 Recycling

At present in Sweden there is no recycling of PVC products. However a certain amount of recycling does occur in connection with production and installation wastage. In other countries there is a certain re-use of material from PVC products such as pipes, profiles, bottles and flooring. The scale of this recycling is however small compared with the large amount of newly produced PVC product.

According to the commission a decision is to be made whether it is, for certain long-life products, that it can be more advantageous to recycle the plastics than to replace the material. In terms of volume, the amount of the long-lived PVC products which could be considered for recycling are pipes, flooring and cables. According to the Trade Organisation there is only a small amount of PVC piping available for recycling. The Pipelayers Organisation note further that it would be difficult to achieve the large collection level that is required to reach an economic basis for recycling. Technically there are no problems for the recycling of PVC from PVC-piping.

No large amounts of waste PVC cable are available for recycling, according to

information from involved industries. Approximately 10 500 ton per annum PVC flooring are put in landfills.

15.4 Combustion (Waste burning)

PVC contains 57 percent chlorine. The presence of chlorine in combustible waste can create dioxins and other chlor-organic compounds as well as hydrogen chloride which is acid producing and strongly corrosive. High levels of chlorine in waste make it difficult to stabilise the ash before storage.

Chlorine in combustible waste can be dealt with with today's purification techniques, but it requires special corrosion resistant material in the combustion installations, extra cleaning stages, purification stages and treatment of the gases. With lower chlorine content in the combustible waste the investment costs are lower and the storage of ash from the dry neutralisation of the hydrochloric acid in the gases should, according to The National Environmental Protection Board, not be required to its current extent. For fluid neutralisation the chloride is released into the container and no costs for the treatment of ash arise.

Chlorine in the waste which is burned today comes mainly from waste fat and PVC. The PVC-containing waste whch today is combusted originates mainly in households. Chlorine from PVC is judged by The National Environmental Protection Board to be responsible for between 35-50 percent of the chlorine content in the gases produced.

In future the proportion of chlorine in waste which is due to PVC is anticipated to increase because half of the chlorine content is expected to be removed by, for example, composting or rotting, PVC's relevance for the chlorine content in the waste-gases will increase, everything else being the same. The combustible waste has a low energy content. PVC's energy content is also low in comparison with the energy content of other thermoplastics.

Metallic stabilisers in PVC are not broken down during combustion but remain as an environmental hazard in ash and slag.
This covers also cadmium which can occur in older PVC products.

Any great release of uncombusted phthalates (plasticisers) is judged by The

Chemical Inspectorate not be relevant from the Swedish waste combustion installations.

PVC's importance for the buildup of dioxins and other chlor-organic compounds during combustion is well discussed. Dioxin emissions from waste combustion installations have been greatly reduced during the past ten years through optimisation of the combustion process and better purification techniques.

The improved cleaning techniques have, apart from lower dioxin levels released to the environment, also given lower levels of chlorophenols and chlorobenzenes, which, according to The National Environmental Protection Board is of importance since these to a lesser extent are trapped in the cleaning stage.

Other dioxin release where PVC can be the source, are uncontrolled burning on landfills, illegal burning of cable and remelting of PVC-coated plating.

The Recycling delegation note that for the waste which today, is burned, special cleaning stages are required to neutralise the hydrochloric acid which is built up and reduce the release of chlor-organic compounds.

The Recycling Delegation find that the burning of PVC, amongst other things, on the basis of its low energy content alone, can be regarded as a method of disposal.

15.5 Landfills

Altogether there are approximately 350 000 ton PVC products accumulated in landfills since the year 1965. During the same period approximately 200 000 ton PVC products have been burned in communal combustion installations. Approximately half of the deposited amount is plasticised PVC in the form of flexible film and coated PVC products.

The amount of PVC piping and PVC cable in the ground is great and accumulates continuously. Overall an order of magnitude is calculated to 900 000 tons PVC piping and 390 000 ton PVC coated cable have been accumulated in the communes from the years 1965 -1992. Pipe has a lifetime of at least 100 years and according to the trade organisation, cable has a lifetime of 30 years. These

products have not yet to any great extent served their time.

Every year approximately 10 000 PVC flooring and 3 000 tons PVC coated products are deposited in landfills. Approximately 3 000 tons PVC film and 5 000-6 000 tons of other PVC products are calculated annually to end up at household waste dumps. PVC which is taken to these landfills is mostly plasticised PVC.

The amount of research and investigation around PVC and its effects is great. However, information is lacking in certain important areas such as in which way decomposition takes place, which decomposition products are built up and the environmental influence from these. PVC's slow decomposition rate can in itself mean risks since a lot of PVC material is produced and spread in that time before the effects of any eventual decomposition products are noticed. This was noted in 1983 by Naturresurs och Miljökommittén (Natural Resources and Environment Committee) (SOU 1983:56).

Plasticisers migrate gradually out of the PVC products. Decomposition of the polymer results in a great accessibility also to the additives.
Heavy metals in stabilisers come out into the environment. The additives in turn are degraded. The speed at which this happens and how much plasticiser and stabiliser are transmitted to the environment via leach water and to the air from existing landfills is unknown and neither are the effects on the environment.

Those PVC products which remain in the environment after use will in the long term give rise to leaching of additives, for example lead, to the surroundings. The Recycling Delegation considers it appropriate to find out what happens to PVC polymers and additives in landfills and in the ground. The Delegation assumes that the involved sections of the Industry will carry out this investigation.

The Recycling Delegation finds that those PVC products which today are in buildings and installations are a special problem, from the point of view of wastes, since these older PVC products can include larger amounts and more environmentally hazardous ingredients than todays' PVC.

The Recycling Delegation considers that conventional landfills are an unsuitable

method of disposal for older PVC waste which includes environmetally hazardous components.

The Recycling Delegation's finding is that there should be an investigation into the special measures required for the waste which already exists and which includes PVC where information is to be found out about the decomposition processes' possible effects on the environment.

16 Means of Control

16.1 Producer Responsibility

The government required The Recycling Delegation to analyse whether an overall producer responsibility for PVC and other chlorinated plastics should be introduced for short-lived and/or long lived products.

The Recycling Delegation shall, according to its terms of reference, gradually suggest producer responsibility for new product groups. The Delegation's suggestion for product responsibility for tyres was delivered to the government in April 1994. The Delegation has in its continued work prioritised cars, electronics and building materials. PVC is used within all of these three areas and in especially high levels in the building sector.

The use of PVC within the building and installations sector, covers 80 percent of the total use of PVC in the community, in total 80 000 tons of PVC raw materials per year.

The repsonsibility of those who are defined as the producers include the physical and economic responsibility for the treatment of the products when they have served their time.

The Recycling Delegation intend to suggest producer responsibility for among other product groups cars, electrical and electronic products and building materials.

16.2 Phasing Out

One way of avoiding environmental effects from PVC is to phase out its use. Through a total prohibition of PVC covering import and export from a certain date, the continued environmental influence from the new PVC products could be avoided completely.

Import restriction demands, however, partly that it is in accordance with current agreements and rules within political trade areas such as EES and GATT agreements, and partly that the import can be regulated.

Information about exactly which imported products include PVC is, today, not complete. It would be difficult to effectively maintain a fair import restriction.

A rapid phasing out of PVC does not give the opportunity for a successive change-over to alternative materials. According to the studies the Delegation have carried out a rapid phasing out of PVC is calculated to give high additional costs for the affected branches of industry. On the other hand if room is given for, among other things, development of good alternative materials to PVC then the additional costs can be lower.

A phasing out through the active use of the substitution priciple can be effective in areas where alternatives exist or can be developed, which applies to a large section of the PVC-useage areas. Such a phasing out should cover imported products. For the most important areas of use it should be possible that via a step-by-step phasing out of the use of specified products should also cover imports. For certain production areas, for example, the import of consumer products with PVC, it can possibly be more difficult to achieve phasing out.

16.3 Marking

Marking is desirable to make it possibe to distinguish between different types of plastic. Many companies already choose today to voluntarily mark their plastic products. Among those plastic products which are used by individual consumers, such as packaging and household items, the marking of, more than anything else, polyethylene products, has become the norm.

