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DRAFT REPORT

May 3, 1993

ChemRisk has completed a preliminary review of a letter to EPA from Greenpeace dated February 22, 1993. The letter comments on the Environmental Impact Statement (EIS) prepared by EPA (1992) for the expansion of the Formosa Plastics Corporation facility in Point Comfort, TX. In our review of the Greenpeace letter, we discovered numerous factual errors relating to technical points. Greenpeace appears to have misinterpreted some of the sources cited, assumed that data from one Swedish ethylene dichloride (EDC) production facility is applicable to all EDC production facilities, and reached the unsupported conclusion that extreme risks to human health are associated with this process. Concerns regarding these issues are further detailed below.

Editorial Issues

Concerns regarding editorial issues were raised when, in an effort to verify the Greenpeace's interpretation of information cited in their letter, a search for primary references was undertaken. It soon became clear that certain citations were unavailable, others were misinterpreted, and others were clearly marked by their authors "Do Not Cite or Quote" for reasons of confidentiality or draft status. The cited portions of those references which we have been able to obtain are included as attachments to this letter.

Enclosure 1 provides a list of citations that are unavailable from the source identified in the Greenpeace letter, and reports the status of obtaining other references that Greenpeace cited.

Examples include:

1) Fisher-Gundlach (1990). The data to which Greenpeace refers on page 2 of their letter regarding Nordic TCDD equivalents, are attributable to Ahlborg (1990) rather than Fisher-Gundlach (1990). The confusion with these citations appears

attributable to the fact that Fisher-Gundlach (1990) appears immediately after Ahlborg (1990) in the Dioxin '90 Conference Proceedings. Both of these presentations are enclosed (Enclosure 2).

2) EPA (1992). *EPA's Scientific Reassessment of Dioxin: A Status Briefing for the Deputy Administrator* is cited on page 9 of the Greenpeace letter, regarding recent scientific conclusions of EPA on the toxicity of dioxin. This document could not be located through EPA's Office of Research and Development (ORD), although the citation specifies that ORD issued the briefing. Additionally, John Schaum of ORD specified that briefings are not appropriate to cite because they are neither peer-reviewed nor published (personal communication, 1993). Schaum also stated that his office had recently received a Freedom of Information Act (FOIA) request for this document, but had denied the request because the document could not be found. Additional information regarding our efforts to retrieve the briefing is detailed in Enclosure 1.

3) Swedish EPA (1992). Upon request of this report from the Swedish EPA, the Agency indicated that they were not aware of any document with that citation. The Swedish EPA did, however, provide a summary of the action in question (in English) as well as the text of the ruling (in Swedish). The Swedish text was translated and copies of the original Swedish text, the translation, and summary are included (Enclosure 3). In the Swedish case, Greenpeace voiced many of the concerns that they raised in their letter of February 22, but the Swedish EPA did not support the appeal.

In a number of instances, Greenpeace misinterpreted the cited material. Some examples are presented below.

1) On page 5 of the Greenpeace letter, data are presented on releases of dioxin from the Norsk Hydro Facility in 1991, based on Figure 11.6 (p. 165) of Kamsvag (1992). This figure is included (Enclosure 4). The figure presents flow rates of dioxin between processes in Norsk Hydro's VCM production facility. Greenpeace

misinterpreted this figure to indicate that all rates given are outputs from the entire facility, rather than fluxes between processes within the facility. Figure 11.6 clearly indicates that 0.3 g/year are released to air, 0.04 g/year are released to water, and 0.03 g/year are released with the product, for a total release rate of 0.37 g/year. Greenpeace, on the other hand, asserts that the figure indicates that 3.465 g/year are released.

2) On page 4 of the Greenpeace letter, Kamsvag (1992) is quoted out of context as follows:

> Unfortunately, there are no publicly available data on the emissions from other production plants . . . but it is our impression that Norsk Hydro's emissions compare well with those of other producers. It is our intention to be among the very best producers in terms of emission standards.
>
> (Kamsvag, 1992, p. 22)

An earlier portion of the same paragraph - not provided in the Greenpeace letter - describes the critical importance of the particular production process and its emissions to the environmental impact of the product. Photocopies of pages 21 and 22 are included (Enclosure 5).

3) On page 8 of Greenpeace's letter, Kramlich et al. (1989) is incorrectly quoted as stating that DREs have not been met when chemicals are present in wastes at concentrations of 10,000 ppm or less. The value actually stated by Kramlich et al. (1989) is 1,000 ppm or less. Greenpeace's technical misunderstanding of DREs is further described later in this letter.

4) Also on page 8, Greenpeace quotes Lowrance's (1992) memo without providing adequate supporting text. This supplementary text is included (Enclosure 6).

5) Lorber (1993), cited by Greenpeace on page 9 of their letter, refers to potential risks to human health associated with emissions from a hazardous waste incinerator. Although the paper is cited incorrectly (the assessment was actually issued by William Farland, Director of the Office of Health and Environmental Assessment of

EPA), of greater importance is the fact that the quote is taken out of context. Farland's memorandum states on the first page that the Screening Level Analysis "is not exhaustive in its analysis, nor does it characterize dioxin hazards. It should not be construed as a comprehensive risk assessment and should not be generalized to other sites." The next paragraph goes on to say, "We have used conservative, hypothetical exposure scenarios which relate to plausible but unlikely situations surrounding the WTI site. The resulting exposure estimates lead to upper bound risk predictions which are not likely to underpredict risk. Actual risks are likely to be less and may even be zero." A copy of the cover sheet is included (Enclosure 7).

A final editorial concern raised by the Greenpeace letter relates to Greenpeace's citing of documents marked "Do Not Cite or Quote." Generally, documents are marked in this way when they are in draft form, have not undergone technical review, or are for internal use only. Examples of such cited documents are presented below.

1) William Farland's 1993 memorandum, discussed above, is clearly marked, "Work Product - Privileged and Confidential - Deliberative Process, Draft - Do Not Quote or Cite" on every page. Because of the confidential nature of the memorandum, it seems inappropriate for Greenpeace to quote from it.

2) The EPA (1992) document *Chapter 8 Dose Response Relationships* (EPA/600/AP-92/001h), cited by Greenpeace as Gallo (1992), is marked "Do Not Cite or Quote" on the cover and on every page, because it is a Workshop Review Draft.

3) EPA (1988) *A Cancer Risk-Specific Dose Estimate for 2,3,7,8-TCDD: Review Draft*, cited by Greenpeace on page 5 of their letter, also contains the "Do Not Cite or Quote" admonition. This document is an external review draft as suggested by its title.

As additional material is received by ChemRisk, it will be integrated in an updated version of this report.

Technical Issues

The Greenpeace letter also raises several technical issues, many of which are based on questionable assumptions. First, Greenpeace assumes a level of comparability among EDC production facilities that does not account for differences in regulations, engineering, or site characteristics. Second, it appears that Greenpeace miscalculated risks to human health. Third, conclusions regarding the Vertac incinerator appear to be outdated.

Concerning the level of comparability that Greenpeace assumed, it is inappropriate to infer the performance of one EDC production facility based on data from a different facility. While dioxin may be released from Norsk Hydro, data do not exist to support the same conclusions for other EDC facilities. In issuing permits in the United States, state environmental agencies consider numerous site-specific factors in establishing permit requirements. Facilities located in areas with relatively low population densities, stable atmospheric conditions, and/or advanced waste management practices can substantially limit risks to human health and, as a result, may be permitted at different levels than would be allowed for facilities lacking these protective attributes.

Largely as a result in different regulatory requirements, the types and efficiencies of air pollution control devices at various EDC production facilities are unlikely to be identical or even comparable. Differences in EDC production facility designs, processes, and operating practices also contribute to the difficulty of extrapolating from one facility to another. Operator control practices are likely to vary depending on the experience and skill of individual engineers. Likewise, the quality and type of feedstock directly influence the purity of EDC produced and the level and type of emissions from the process. Because different grades of EDC are produced for different purposes, varying levels of purity and refinement are expected both within and between facilities. Greenpeace does not explore any of these potential differences between Norsk Hydro and other facilities.

Also, potential risks associated with individual facilities depend on the locations of key receptor (i.e., population) groups. The population density and presence of sensitive subpopulations are not likely to be identical for any two facilities and, as a result, even if emissions were comparable, risks attributable to any two facilities would differ.