For recycling and the disposal of waste, knowledge of the different product content is important. There are problems today in the form of hydrochloric acid development from PVC materials when recycling plastics and other thermoplastics. Marked products would make sorting easier. Marking would also give guidance for product choice and change of products.

The system and standards for marking plastic has been developed in certain countries and discussed in the international standardisation context. It is common that the marking of plastics is according to DIN standards. These standards include marking symbols for the most common thermoplastics

including PVC.

In the USA 32 States have passed laws about the marking of plastic bottles and containers. All thermoplasts shall be marked with symbols which, for the most part, look like the DIN standard.

17 Plan for the avoidance of environmental effects from PVC and other chlorinated plastics

The Government has, through its decision on 27th May 1993, given The Recycling Delegation the assignment to develop a plan for the avoidance of environmental effects from PVC and other chlorinated plastics.

Those measures which The Recycling Delegation suggest cover only PVC. The use of other chlorinated plastics is so limited that they have been left aside. The Chemical Inspectorate should be commissioned to follow the development and use of the other chlorinated plastics. If their use should suddenly increase greatly, the Inspectorate should decide whether or not measures are required to prevent the eventual environmental effects from these products.

The Recycling Delegation's proposals cover the use of PVC raw materials and PVC products which takes place in Sweden, which includes imported PVC.

17.1 Flexible PVC

Of all the PVC products little more than half are flexible. Plasticisers gradually migrate from the flexible PVC products into the environment. The largest group of plasticisers are phthalates. Other plasticisers are diesters, triesters and phosphates.
The Recycling Delegation works from and has the same basis as the previous governmental decision that the use of phthalates and chloroparaffins should be reduced, repectively phased out. Against the background of risk assessments that have been made in terms of the effects on health and the environment the Recycling delegation believe that the use of those phthalates that today are used to soften PVC should be phased out.
The information which exists suggests, according to the Chemical Inspectorate, that a change from DEHP to one of the other plasticisers which were investigated would probably not give any significant risk reduction, if any reduction at all. It is included in the producers and importers responsibility to show that an alternative is acceptable in terms of health and environment.

The Recycling Delegation believes that the use of todays flexible PVC should be phased out. With todays plasticisers are included phthalates, diesters, triesters

and phosphates.

The Recycling Delegation believe that it is especially important to phase out, as soon as possible, todays flexible PVC's products which use large amounts of plasticisers or which emit large amounts of plasticisers.

The change-over shall be initiated as soon as possible in the product areas where PVC can be exchanged for an alternative with better health or environmental properties, can take place with equivalent performance and without greater costs.

The greatest single release of plasticisers to air in the area of usage takes place from coated metal sheeting and coated fabric. It is therefore important that the phasing out of todays flexible PVC takes place soonest within those two groups. Also it is of great importance that the phasing out of flooring is carried out a soon as possible since flooring is the product group which today has the greatest use of plasticisers. PVC products which have a short life-time are to the greatest part, flexible. Within several product areas, such as offices and leisure, there are today alternative materials without the plasticisers and stabilisers which are used for PVC. For certain short-lived products for example medical packaging, a slightly longer change-over period is required.

The Recycling Delegation find that the governmental aim of phasing out short-lived PVC products through substitution can and should be followed as soon as possible.

Consequently, in order to reduce the overall use of todays flexible PVC and its environmental effects, the phasing out shall be carried out as soon as possible for the flexible short-lived PVC products, PVC coated fabric, PVC coated metal sheeting and PVC flooring. Also for other flexible PVC products, the phasing-out should be initiated.

17.2 Stabilisers in PVC

Stabilisers are added to all PVC. The largest group of stabilisers is lead compounds, followed by barium/zinc compounds, organic tin compounds and calcium/zinc compounds.

The Recycling Delegation note that the use of lead according to a previous Government decision should be phased out and the most environmentally hazardous organic tin compounds should be phased out as soon as possible.

The phasing out of lead and organic tin compounds in PVC has until now gone very slowly.

The Recycling Delegation believe that the phasing out of these indicated stabilisers shall be carried out as soon as possible. It is unclear to what extent it is possible to replace these stabilisers with other alternatives. Knowledge about the environmental effects of alternatives is also inadequate. It is part of the producers and importers responsibility to show that an alternative is acceptable from an health and environmental viewpoint.

17.3 Elimination

Large quantities of PVC are today accumulated in the community in products in landfills and large amounts are added yearly.

The Recycling Delegation has noted that todays PVC products contain additives which can lead to environmental damage. Older products can also contain, for example, cadmium, which, in this use, has been forbidden in Sweden.

An important issue of avoiding environmental damage from PVC is how the PVC which already exists accumulated in the community shall be treated.

The Recycling Delegation believe that conventional landfills are an unreasonable elimination method for the older PVC waste which contains hazardous components.

The Recycling Delegation finds further that the conventional landfills are doubtful solutions for the expended newer PVC products with hazardous components. Plasticisers and stabilisers will be, in time, released and can be spread in the environment. The effects are not kown. Neither is it investigated which biodegradation products can, in the long term, be formed from the polymers themselves.

The Recycling Delegation believe that the appropriate sections of industry shall speedily carry out the biodegradation studies of PVC in accordance with the knowledge required for production and imports according to the law (1985:426) about chemical products. This work should include an investigation of the risks for the production of persistant toxic compounds through the biodegradation of PVC polymers and their additives in landfills and in the ground.

The Recycling Delegation suggests that the National Environmental Protection Board shall be assigned to monitor this work. An interim report of how the work is developing and what results have come out should also be presented at the latest June 1st 1995. The National Environmental Protection Board shall also be assigned to assess the results from the biodegradation studies and if necessary suggest measures, including time-frames for these measures, whose aim is to reduce the environmental impact of PVC in landfills and in the ground.

When PVC is burned the majority of the plasticisers are made harmless while the heavy metals from the stabilisers are collected in the ash and slag.

The chlorine content of the waste which is burned involves risks for dioxin build up. Due to the chlorine content of the waste special cleaning stages for the smoke and corrosion-resistant equipment in combustion installations are required.

The Recycling Delegation believe that all PVC waste which contains environmentally hazardous components shall be managed of in an environmentally acceptable way.

The Recycling Delegation suggest that the National Environmental Protection Board be assigned to investigate what final treatment is the most appropriate from an environmental point of view and to suggest suitable measures so that a negative influence from PVC in waste shall be avoided. Special landfills of PVC-containing waste shall be considered. The development of information at an international level should be carefully followed.

17.4 Recycling of Material

The older PVC products, accumulated in the community represent a larger

amount of hazardous material than the newer PVC products. Older PVC products can also include cadmium.

It is the Recycling Delegation's opinion that recycling of PVC using todays technology cannot be recommended. It is, according to the Recycling Delegation's understanding therefore that it is not suitable to initiate recycling of PVC at all on any great scale before it is known what eventual influence on the environment can occur through recycling of PVC. It is the responsibility of those who want to start recycling to show that recycling does not give unacceptable environmental effects. The Environment Protection Department ought to study the information and judge the suitability from an environmental point of view. The Environment Protection Department should follow the international development of understanding within this area.

17.5 Producer Responsibility

The Recycling Delegation intend to propose producer responsibility for amongst other product groups cars, electrical, electronic and building materials. The largest part of the PVC which is used today will thereby be covered by producer responsibility for separate product areas.

In the formation of producer responsibility are included the proposals and measures for the avoidance of environmental influence from PVC, which have been introduced here.

The Recycling Delegation believe that producer responsibility normally shall be expressed in product groups and that therefore it is not appropriate to initiate producer responsibility for the material PVC.

17.6 Marking

The Recycling Delegation suggest that all PVC products and other chlorinated plastics be marked to ease sorting for recycling of other thermoplasts and the treatment of waste. Marking gives also important information about plastics, that is for both companies and consumers. Marking can also make it easy to introduce product responsibility and change over of PVC material. marking shall at first be voluntary. The affected Trade Organisations have an important role in

this.

The Recycling Delegation propose that The Chemical Inspectorate be assigned to monitor the work with marking, which is voluntary and if this does not take place to consider compulsory measures.

17.7 Phasing Out

The Delegation has judged the environmental influence of PVC in all aspects from the production of chlorine to waste.

The Recycling Delegation suggest that today's flexible PVC and rigid PVC with environmentally hazardous additives be phased out as soon as possible.

Within certain product areas the replacement of PVC has taken place or is taking place. The Recycling Delegation has noticed that within many product areas there are alternatives which already can replace PVC or can become alternatives after a certain period of change-over. For certain products there is today difficulty in replacing PVC, which can be due either to prohibitive international standards, todays machinery or demands for specific material properties. The Recycling Delegation find that many technical problems can be solved and that PVC can be replaced within several areas of use. If time for the change-over is given. The Recycling Delegation's investigation shows that the extra costs involved for the affected areas of industry will be significantly lower if sufficient time is given for the change-over and for material development. The Recycling Delegation have, amongst other things, for this reason, chosen a successive phasing out which should however be initiated immediately and carried out quickly for the specified areas.

The Recycling Delegation suggest that the Chemical Inspectorate be given the assignment to pursue and follow up the phasing out of todays flexible PVC, as well as the phasing out of rigid PVC with environmentally hazardous additives, in such a way that the phasing out can be carried out by the year 2000. In the assignment should be included the follow up of the introduction of new additives. It rests with the producers and importers to produce the environmental effect data which will be referred to. The Recycling Delegation should, further, yearly report to the government how the phasing out is

progressing and whether compulsory measures should be brought in. The Recycling Delegation should follow the international development and pursue the issues of the phasing out of this health and environmentally damaging PVC within the framework of the international chemical cooperation.

VRD 0002018909

COMMITTEES

VISTA

Interoffice Communication

To: **Distribution**

From: **D. Penney, Corp. R & D**

Date: **March 1, 1994**

Subject: **International Agency for Research on Cancer Classification of Ethylene Oxide**

The working committee of the International Agency for Research on Cancer (IARC) has recommended upgrading ethylene oxide to "carcinogenic to humans". IARC had previously classified ethylene oxide as "possibly carcinogenic to humans". This is the first time IARC has determined a substance to be a human carcinogen based on human genetic data without clear evidence in human cancer studies. It will be several months before an IARC monograph, which fully describes the rationale for IARC's decision, is published.

For years the industry has treated ethylene oxide as a possible human carcinogen and has successfully adopted stringent measures to protect both employees and the environment. Consequently, IARC's upgrading of the classification of ethylene oxide is not expected to have any significant regulatory impact on its manufacturing or use.

The attached questions/answers document was developed by the Chemical Manufacturer's Association's ethylene oxide toxicology task group to answer some questions about IARC's action. Please note that this document is for our use only and should not be distributed outside of Vista at this time. If you have any additional questions, please give me a call (512-331-2468).

Distribution:

Austin:
R. Bauer, M. Cox, C. Hammond, J. Heinze, K. Kinsley, R. Martin, J. Roheim

LCCP:
K. Fogg, J. Friend, N. Tower

Houston:
T. Grumbles, T. Huffman, P. Jernigan, B. Larsen, J. Ledvina, T. O'brien, J. Stokes, M. Reynolds, W. Vogel

ETHYLENE OXIDE QUESTIONS/ANSWERS

1) Are there any recent studies that provide evidence that EO is a human carcinogen?

No. In fact, the additional scientific evidence from numerous recently completed human studies, while not definitive, lessens concerns raised by the early animal and Swedish human studies.

2) What have animal (toxicology) studies shown regarding EO human carcinogenicity?

EO has been shown to cause cancer in laboratory animals. The evidence has been used to conclude that this chemical is possibly a human carcinogen.

3) What have human (epidemiology) studies shown regarding ethylene oxide carcinogenicity?

A detailed assessment of all the human studies related to whether ethylene oxide is a carcinogen has recently been published in the scientific literature. Nearly 30,000 ethylene oxide workers from five countries were included in the 11 studies considered in this evaluation. The evidence indicate that ethylene oxide does not cause an increase of cancer overall or brain, stomach or pancreatic cancers, which were seen in some animal and isolated human studies. The findings with respect to leukemia and non-Hodgkin's lymphoma are less definitive. While the majority of evidence does not indicate that ethylene oxide causes these cancers, there are some suggestive trends, and longer follow up of ethylene oxide workers is needed to better clarify these relationships.

4) For what reasons did IARC upgrade EO to "carcinogenic to humans"?

Historically, IARC required clear evidence of increased cancer risk in humans in order to classify an agent into Category 1, "carcinogenic to humans". This is the first time IARC has determined a substance to be a human carcinogen based upon human genetic data without clear evidence in human cancer epidemiology studies.

5) What is the health significance of the genetic effects seen in workers exposed to ethylene oxide?

We really aren't sure. The current view is that the genetic effects which have been demonstrated in humans are indicators of exposure rather than predictors of specific toxicological endpoints. Ethylene oxide is known to react with genetic material

(DNA) to form adducts. DNA adducts are naturally formed and repaired in all living organisms. Although some genetic effects have been associated with an increase in cancer incidence in some populations, there is no information concerning the specific events which lead to tumor formation from ethylene oxide exposure in animals.

6) What impact will the upgrading to "carcinogenic to humans" have on ethylene oxide manufacturers?

For years the industry has treated ethylene oxide as a possible human carcinogen and has successfully adopted stringent measures to protect both employees and the environment. These measures will continue to be employed.

7) How much ethylene oxide is produced in the United States?

About 7 billion pounds per year.

8) What is ethylene oxide used for?

Most of ethylene oxide produced is consumed by converting it to other important chemicals, such as ethylene glycol and ethylene oxide derivatives. Ethylene oxide derivatives include polyethylene glycol, glycol ethers, ethanolamines, and surfactants. It is also an extremely effective antimicrobial used in the cold sterilization of heat-sensitive medical devices and culinary spices.

9) Who is exposed to EO? Is it mainly industrial exposures or is the average person also exposed?

Under the OSHA Ethylene Oxide Rule, workers are exposed to one part per million parts of air (ppm) or less averaged over an eight hour work day. OSHA has determined that this level of exposure protects workers from carcinogenic hazards. Residents in communities adjacent to facilities which make or use ethylene oxide are exposed to far less than are workers. Another possible exposure is natural formation of ethylene oxide in the human body.

10) Are there alternative materials available if EO use is banned?

For most applications there are no feasible substitutes.

11) What are the hazards associated with ethylene oxide?

For over 50 years, it has been known that ethylene oxide is extremely flammable and its vapor could violently explode. Because of ethylene oxide's reactive nature, industry began its own test program to investigate the toxicity of ethylene oxide.

It was found in animal testing that exposure by inhalation resulted in adverse effects in reproduction studies and also produced tumors in studies where animals were exposed for a lifetime. Consequently, promoting the safe handling of ethylene oxide has been a major effort of the industry for many years.

12) What is the OSHA standard for worker exposure to ethylene oxide?

The OSHA standard is designed to protect workers from possible reproductive and cancer hazards. The OSHA rule limits worker exposure to an eight-hour time-weighted average of 1 part per million parts of air (ppm). There is also an excursion limit (similar to a STEL) of 5 ppm for 15 minutes.

13) What are the future plans for research on ethylene oxide?

The Ethylene Oxide Industry Council (EOIC) continues to sponsor relevant health effects studies on ethylene oxide and has committed significant resources to this effort.

A

cc: T. Arcuschin - Houston
J. Ledvina - Houston
K. Fogg - Lake Charles
W. Tower - Lake Charles
M. Reynolds - Houston
R. Martin - Austin

CHEMICAL MANUFACTURERS ASSOCIATION

April 19, 1994

To: EOIC & all Task Groups

Re: EO Q&A Sheet

Enclosed is a copy of the ethylene oxide question and answer sheet for your information/use in response to IARC's decision to bump EO up to "Carcinogenic to humans". Questions # 5 and # 13 are new. Please replace this with the old Q&A sheet.