Although Greenpeace does not include any of the calculations or assumptions applied in their calculation of risk, it appears that they may have misapplied or miscalculated potential risks to human health associated with EDC production. In their letter, Greenpeace repeatedly refers to population risks (e.g., " . . . exceeds the acceptable lifetime intake for more than 320 million people," "exceeds the acceptable daily intake for more than 2.8 million adults," and "risks of cancer deaths caused by dioxin emitted from one hazardous waste incinerator . . . are estimated at 42 deaths per one million people). These statements raise several concerns regarding Greenpeace's understanding of the practice of human health risk assessment.

As detailed in the *Risk Assessment Guidance for Superfund* (EPA, 1989), the Lifetime Average Daily Dose (LADD) is multiplied by the Cancer Slope Factor (CSF) in order to estimate the 95 percentile upper-bound incremental risk (i.e., probability) that an individual might develop cancer within his or her lifetime as a result of exposure to a carcinogen. Greenpeace appears to assume that a risk of 10^{-6} (1 in one million) refers to one cancer death per one million persons, rather than a probability of 0.000001 that an individual may develop cancer, which is the correct interpretation. The LADD is calculated for an individual and is based on numerous assumptions regarding the behavior of an individual and his or her potential for exposure to a carcinogen. As a sidenote, the current science of risk assessment cannot estimate the likelihood of death by cancer, but rather estimates the probability of an individual developing cancer.

Due to the absence of supporting data for Greenpeace's risk calculations, it is impossible to fully understand the source of their risk estimates. At a minimum, the basic assumptions regarding exposure and the methods used to calculate risks should be presented with the risk estimates. However, EPA (1989) correctly specifies that, "a risk characterization cannot be considered complete unless the numerical expressions of risk are accompanied by explanatory text interpreting and qualifying the results." Indeed, results regarding risks associated with any chemical (and especially with dioxin) are likely to be relatively uncertain, due to:

- uncertainty in the potency of dioxin;
- application of the Linearized Multistage model to derive CSF;
- extrapolation of toxicity data from animals to humans;
- extrapolation of toxicity data from high dose to low dose;

- likelihood of exposure pathways being complete;
- potential degradation of chemicals over time; and,
- individual variation in exposure frequency, duration, and intensity.

Given these uncertainties, it is inappropriate to present potential risks without additional qualification.

Greenpeace refers to the February 12, 1993 decision by Federal Judge Stephen Reasoner regarding the inacceptability of surrogate compounds in demonstrating 99.9999 percent destruction or removal efficiency (DRE) for dioxin for operation of the Vertac facility in Jacksonville, Arkansas. Since Greenpeace's letter was written, this decision has been reversed. In the opinion of Circuit Judge McMillian,

> . . . granting the stay, and allowing the incinerator to operate, serves the public interest because doing nothing to the thousands of drums of hazardous wastes involves substantial risks of accidental and uncontrolled releases of toxic substances into the environment, whereas incineration destroys the toxic substances. We do not underestimate the environmental problems associated with incineration, but we think defendants have shown that, particularly in light of the EPA's continuous monitoring of air quality at the Vertac site and its detailed specific risk assessment, which included the assessment of the risks of food-chain and inhalation exposure, a stay will not harm, and may in fact benefit, other interested parties and the public interest (1993 U.S. App. LEXIS 7002).

The history of the Vertac site is included for your records (Enclosure 8). It is also dated and will require tracking to maintain current conditions. To the best of our knowledge, both the Vertac incinerator and the WTI incinerator (referred to earlier in this analysis) are currently operational.

In general, some confusion exists regarding the implications of not achieving "six nines" when very low concentrations of dioxin are present and the use of surrogate compounds to demonstrate DRE. Contrary to Greenpeace's interpretation, if "six nines" are not achieved at very low concentrations of dioxin, it is likely related to the level of precision which is technically possible in sampling and measuring very low levels, rather than the actual performance of an incinerator. Also, EPA has traditionally encouraged the use of surrogate compounds to demonstrate DRE for several reasons, including: 1) surrogate compounds are generally less toxic than dioxin; 2) surrogate compounds are generally more difficult to destroy than dioxin; and 3) wastes may be spiked with precise quantities of surrogate compounds, ensuring that DRE may be calculated to four decimal places.

Finally, Greenpeace makes the assumption that, because the descriptions of Norsk Hydro's "EDC Tar" and the Formosa's "still bottoms" or "distillation bottoms" are similar, their compositions are also similar. This logic is flawed because the composition of the byproducts of EDC production is directly related to the production process, feed stock, purity of product, and other facility-specific factors. In fact, the wastes to which Greenpeace refers are neither EDC tars nor heavy ends, because neither contains adequate residual product to allow for efficient recycling.