As always, refer all media requests to Tom Gilroy of CMA at (202) 887-1100.

Sincerely yours,

FOR

Robert R. Romano, Ph.D
Associate Director, CHEMSTAR
Manager, EOIC

2501 M Street, NW, Washington, DC 20037 Telephone 202-887-1100 Fax 202-887-1237

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ETHYLENE OXIDE QUESTIONS/ANSWERS

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5) Does EOIC agree with classification of EO as Category 1?

No. EOIC does not believe that it is appropriate to classify EO as Category 1, given that in the case of EO, there is no systematic relationship between measured genetic endpoints and development of malignant disease in the extensive animal studies that have been conducted. Genotoxicity data of uncertain

relevance to humans was used to upgrade EO to Category 1, in the absence of direct evidence of human cancer risks.

6) What is the health significance of the genetic effects seen in workers exposed to ethylene oxide?

We really aren't sure. The current view is that the genetic effects which have been demonstrated in humans are indicators of exposure rather than predictors of specific toxicological endpoints. Ethylene oxide is known to react with genetic material (DNA) to form adducts. DNA adducts are naturally formed and repaired in all living organisms. Although some genetic effects have been associated with an increase in cancer incidence in some populations, there is no information concerning the specific events which lead to tumor formation from ethylene oxide exposure in animals.

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13) Does the proposed reclassification indicate that IARC has concluded that daily EO exposures pose a significant cancer risk?

No, IARC assesses hazard. It does not make a <u>risk</u> evaluation which would require that exposure levels be considered.

14) What is the OSHA standard for worker exposure to ethylene oxide?

The OSHA standard is designed to protect workers from possible reproductive and cancer hazards. The OSHA rule limits worker exposure to an eight-hour time-weighted average of 1 part per million parts of air (ppm). There is also an excursion limit (similar to a STEL) of 5 ppm for 15 minutes.

15) What are the future plans for research on ethylene oxide?

The Ethylene Oxide Industry Council (EOIC) continues to sponsor relevant health effects studies on ethylene oxide and has committed significant resources to this effort.

VRD 0002018918

CHLORINE COORDINATING COUNCIL(CMA)

cc: J. Ledvina
T. Granville
Note EO exposure survey coming.
Dave Penney
Dave
pvg to D. Penney

CHEMICAL MANUFACTURERS ASSOCIATION

August 23, 1994

To: EOIC Voting Members
EOIC Environmental Task Group
EOIC Safety Task Group
EOIC Toxicology Task Group
EOIC Medical Epidemiology Task Group

Re: September 13, 1994 Meeting Cancelled

In discussion with Ron Van Mynen it was decided to postpone the EOIC meeting scheduled for September 13, 1994. We believe that we can get everything accomplished at our next meeting scheduled for December 8, 1994 (1-4 pm) in Washington, DC.

Listed below for your information is an update for each of the task groups.

•Safety Task Group: The EO Propagation study contracted at the Southwest Research Institute in San Antonio, Texas is progressing slower than expected. SwRI is pulling together the test apparatus with 2" pipe being tested Sept.- Oct., and 12" pipe being tested late Oct.-Nov. Task Group members will have an opportunity to witness one or both types of field tests. The group will meet again in New Orleans on October 17, 1994.

•Environmental Task Group: The group is evaluating the final HAP's rule for EO compliance issues.

•Medical Epidemiology and Toxicology Task Groups: On 8/17/94 the group met with CIIT and received a semi-annual update on EO research. On 8/18-19 an EO Risk Assessment Workshop was held at CIIT, with EPA, OSHA, academia, and industry reps. The workshop members will break-up into small work groups and resolve several EO risk assessment issues. The tox task group will meet again on October 18 in Washington, DC.

•Industrial Hygiene Task Group: An article for publication on our protective clothing research is being prepared. An EO draft exposure survey is also being prepared for ultimate distribution to all members.

Please call me at (202) 887-1198 if there is anything I can do for you.

Sincerely yours,

Robert R. Romano

Robert R. Romano, Ph.D
Associate Director, CHEMSTAR
Manager, EOIC

2501 M Street, NW, Washington, DC 20037 Telephone 202-887-1100 Fax 202-887-1237

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GLWQI (EPA)

JRR,
I asked Dave to update us on the Great Lakes Initiative since he was more familiar with it. If you have questions on this -- ask Dave. Thanks! -John A.

JEH / DAP
Only one question - What impact does this have on ZAS?

JRR
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more DWE P.

VISTA

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of species. While costly to develop, this results in
re more scientifically valid. The newly proposed method
application of **arbitrary safety factors** which are likely
ny chemicals. The GLWQI also uses Bioacculumation
er than the bioconcentration factors used in the previous
in lower WQC values. BAFs, not determined in the
by use of **food chain multipliers** (FCMs). The FCMs
tration of chemicals as they move up the food chain to
oach is that the FMCs are estimated and may not be
appropriate for a specific chemical. Thus, overconservative estimates of a chemicals
potential to bioaccumulate are likely to result from this process.

Bioaccumulative Chemicals of Concern (BCCs), are defined as materials with BAFs >1000. 28 of the 138 chemicals considered in the initiative are considered BAFS. This includes certain chemicals of some potential concern to Vista, i.e., dioxins, chlorinated benzenes, polynuclear aromatics and hexachlorobenzene. Toulene is listed but as a potential BCC. Designation as a BCC has major implications for potential restriction on a chemical (see next section). However, the BCC designation doesn't refer to inherent toxicity, just the potential for significant exposure in certain environmental compartments. Consequently, chemicals of low toxicity and low potential for significant environmental impact may be regulated more stringently than appropriate.

In addition to BCCs, EPA has ear-marked other chemicals of concern such as mercury and other metals. These materials will also be subject to the new WQC setting process which will use this new methodology.

Setting NPDES Permit Limits

This is probably the most controversial portion of the initiative. Using WQSs derived

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VRD 000201892

To: J. Heinze

Interoffice Communication

From: D. Penney

Date: September 15, 1993

VISTA

Subject: **The Proposed Great Lakes Water Quality Initiative (GLWQI)**

The GLWQI is the first of EPA's ecosystem-based approache to managing pollutants in the environment. This initiative is only supposed to be applied to the Great Lakes area, however, there is a concern that this approach will be applied inappropriately throughout other US ecosystems. Additionally, there are certain technical concerns about the methodology proposed in this initiative.

Current methods for calculating Water Quality Criteria (WQC) require as great deal of ecotoxicity data in a variety of species. While costly to develop, this results in ecotoxicity evaluations which are more scientifically valid. The newly proposed method uses less data and relies on the application of **arbitrary safety factors** which are likely to be overconservative for many chemicals. The GLWQI also uses Bioacculumation Factors (BAFS) which are higher than the bioconcentration factors used in the previous methodology. This will result in lower WQC values. BAFs, not determined in the laboratory, will be determined by use of **food chain multipliers** (FCMs). The FCMs account for the increase concentration of chemicals as they move up the food chain to man. The problem with approach is that the FMCs are estimated and may not be appropriate for a specific chemical. Thus, overconservative estimates of a chemicals potential to bioaccumulate are likely to result from this process.

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Setting NPDES Permit Limits

This is probably the most controversial portion of the initiative. Using WQSs derived

from the new methods discussed above, EPA will calculate the total maximum daily load for receiving waters as well as the wasteload allocations for each discharge into the receiving waters and then establish the NPDES permit effluent limitations. This process differs significantly from that used previously in the way it handles mixing zones. Mixing zones are allowed for some materials, but not for BCCs (restriction phased in over ten year period). For BCCs the water quality criteria will have to be met at the end of the pipe. For example, the criteria for dioxin, a BCC, is 0.0000000096 and 0.00000001 μg/L for wildlife and human health, respectively. The human health criteria for hexachlorobenzene is 0.0001 μg/L. Since these chemicals are BCCs, these values would be used to set the permit limits required for discharge at the end of the pipe, not the stream since mixing zones are not allowed. Compliance would be judged at or below the detection level for these materials. Permits might also require waste minimization and monitoring features for BCCs as well. All of this means increased costs for compliance.