Venue

Greenpeace also raises several concerns regarding additional informational needs, such as: 1) congener-specific analyses of polychlorinated dioxins and furans for many different production streams, 2) descriptions of on-site recycling/reclamation technologies, 3) detailed descriptions of off-site recycling facilities and their emissions, and 4) current and projected quantities of EDC, VCM distillation bottoms, heavy ends, and light ends and their final destination.

Although some of the points made by Greenpeace are of interest, an EIS is not the appropriate venue for addressing them. An EIS is an initial, interdisciplinary analysis of all potential environmental effects resulting from a proposed action, rather than a comprehensive assessment detailing every aspect of an industry and the products and wastes produced. Greenpeace states that the information needs listed in their letter should have been included in the EIS for the proposed expansion of the Formosa facility. In actuality, much of the information requested by Greenpeace to be included in the EIS is: 1) beyond the scope of an EIS, 2) found in other documents, and/or 3) proprietary information.

Information regarding off-site recycling, congener-specific analysis of polychlorinated dioxins and furans for many different production streams, and current and projected quantities and destinations of EDC and VCM wastes are beyond the scope of an EIS. Greenpeace also asks for descriptions in the EIS of on-site recycling/reclamation technologies. In general, this information is proprietary and, therefore, not appropriate to divulge in a public document where concerns over competitive disadvantages may reign.

In conclusion, ChemRisk found numerous factual errors in Greenpeace's letter, including editorial mistakes, technical misinterpretations, and perceived scope of an Environmental Impact Statement. We are most concerned with Greenpeace's misinterpretation of sources cited, assumption that data from one Swedish EDC production facility are applicable to all EDC plants, and unsupported presentation of risks to human health. Our review has been undertaken to offer the full text of Greenpeace-cited information so that a full, unbiased evaluation may be performed. If you require additional information or have any questions on this matter, please do not hesitate to contact us.

Sincerely,

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Chief Health Scientist and Regional Manager, McLaren/Hart

Michael N. Gray
Senior Associate Environmental Scientist
Project Manager

REFERENCES

Ahlborg, U.G. 1990. Research and regulation of dioxins and related compounds in Sweden. *Organohalogen Compounds* 4:36-40.

EPA. 1988. *A Cancer Risk-Specific Dose Estimate for 2,3,7,8-TCDD; Review Draft.* U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. EPA/600/6-88/007ab. June.

EPA. 1989. *Risk Assessment Guidance for Superfund: Human Health Evaluation Manual Part A.* U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. Report No. 9285.701A. July.

EPA. 1992. *Draft Environmental Impact Statement.* U.S. Environmental Protection Agency, Washington, DC. EPA/906/07-92-001. July. (cited in Greenpeace, 1993).

EPA. 1992. *EPA's Scientific Reassessment of Dioxin: A Status Briefing for the Deputy Administrator.* U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. February 14. (cited in Greenpeace, 1993).

EPA. 1992. *Health Assessments for 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Related Compounds, Workshop Review Draft: Chapter 8. Dose Response Relationships.* U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Washington, DC. EPA/600/AP-92/001h. August.

Farland, W.H. 1993. Memo to B. Grant and G. Goldman, Attorneys, U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC from W.H. Farland, Director, Office of Research and Development. Re: WTI Screening Level Assessment. February 8.

Fisher-Gundlach, U. 1990. Regulation and research activity in Germany. *Organohalogen Compounds* 4:41-47.

Greenpeace. 1993. Memo to N. Thomas from G. Martin et al. Re: USEPA's Final Environmental Impact Statement for the Proposed Expansion of the Formosa Plastics Corporation, Point Comfort, TX.

Kamsvag, N. 1992. *PVC and the Environment.* Kamsvag, N. and Baldwin, J. (eds.). Norsk Hydro, Oslo, Norway. August.

Lowrance, S. 1992. Memo to USEPA Waste Management, Division Directors, Regions I-X from S. Lowrance Director, Office of Solid Waste. Re: Assuring Protective Operation of Incineration Burning Dioxin-Listed Wastes. September 22. (cited in Greenpeace, 1993).