Industry Response

The chemical manufacturer's association (CMA) has been attempting to influence this initiative for some time. CMA has addressed a whole host of issues, including others besides those mentioned above, in the form of comments and recommendations offered at public hearings, pre-proposal meetings and directly to the GLWQI steering committee. Both generic and chemical-specific groups, such as the phthalate ester group which Vista is a member of, have provided EPA with specific comments on the proposal. The effectiveness of these efforts is doubtful. We probably won't know how successful they have been until the final regulation is issued. However, CMA admits that their previously voiced concerns were not addressed in the proposed regulation. I am not aware of any response to this issue from the Vinyl Institute, Chlorine Coordinating Council, or SDA. Obviously, various member companies of these organizations may have responded individually, or as part of CMA.

Impact on Vista

The current impact of this proposed regulation on Vista is minimal. We do not have plants in the Great Lakes area and none of our products are specifically targeted.
We might suffer some indirect effect from some customers in the area who are affected more directly. Concern for Vista would be heightened if the provisions of the initiative were to be adopted "as is" for the Gulf Coast area, which is an area of concern for the Congress and EPA. This initiative would potentially affect all of our manufacturing sites in any designated area.

Recommendations

Vista should monitor water quality criteria activity through internal surveillance, our associations with Texaco and, for sometime, with the CMA phthalate ester panel (Vista membership on this panel is due to expire at the end of this year). We should also monitor the proposed 1994 environmental and economic study of the Gulf Coast area.

CC: Veldon Messick
Tom Grumbles

VRD 0002018924

IMC (VI)

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-VISTA R&D -

********** -VISTA R&D - ***** - 512 331 2594- **********

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To Beverly Thelen	From Dave Tierney
Co. Georgia Health	Co. Vista
Dept. CVI-IMC	Phone #
Fax # 404/395-4529	Fax # 512/331-2594

To: **V. Messick**

Interoffice Communication

VISTA

From: **D. Penney**
Date: **September 16, 1993**

Subject: **Union Carbide report of Pancreatic Cancers in a PVC processing operation**

I spoke with Dr. Jane Teta of Union Carbide about a report of an increased risk of pancreatic cancer in workers involved in PVC processing. Dr. Teta said that Carbide had recently reported the study to EPA, however, she was not willing to make a copy of the study available for wider distribution before it was accepted for publication. However, Dr. Teta offered to meet with the Vinyl Institute to discuss her findings. I told her that I would contact her if such a meeting was desired. Dr. Teta briefly summarized the study as follows.

Twenty-eight male pancreatic cancer cases which were compared to 140 control cases with no pancreatic tumors were included in the study. Workers were assigned to work areas where both PVC and polyethylene were processed. Men assigned for more than sixteen years to these areas experienced slightly over a seven-fold increased incidence of pancreatic cancer. No excess was seen amongst workers with shorter duration of assignments. Seven of the nine cases of pancreatic cancer began working in this area in the 1940s. All but three cases had worked 20 years or more.

While recognizing that the workers in this study were assigned to units in which both PVC and polyethylene were processed, Teta places most of the blame for the excess pancreatic tumor rate on the PVC processing. She believes this is because PVC processing practices of the time resulted in higher chemical exposures and involved working with more hazardous raw materials than polyethylene. Teta does not believe the increase of pancreatic tumors was due to vinyl chloride exposure. This is primarily because there were no cases of angiosarcoma of the liver. She instead points the finger at the phthalate plasticizers used in PVC, citing diethylhexyl phthalate being reported as carcinogenic in mice and rats. Teta also expressed concern for stabilizers, some of which contain cadmium and lead, which have been demonstrated to produce cancer in animals.

Teta maintains that chemical exposure of workers during PVC processing prior to the 1950s was very high because materials were weighed and fed manually into a blender. Workers climbed inside the blenders to scrape off excess chemical residues whenever different additives were required for different vinyl products. She says that this occurred

The Vinyl Institute

A Division of The Society of The Plastics Industry, Inc.

VINYL INSTITUTE
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5/93

To: V. Messick

Interoffice Communication

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Teta maintains that chemical exposure of workers during PVC processing prior to the 1950s was very high because materials were weighed and fed manually into a blender. Workers climbed inside the blenders to scrape off excess chemical residues whenever different additives were required for different vinyl products. She says that this occurred

as often as twice a day. Teta pointed out that the blenders that were used in polyethylene processing were not cleaned very often because there was little variation in the additives used.

Teta cites, as confirmatory evidence, four previous studies which she says have shown elevated risk of digestive cancer linked to PVC processing.

COMMENTS

The results of this new study bear careful consideration due to the strong excess cancer risk reported. However, its interpretation is complicated by the fact that, as with many other epidemiological studies, all the workers were exposed to a variety of different chemicals in the work place. This makes it impossible to prove that the excess cancer risk is associated with a specific chemical or combination of chemicals.

Dr. Teta stated that the observed excess in pancreatic cancer risk may have been due to practices early on in the industry which resulted in workers being exposed to high concentrations of a variety of chemicals associated with PVC manufacturing. Dr. Teta acknowledged that she was not very familiar with current PVC processing and formulating operations, such as the phasing out of lead and cadmium-based stabilizers. It would be helpful for the industry to document the changes in processes and work practice which have occurred over the years.

I am not aware to what degree Dr. Teta is aware of the toxicological controversy about the potential human carcinogenicity of diethylhexyl phthalate. Many reputable scientists question whether the results obtained in animal studies on this material are applicable to humans.

I think we should ask Dr. Teta to give a presentation on her study to the Vinyl Institute.

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-VISTA R&D -

********** -VISTA R&D - ***** - 512 331 2594- **********

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To Mike Raymond	From Dave Penney
Co. Vista	Co. Vista
Dept. (V1-1MC)	Phone #
Fax # 713/588-3119	Fax # 512/331-2594

To: V. Messick

Interoffice Communication

VISTA

From: D. Penney
Date: September 16, 1993

Subject: **Union Carbide report of Pancreatic Cancers in a PVC processing operation**

I spoke with Dr. Jane Teta of Union Carbide about a report of an increased risk of pancreatic cancer in workers involved in PVC processing. Dr. Teta said that Carbide had recently reported the study to EPA, however, she was not willing to make a copy of the study available for wider distribution before it was accepted for publication. However, Dr. Teta offered to meet with the Vinyl Institute to discuss her findings. I told her that I would contact her if such a meeting was desired. Dr. Teta briefly summarized the study as follows.

Twenty-eight male pancreatic cancer cases which were compared to 140 control cases with no pancreatic tumors were included in the study. Workers were assigned to work areas where both PVC and polyethylene were processed. Men assigned for more than sixteen years to these areas experienced slightly over a seven-fold increased incidence of pancreatic cancer. No excess was seen amongst workers with shorter duration of assignments. Seven of the nine cases of pancreatic cancer began working in this area in the 1940s. All but three cases had worked 20 years or more.

While recognizing that the workers in this study were assigned to units in which both PVC and polyethylene were processed, Teta places most of the blame for the excess pancreatic tumor rate on the PVC processing. She believes this is because PVC processing practices of the time resulted in higher chemical exposures and involved working with more hazardous raw materials than polyethylene. Teta does not believe the increase of pancreatic tumors was due to vinyl chloride exposure. This is primarily because there were no cases of angiosarcoma of the liver. She instead points the finger at the phthalate plasticizers used in PVC, citing diethylhexyl phthalate being reported as carcinogenic in mice and rats. Teta also expressed concern for stabilizers, some of which contain cadmium and lead, which have been demonstrated to produce cancer in animals.

Teta maintains that chemical exposure of workers during PVC processing prior to the 1950s was very high because materials were weighed and fed manually into a blender. Workers climbed inside the blenders to scrape off excess chemical residues whenever different additives were required for different vinyl products. She says that this occurred

APPLIED EPIDEMIOLOGY INC.

September 22, 1993

Tom Grumbles, Manager
Safety Health and Environment
Vista Chemical
900 Threadneedle
Houston, TX 77079-2990

Dear Tom:

Enclosed is a description of Applied Epidemiology, Inc. I look forward to assisting you with whatever epidemiological support you may need. Please do not hesitate to call if you would like additional information.

Thank you for your interest in Applied Epidemiology, Inc.

Sincerely yours,

Kenneth A. Mundt, Ph.D.

enclosure

P.O. BOX 2424 • AMHERST, MA 01004 (413) 256-3556 • FAX (413) 256-3503

Applied Epidemiology, Inc.

DESCRIPTION

APPLIED
EPIDEMIOLOGY
INC.

Applied Epidemiology, Inc.

DESCRIPTION

BACKGROUND

Applied Epidemiology, Inc. is a full-service epidemiological consulting firm specializing in occupational and environmental health, as well as biostatistical, methodological and interpretational issues. We have extensive experience ranging from formal epidemiological studies, to critical reviews and interpretations of the human health and medical literature, to educational and instructional programs.

Founded in 1989 and incorporated in 1991, **Applied Epidemiology, Inc.** has provided consulting services to a variety of North American and European clients including government agencies, non-profit organizations, industry trade groups, as well as private corporations. This heterogeneity of clientele is indicative of our strong philosophical commitment to scientific objectivity, as well as our general goal of providing practical solutions derived from an epidemiological perspective.

We at **Applied Epidemiology, Inc.** invite you to discuss with us your occupational and environmental health interests, or research or instructional needs.

Mailing address:

P.O. Box 2424
Amherst, MA 01004

Office address:

South Towne Commons
479 West Street, Suite 90
Amherst, MA 01002

(413) 256-3556 (Telephone)
(413) 256-3503 (FAX)

PEOPLE

Applied Epidemiology, Inc. enjoys and benefits from the participation of a variety of professionals as staff and associates. The following individuals are available on a regular basis to address most project needs:

Kenneth A. Mundt, Ph.D., is President and Senior Epidemiologist of the Company. He received an M.S. in Epidemiology from the University of Massachusetts and a Ph.D. in Epidemiology from the University of North Carolina at Chapel Hill. Dr. Mundt holds university appointments in the Department of Biostatistics and Epidemiology at the University of Massachusetts; Akademie für Öffentliche Gesundheit at the Ruhr Universität in Bochum, Germany; and the Institut für Epidemiologie und Sozialmedizin at the Westfälische Wilhelms Universität in Münster, Germany.

Linda D. Dell, M.S., is Project Manager and Epidemiologist. She received her M.S. in Epidemiology from the University of Massachusetts, and has experience in industrial epidemiology from her work in the corporate epidemiology department of a major chemical company. Ms. Dell also has interest and experience in environmental epidemiology as well as reproductive epidemiology.

Carol Bigelow, Ph.D., serves as Biostatistician for the Company. Dr. Bigelow received both an M.S. and Ph.D. in Biostatistics from the University of Washington at Seattle, and holds a faculty appointment in the School of Public Health of the University of Massachusetts. Dr. Bigelow is expert in multivariate analytical techniques, and teaches biostatistics and computer analysis in our "Intensive Course in Occupational Epidemiology" (ICOE).

Rainer Noess is an information management specialist, and provides hardware and software developmental support for the Company. Mr. Noess has extensive experience in managing data from large epidemiological studies, as well as Health and Safety and Occupational Surveillance databases.

Elizabeth Mundt is office manager of the Company, and provides support services in data entry, word processing, accounting, and library search and retrieval.

PEOPLE (continued)

Associates of Applied Epidemiology, Inc. provide expertise and a broader perspective to certain projects and activities, as well as facilitate our ability to meet the needs of clients in Europe or other locations.

Joseph P. Tritschler, Ph.D., is an agricultural environmental expert with particular interest in applying epidemiological methods to the study of environmental determinants of animal and human health, especially nutrition and parasites. Dr. Tritschler received his Ph.D. from the University of Florida at Gainesville, and holds a faculty appointment at the University of Hawaii at Hilo, where he also serves as Extension Service and Research Station Director.

Walter Dieckmann, Dipl. rer. Soc., is Manager of the ICOE, and other European projects. Mr. Dieckmann is a medical sociologist by training, and holds an academic appointment at the Ruhr Universität in Bochum, Germany.

Two epidemiologists of international recognition serve as external advisors to the Company:

Carl M. Shy, M.D., Dr.P.H., Professor and Chair, Department of Epidemiology, University of North Carolina at Chapel Hill

Harvey Checkoway, Ph.D., Professor of Epidemiology, Department of Environmental Health, University of Washington at Seattle. Dr Checkoway also serves as an instructor in the ICOE.

In addition, **Applied Epidemiology, Inc.** maintains an extensive network of experts and support staff available on a project-specific basis, or as needed, representing the following areas:

Occupational Medicine

Toxicology and Risk Assessment

Industrial Hygiene and Environmental Monitoring

Workplace Health Education and Health Promotion

EXAMPLES OF RECENT PROJECTS

Research

- Developing an epidemiological occupational surveillance system and survey to determine the health status of employees at a chemical plant;
- Preparing a research plan for an organization interested in identifying workplace stress and evaluating preventive measures and interventions, including study design, analysis and interpretation;
- Analyzing data on toxic metal exposure and reproductive outcome to determine shape of risk curve;
- Advising company on epidemiological approach to determine possible health effects of an accidental chemical release to the community;
- Comprehensively reviewing and critiquing health literature on human health effects of low-level exposure to mercury.

Short Courses

- Intensive Course in Occupational Epidemiology (ICOE), held May 25-30, 1993 and to be held again June 5-10, 1994 in Wermelskirchen, Germany. ICOE will be held in Kiev, Ukraine in 1995;
- Occupational and Environmental Epidemiology, held August 12-16, 1991 at the Cancer Registry of Norway, Oslo, Norway.
- Establishing an Occupational Epidemiology Program, held March 12, 1991 for the Chemical Manufacturer's Association, Washington, D.C.

RESOURCES

Applied Epidemiology, Inc. utilizes both Macintosh and IBM-compatible computers. We maintain an extensive library of textbooks and references on epidemiology, toxicology, medicine, environmental health, biostatistics, etc. A partial listing of our journal subscriptions includes

American Journal of Epidemiology

American Journal of Industrial Health

American Journal of Public Health

American Scientist

Applied Occupational and Environmental Hygiene

Archives of Environmental Health

British Journal of Industrial Medicine

Epidemiology

Occupational Health and Safety

Occupational Medicine: State of the Art Reviews

Scandinavian Journal of Work Environment and Health

Science News

Additionally, we receive numerous newsletters, government publications, mailings and catalogues on relevant topics.

Because **Applied Epidemiology, Inc.** is located in central Massachusetts, we have direct access to several local libraries including the University of Massachusetts, Smith College, Hampshire College, Mount Holyoke College and Amherst College. All relevant databases and search services are available in addition to their collective holdings. Specialized collections at the University of Massachusetts Medical School Library and the Countway Library at Harvard University Medical School are located nearby.

LIST OF RECENT CLIENTS

Allied-Signal, Inc., Morristown, New Jersey

Akademie für offentliche Gesundheit , Bochum, Germany

American Chrome & Chemicals, Corpus Christi, Texas

Association of Schools of Public Health, Washington, D.C.

BASF AG, Ludwigshafen, Germany

Bayer AG, Leverkusen, Germany

The Cancer Registry of Norway, Oslo

Chemical Manufacturers of America, Washington, D.C.

The Chlorine Institute, Washington, D.C.

E. I. Du Pont de Nemours, Wilmington, Delaware

Epach, Inc., Amherst, Massachusetts

GeoTrans, Inc., Sterling, Virginia

The Global Center for Occupational and Environmental Health Studies, Inc., Albany, New York

Health Protection Branch, Health and Welfare, Canada

Hoechst AG, Frankfurt, Germany

International Chrome Development Association, Paris

Industrial Health Foundation, Pittsburgh

(continued)

LIST OF RECENT CLIENTS (continued)

New York State Department of Health, Albany, New York

Occidental Chemical Corporation, Dallas

Occusafe, Inc., Chicago, Illinois

Ruhr-Universität, Bochum, Germany

State of Colorado (Office of the Attorney General), Denver

UOP, Chicago, Illinois

The World Bank, Washington, D.C.