Norsk-Hydro. 1992. Hydro Plast. Overklagandn av baslut 1992 D1-10 av Koncessionsnsmden for miljokydd rorande hydro plast AB:s workamhelt i stanungsund. Overiamnas for kannedon Miljo-och naturrasturs-departementst: DNR M92/610/8. Stockholm. October 29.

Rand McNally. 1992. *Rand McNally Road Atlas, United States, Canada, and Mexico.* Rand McNally and Company, Chicago, IL.

Swedish EPA. 1992. Memo to D. Thompson from A. Petsonk Re: Concerning an appeal by Greenpeace and others of a permit issued by the National Franchise Board for Environmental Protection for partial changes in activities at Hydro Plast in Stenungsund. November 11.

ENCLOSURE 1

A

VRD 0002021509

April 22, 1993

DOCUMENT RETRIEVAL

Citations from GreenPeace letter (2/22/93)

The following documents have not yet been located or obtained:

- USEPA. 1992. "EPA's Scientific Reassessment of Dioxin: A Status Briefing for the Deputy Administrator." U.S. Environmental Protection Agency, Office of Research and Development. February 14, 1992.
    - John Rettig, Librarian, ORD library in Cincinnati, could not locate this document in the holdings of any USEPA library in Cincinnati or Washington, D.C.
    - John Schaum, USEPA, Office of Research and Development, Washington, D.C., said that his office recently received an FOI request for this document but denied the request because the document could not be found. In addition, he made the following comments:
        - "If the paper exists at all, there are probably one or two copies tucked away in peoples personal files,"
        - "Briefings are not appropriate to cite in scientific papers .... Briefings are not peer-reviewed or published."
        - "Since it's a briefing, it is likely to be in the form of slides rather than a complete document"
    - Bill Farland, Director, Office of Health and Environmental Assessment, USEPA, Washington, D.C. is currently searching his files to locate the document. He suggested that some type of status briefing may have been issued at that time, but he believes the date of February 14 is probably incorrect. In addition, Dr. Farland also stated that status briefings "should never be cited" since they are not subjected to a proper review process.

- USEPA. 1992. Draft Environmental Impact Statement. EPA-906/07-92-001. July.
    - Efforts to obtain this document have been unsuccessful; the document does not appear to exist in any holdings of the USEPA libraries contacted.
    - Ms. Pearl Young, USEPA, Office of Federal Activities, is currently compiling a reference list of all EIS documents generated within Region VI for 1992. The document is expected to arrive during the week of April 18.

VRD 0002027518

- Norsk Hydro. 1992. Hydro Plast. "Overklagande av beslut 1992-01-10 av Koncessionsnamnden for miljoskydd rorande Hydro Plast AB:s verksamhat i Stenungsund. Overiamnas for kannedon Miljo-och naturresurs-departementat," DNR M92/610/8, 1992-10-29.
  - Norsk-Hydro officials have indicated by Telefacsimile that this document is not in their possession.

- Swedish EPA. 1992. Miljo-och Naturrasurs-Departementat, "Overklagande av beslut 1992-01-10 av Koncessionsnamnden for miljoskydd rorande Hydro Plast AB:s verksamhat i Stenungsund. Overiamnas for kannedon Miljo-och naturresurs-departementat," DNR M92/610/8, January.
  - Norsk-Hydro officials have indicated by Telefacsimile that this document is not in their possession.

- Fischer-Gundlach, U. 1990. "Regulation and Research Activity in Germany." Presented at Dioxin '90. Bayreuth, Germany. 1990.
  - This document should not have been cited. The correct citation should be attributed to Ahlborg, 1990 (as cited below).

<u>The following documents have been located and ordered:</u>

- Bretthauer, E. 1992. Eric Bretthauer, Assistant Administrator, USEPA. Memorandum to William Reilly, Administrator, October 19, 1992.
  - A Freedom of Information Request has been filed with the USEPA to obtain this document.

- Evers, E. and K. Olie. 1989. "De vorming van PCDFs, PCDDs un gerelataarde Verbindingen bij de Osychlorering van Etheen," University of Amsterdam, MTC publication No. MTC89EE, 1989.
  - This document has been forwarded by Dr. Olie from Amsterdam. It is written in Dutch, however, and will need to be translated. Dr. Olie believes that any tables, graphs, and figures will be easily understood and should not require translation.
  - This report consists of 65 pages and has not been published in a peer-reviewed journal. An abstract of the study, however, was published in Dioxin '89.
  - Efforts are currently being made to contract an interpreter to translate necessary portions of this document.