Curriculum Vitae

KENNETH ARTHUR MUNDT, Ph.D.

CURRENT POSITIONS

Assistant Professor (1989-present)

Department of Biostatistics and Epidemiology
School of Public Health
403 Arnold House
University of Massachusetts
Amherst, MA 01003

Telephone (413) 545-2861
Fax (413) 545-1645

Visiting Assistant Professor (1991-1996)

Abteilung für Sozialmedizin und Epidemiologie
Ruhr-Universität Bochum
Postfach 10 21 48
D-4630 Bochum 1
Germany

Senior Epidemiologist (1989-present)

Applied Epidemiology, Inc.
P.O. Box 2424
Amherst, MA 01004

Telephone (413) 256-3556
Fax (413) 256-3503

EDUCATION

Ph.D., Epidemiology

University of North Carolina at Chapel Hill,
Chapel Hill, North Carolina, 1990.

M.S., Epidemiology

University of Massachusetts at Amherst,
Amherst, Massachusetts, 1986.

M.A., English

University of Virginia at Charlottesville,
Charlottesville, Virginia, 1982.

A.B., English

Dartmouth College,
Hanover, New Hampshire, 1981.

UNIVERSITY RESEARCH

1993

Principal Investigator
Healy Endowment Award. Lead Prevalence Study
(1993-4) $5,000

Principal Investigator/Convenor.
Second National Conference on Occupational Surveillance,
University of Massachusetts, Amherst, MA.
(March 9-11, 1993) $26,000

Sponsors: E.I. Du Pont de Nemours
Monsanto
Eastman Kodak
Unocal
Dow Chemical

1992

Principal Investigator.
E.I. Du Pont de Nemours Company. Educational Aid Program. Occupational Epidemiology Unit.
(1992-4) $15,000/year

Co-Investigator.
Chemical Manufacturers of America. Definition and Strategies for Developing Occupational Surveillance.
(1992-3) $38,000

Principal Investigator.
Faculty Research Grant. Epidemiological Surveillance.
(1992-3) $4,940

Principal Investigator.
Faculty Research Grant for Conference/Performance Travel.
Third Annual Symposium on Environmental and Occupational Health in Central & Eastern Europe in Poland.
(1992) $600

Investigator.
Occidental Chemical Corporation. Development of a Corporate Epidemiological Surveillance System.
(1991-2) $50,000/year

1991

Principal Investigator/Convenor.
National conference, "Occupational Surveillance"
University of Massachusetts, Amherst, MA.
(April 28-30, 1991) $22,000

Sponsors: Occidental Chemical
E.I. Du Pont de Nemours
Exxon
Monsanto
Eastman Kodak
General Electric
American Industrial Health Council

UNIVERSITY RESEARCH (continued)

1990	Investigator. Chemical Manufacturers of America. Development of Resource Materials for Occupational Epidemiology. (1990) $75,000
	Principal Investigator. National Institute of Occupational Safety and Health. Immuno-Epidemiology of Crab-Induced Occupational Asthma. (1989-1990) $43,500.
1989	Principal Investigator. United Way of North Carolina. Immuno-Epidemiology of Crab-Induced Occupational Asthma: Pilot and Preparatory Phases. (1989) $4,000.
	Principal Investigator. Biomedical Research Support Grant, School of Public Health, University of North Carolina. Production of Antigen Solutions for Skin Testing. (1988-1989) $5,886.

RELEVANT EXPERIENCE

1993 - 1994	Guest Editor, Journal of Ambulatory Care Management (April, 1994 issue on Occupational Health).
1993 - present	Director, Occupational Epidemiology Unit School of Public Health, University of Massachusetts.
1993	Member, 1993 Internship Program Objective Review Committee, Association of Schools of Public Health/Centers for Disease Control/Agency for Toxic Substances Disease Registry.
1992 - present	Founder and Director, Surveillance Resource Center, Occupational Epidemiology Unit.
1992 - present	Epidemiologist, Northeast Regional Environmental Public Health Center, School of Public Health, University of Massachusetts.
1992 - present	Member, Human Subjects Committee, School of Public Health, University of Massachusetts.
1991 - present	Member, Union Carbide Scientific Board of Advisors.
1990 - present	Member, International Chrome Development Association, Health, Safety and Environment Committee, Paris, France.

RELEVANT EXPERIENCE (continued)

1990 - present	Epidemiologist, Chromium Environment, Health and Safety Committee, Industrial Health Foundation, Pittsburgh, PA.
1989 - 1993	Founder and C0-Director, Occupational Epidemiology Unit, School of Public Health, University of Massachusetts.
1988 - 1989	Research Assistant to Carl M. Shy, M.D., Dr.P.H., on Oak Ridge Universities Occupational Studies of Department of Energy Employees, and on North Carolina Dusty Trades Occupational Health Studies, University of North Carolina.
1988 - 1989	Visiting Researcher, Duke University Marine Biomedical Center, Duke Marine Laboratory, Pivers Island, Beaufort, North Carolina.
1983 - 1984	Commissioned Officer Student Training Extern Program (COSTEP). United States Public Health Service, Health Resources and Services Administration, Silver Spring, Maryland.

TEACHING EXPERIENCE

1989 - present	Assistant Professor University of Massachusetts, School of Public Health: "Principles of Epidemiology" "Applied Epidemiology" "Occupational Epidemiology" "Special Topics in Occupational Epidemiology" "Departmental Doctoral Seminar" Numerous Independent Study Projects
1987 - 1988	Teaching Assistant to David G. Kleinbaum, Ph.D. University of North Carolina, School of Public Health. "Special Topics in Epidemiological Methods" "Advanced Methods in Epidemiology"

SHORT COURSES

1993	Applied Epidemiology, Inc. and Akademie für offentliche Gesundheit , Wermelsckirchen, Germany. May 23-28: "Intensive Course in Occupational Epidemiology"

SHORT COURSES (continued)

1991	Cancer Registry of Norway, Oslo, Norway. August 12-16: "Occupational and Environmental Epidemiology"
1989, 1990, 1991	International Summer School for Epidemiology, World Health Organization and the Akademie für offentliche Gesundheit , Bochum, Germany "Occupational and Environmental Epidemiology"

HONORARY AND PROFESSIONAL SOCIETIES

American Conference of Governmental Industrial Hygienists (Full Member)

American Public Health Association

Delta Omega, Public Health National Honor Society

International Society for Environmental Epidemiology

Massachusetts Public Health Association

Sigma Xi, Scientific Research National Honor Society

Society for Epidemiologic Research

PRESENTATIONS

1993

Mundt K.A. "Occupational Epidemiology in a White-Collar Setting." Invited Speaker, The World Bank, May 11-12, 1993.

Mundt KA. "Occupational Surveillance: Concepts and Goals." Second National Conference on Occupational Surveillance, University of Massachusetts, Amherst, MA, March 9-11, 1993.

Mundt KA. "Practical Stretegy for Developing Epidemiological Surveillance." Design and Analysis Workshop, Second National Conference on Occupational Surveillance, University of Massachusetts, Amherst, MA, March 9-11, 1993.

1992

Mundt KA and Weiland S. "The Association of Asthma Symptoms and Allergic Rhinitis with Traffic Density on Street of Residence." Annual meeting of the International Societies for Environmental Epidemiology and of Exposure Analysis, Cuernavaca, Morelos, Mexico, August 26-29, 1992.

PRESENTATIONS (continued)

Pastides H and Mundt KA. "Retrospective Estimation of Exposure to Hexavalent Chromium in an Occupational Cohort." Annual meeting of the International Societies for Environmental Epidemiology and of Exposure Analysis, Cuernavaca, Morelos, Mexico, August 26-29, 1992.

Pastides H and Mundt KA. "Epidemiological Occupational Surveillance." Surveillance in Europe and the EEC, Devonshire Park Centre, Eastbourne, Sussex, United Kingdom, July 1-3, 1992.