A VRD 00020271511

The following documents have been requested by Telefacsimile:

- NALU. 1989. Report on Norsk Hydro-Rafnes facility, Oslo, Norway.
- NIVA. 1989. Report on Norsk Hydro-Rafnes facility, Oslo, Norway.

The following documents have been obtained:

- Ahlborg, U.G. 1990. Research and Regulation of Dioxin and Related Compounds in Sweden. Presented at Dioxin '90. Bayreuth, Germany. 37-40.
(Cited as Fischer-Gundlach, 1990)
- Arkansas Peace Center et al. vs. Vertac Site Contractors (Morrison Knudsen Corporation and MRK Incineration Corporation, a joint venture) et al. 1993. Amended Temporary Restraining Order. Order Entered February 16, 1993. File No. LR-C-92-684, Document No. 54. U.S. District Court, Eastern District of Arkansas.
(Cited as February 12, 1993)
- Claus, F., H. Friege, and D. Gremler. 1990. "Es Geht auch ohne PVC: Einsatz-Entsorgung-Ersatz ein Ratgeber," Hamburg: Rausch und Rohring Verlag. (In German).
- Davis, S. 1993. "Judge Halts Dioxin Burn at Vertac: Stuns Lawyers, Finds Regulations Violated." Arkansas Democrat-Gazette, Little Rock, Arkansas. February 13.
(Cited as February 12, 1993)
- EPA. 1992. *Health Assessments for 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Related Compounds, Workshop Review Draft: Chapter 8. Dose Response Relationships.* U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Washington, D.C. August.
(Cited as Gallo et al., 1992)
- EPA. 1989. *Experimental Investigation of Critical Fundamental Issues in Hazardous Waste Incineration.* EPA/600/2-89/048. U.S. Environmental Protection Agency, Air and Energy Engineering Research Laboratory, Office of Research and Development, Research Triangle, North Carolina. September.
(Cited as Kramlich et al., 1989)
- EPA. 1988. *A Cancer Risk-Specific Dose Estimate for 2,3,7,8-TCDD; Review Draft.* EPA/600/6-88/007ab. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C. June.
- Farland, W.H. 1993. *WTI Screening Level Assessment.* Memorandum from William H. Farland, Director, Office of Research and Development to Brian Grant and Greer Goldman, Attorneys. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C. February 8.
(Cited as Lorber, 1993; January 22, 1993)
- ICI Merseyside. 1992. *Pamphlet: Merseyside Operations - Environmental Update: 1992 Report.* ICI Public Affairs, ICI Merseyside, London, England.

- Lowrance, S. 1992. *Assuring Protective Operation of Incineration Burning Dioxin-Listed Wastes*. Memorandum from S. Lowrance, Director, Office of Solid Waste to Waste Management Division Directors, Regions I - X. U.S. Environmental Protection Agency, Office of Solid Waste, Washington, D.C. September 22.

- Norsk Hydro. 1992. *PVC and The Environment*. Norsk Hydro a.s, Petrochemical Division, Oslo, Norway. September.
(Cited as Kamsvag, 1992)

ENCLOSURE 2

VRD 0002027514

REGULATION AND RESEARCH ACTIVITY IN GERMANY

U. Fischer-Gundlach
Ministerium für Umwelt, Naturschutz und Reaktorsicherheit
Postfach 12 06 29, 5300 Bonn 1 / F.R.G.

I do not think you have all had the chance to listen to the opening speech given by the State Secretary at my ministry. So I should like to summarize the legislative issues concerning dioxins and furans that have been passed or are still under discussion. The German Federal Government has developed an overall concept for protection against hazardous substances. This concept is supported by a closely-unit network of precautionary measures.

Anticipatory action has been comprehensively extended with the amended Chemicals Act, with the programme for abandoned contaminated waste and former industrial sites and a whole range of prohibition, limitation and maximum permitted quantity ordinances. Moreover, measures on the safety of installation, the extension of the Federal Immission Control Act and the environmentally compatible disposal of waste are part of the overall concept to overcome the chemical risk.

Now - to the field of special measures against dioxin pollution:

As far as is known to date main sources are

1. the production and use of the industrial chemicals PCP (pentachlorophenol) and PCB (polychlorinated biphenyls) and other processes in the chemical industries,
2. incineration processes of all kinds, in particular improper waste incineration and copper smelting,
3. the use of some special scavengers in leaded petrol.