Mundt KA. "Occupational Surveillance as a Strategy for Policy Development and Disease Prevention." Protecting Workers, the Environment and Health in a Market Economy: Translating Science into Policy and Action. The United States-Central and Eastern Europe Exchange for Occupational and Environmental Health, third annual symposium, Pultusk, Poland, June 26 - July 1, 1992.

Pastides H, Austin R, Lemeshow S, Klar J, Noess R, and Mundt KA. "A Retrospective Cohort Study of Health Risks Among Chromate Production Workers." Annual Meeting of the Society for Epidemiologic Research, Minneapolis, MN, June 10-12, 1992.

Weissman L and Mundt KA. "Prevalence of Immediate Hypersensitivity in Black Women: A Re-evaluation of Skin Prick Test Data from the Second National Health and Nutrition Examination Survey (NHANES II) and Comparison with an Occupational Study." Annual Meeting of the Society for Epidemiologic Research, Minneapolis, MN, June 10-12, 1992.

Mundt KA, Leeser J, Adams R. "Establishing a Mercury Biological Exposure Index (BEI)." American Conference of Governmental Industrial Hygienists (ACGIH) BEI and Threshold limit value (TLV) Committees, Orlando, Fla., March 21-22, 1992.

1991

Mundt KA. "Epidemiological Approach to Occupational Health." Annual Scientific Meeting, Industrial Health Foundation, Pittsburgh, PA, November 6-7, 1991.

Mundt KA. "Role of Epidemiology in an Occupational Medical Department." Bayer Chemical, Leverkusen, Germany, June 19, 1991.

Mundt KA. "Occupational Epidemiological Studies and the Social Context." Department of Epidemiology, State University of New York at Albany, April 18, 1991.

Mundt KA. "Use of Skin Tests in Epidemiological Research." Clinical Epidemiology Department, University of Pennsylvania, Philadelphia, PA, March 14, 1991.

Pastides H and Mundt KA. "Establishing an Occupational Epidemiology Program." Chemical Manufacturers Association, Washington, D.C., March 12, 1991.

PRESENTATIONS (continued)

1990

Mundt KA. "Studies to Document the Healthy Worker Effect." Department of Work Environment, University of Lowell, Lowell, MA, December 11, 1990.

Mundt KA and Miller J. "Use of Industrial Hygiene Data in Epidemiology Research." Occidental Chemical Industrial Hygiene Annual Meetings, Houston TX and Atlantic City, NJ, November 12-14, 1990.

Mundt KA and Shy C. "Occupational Allergies and the Healthy Worker Effect." Annual Meeting of the Society for Epidemiologic Research, Snowbird, Utah, June 12-15, 1990.

Mundt KA. "Health Effects of Vinyl Chloride Monomer (VCM)." Occidental Chemical Company, Plastics and Polymers Group, Berwyn, PA, May 11, 1990.

1989

Mundt KA. "Skin Testing for Allergies in an Occupational Setting." Clinical Epidemiology Seminar Series, University of Massachusetts Medical Center, Worcester, MA, December 20, 1989.

Mundt KA. "Immuno-Epidemiology of Crab-Induced Occupational Asthma: Methodological Issues." Visiting Researcher Program, Duke University Marine Biomedical Center, Beaufort, North Carolina, January, 12-13, 1989.

1987

Mundt KA and Heiss G. "Measuring Ankle Systolic Blood Pressure: Interaction Between Ankle Geometry and Method of Applying Blood Pressure Cuff." National Heart, Lung and Blood Institute Seminar, Bethesda, Maryland, November 3, 1987.

Mundt KA and Pastides H. "Microcomputer-Based Instruction: Applications in Epidemiology." Annual Meeting of the American Public Health Association, New Orleans, Louisiana, October 18-22, 1987.

1986

Mundt KA. "Distribution of Selected Mineral Concentrations in Urban Children's Hair." Annual Meeting of the American Public Health Association, Las Vegas, Nevada, September 28 - October 2, 1986.

PUBLICATIONS AND REPORTS

1993

Weiland SK, Mundt KA, Rückmann A and Keil U. Self-reported wheezing and allergic rhinitis in children and traffic density on street of residence (accepted for publication) Annals of Epidemiology.

Pastides H and Mundt KA. Establishing an Epidemiological Occupational Surveillance Program. Chemical Manufacturers of America, Washington, D.C., 1993.

Pastides H, Austin R, Lemeshow S, Klar J, Noess R and Mundt, K. Retrospective estimation of exposure to hexavalent chromium in an occupational cohort (accepted for publication) American Journal of Industrial Medicine.

1992

Pastides H, Austin R, Lemeshow S, Klar J, Noess R and Mundt, K. Occupational cohort study of chrome chemical manufacturers (submitted for publication).

Mundt KA. Occupational surveillance as a strategy for policy development and disease prevention (in press) In: Proceedings of the Third Annual Symposium on Environmental and Occupational Health during Societal Transition in Central and Eastern Europe. Protecting Workers, the Environment and Health in a Market Economy: Translating Science into Policy and Action, June 26 - July 1, 1992.

Mundt KA. The Workplace as Laboratory. Business Digest, June 1992;34.

Mundt KA, Chambless LE, Burnham CB and Heiss G. Measuring ankle systolic blood pressure: Validation of the Dinamap 1846 SX. Angiology, 1992:43(7);555-566.

Mundt KA. Letter to the Editor: RE: "Exposure to residential electric and magnetic fields and risk of childhood leukemia" and "Case-control study of childhood cancer and exposure to 60-HZ magnetic fields." American Journal of Epidemiology 1992:135(9);1070-1075.

Health, Safety and Environment Committee, International Chromium Development Association. Health, Safety and Environment: Industry Guidelines. Paris, France, April, 1992.

Pastides H, Miller JR, Mundt KA, Klar J, Adams RF, Olendorf T. A characterization of occupational static magnetic field exposures at a diaphragm-cell and a mercury-cell chlor-alkali facility. Applied Occupational and Environmental Hygiene 1992;7:42-48.

1991

Mundt KA. Epidemiological Review of the American Conference of Governmental Industrial Hygienists (ACGIH) Recommended Biological Exposure Index (BEI) for Urinary Mercury. The Chlorine Institute, September 30, 1991.

PUBLICATIONS AND REPORTS (continued)

Pastides H and Mundt KA. Resource Manual for Occupational Epidemiology, Chemical Manufacturers of America, Washington, D.C., 1991.

1990

Walker A and Mundt KA. Feasibility of Conducting an Industry-wide Study of Respiratory Cancer Related to Ceramic Fiber Inhalation, Final Report to Thermal Insulators Manufacturers Association (TIMA), Epidemiology Resources, Inc., Boston, MA, November, 1990.

Mundt KA. Immuno-epidemiology of crab-induced occupational asthma, doctoral dissertation, University of North Carolina, 1990.

1986

Pastides H, Mundt KA, McKnight CJ and Tuthill RW. Formulating case definitions and identifying cases for analysis (computer-assisted instructional software). In "Applied Epidemiology," Centers for Disease Control, Atlanta, Georgia, 1986.

Pastides H, Mundt KA, McKnight CJ and Tuthill RW. Descriptive analysis of the disease outbreak (computer-assisted instructional software). In "Applied Epidemiology," Centers for Disease Control, Atlanta, Georgia, 1986.

Pastides H, Mundt KA, McKnight CJ and Tuthill RW. Formulating and testing hypotheses (computer-assisted instructional software). In "Applied Epidemiology," Centers for Disease Control, Atlanta, Georgia, 1986.

Mundt KA. Distribution of selected mineral concentrations in urban children's hair. Masters thesis, University of Massachusetts, 1986.

1985

Tuthill RW and Mundt KA. An evaluation of hazard abatement activities in selected state-funded lead screening programs, Final report to Massachusetts House of Representatives Post Audit and Oversight Committee, June 27, 1985.

1979

Mundt KA and Polk BF. Identification of site urinary-tract infections by antibody-coated bacteria assay. Lancet 1979;2:1172-5.

Mundt KA and Polk BF. Predictive value of a single diagnostic test: a belated correction. New England Journal of Medicine 1979;300(15):859.