In all these areas the Federal Government has taken decisive legal measures to reduce considerably new inputs of dioxins into the environment.

In the past, use of PCBs containing dioxin - which are pollutants - made up the largest input into the environment. With the 10th Ordinance amending the Federal Immission Control Act the use of PCBs in open systems was banned in the late seventies. With the Ordinance on the prohibition of Polychlorinated Biphenyls of July 1989 the ban is extended to closed systems.

Another chemical responsible for environmental pollution from dioxin is the pesticide PCP (pentachlorophenol). The production of PCP was stopped in Germany in the early eighties on voluntary basis. The Ordinance on the prohibition of Pentachlorophenol of December 1989 bans the production, bringing into circulation and use of PCP. That means that now for example the import of PCP-impregnated wood is no longer permitted. Since PCP contains considerable amounts of dioxins this ordinance will also bring a significant reduction in the input of dioxin into the environment.

The Federal Government recently passes the Ordinance on Incineration Plants for Wastes and Similar Combustible Substances, which includes, with 0.1 ng TE/m^3 of flue gas, a stringent limit value for dioxins. Before, it had already been possible - thanks to the provisions the 1986 Technical Instruction on Air pollution - to keep to a figure of around 1 ng. But with the new ordinance dioxin emission are limited to the absolute technical minimum achievable at the moment.

My ministry recently presented a draft Ordinance on the prohibition of Scavengers in Leaded Petrol. This prohibition blocks off another source of dioxin emissions - independent of the fact that the use of leaded petrol is going down.

In the already well underway draft amendment to the existing Sewage Sludge Ordinance maximum permitted values are set for the first time for dioxin and PCBs in sewage sludge, used for some special agricultural purposes.

The Federal Ministry for the Environment is making efforts to strengthen the existing maximum limit for polychlorinated dioxins and furans, which have been part of the Ordinance on Hazardous Substances since October 1986. Further efforts are being taken to insert maximum limits for polybrominated dioxins and furans into this ordinance.

I should mention that it is planned to put restrictions on flame retardant brominated compounds.

In fact, we have founded a Federation-Länder working group, which has the task of collecting all data available in Germany, to evaluate all results of any investigating and to make a risk assessment. The results of this working group will point out if or in which fields further legislative issues are necessary or research has to be carried out.

Finally there are two ordinancis to speak about concerning PCB:

1. The first is the Ordinance on Waste Oil.
   With this ordinance it is regulated what measures have to be taken in collection of used oils containing PCB, for example separate collection and treatment.

2. The second is the Ordinance on Maximum Permissible Quantities of Contaminants in Foodstuffs:
   Within this ordinance legal maximum limits are fixed for 6 specified PCB-congeners in foodstuffs of animal origin.

Current research projects are mainly carried out on the following topics:

- effects on humans
- toxicity and metabolism
- input routes into the environment
- reduction and prevention strategies with regard to special sources
- development and testing of analytical methods.

It is not for me to present detailed results of special research projects. This has already been done during other sessions of this congress by the experts.

From the point of view of the Federal Ministry for the Environment one of the most important aims in the present discussion about chemicals is to block off further input of dioxin and furans into the environment.

VRD 0002027515

HUMAN LEVELS

It is now undisputed that background levels of PCDDs and PCDFs can be identified in the general population. In an effort to quantify this background, WHO/EURO has collected and compared the levels of PCDDs and PCDFs in human milk collected from selected and comparable mothers from many countries around the world. They should represent urban and rural areas in the respective countries, although the differences between these two categories were not remarkable.

On the other side the differences between the countries are interesting. The highest levels were found in Belgium, Holland, FRG and UK (30-40 pg TEQ/pg milk fat). The lowest levels were found for New Zealand, Hungary and Yugoslavia (5-12 pg TEQ/g milk fat) and Poland and the Scandinavian countries are in the middle. In all samples only 2,3,7,8-substituted congeners were found.

The hepta- and octaCDDs are always the highest in all samples from the general polulation. These congeners are normally low or absent in most food items, consequently there must be another route of exposure than via the food. These two compounds are known contaminants in commercial PCP.

Enhanced levels have been found in occupationally exposed persons as well as in persons with specific life style (very high fish consumption).

MASS BALANCE CALCULATIONS

During his key-note lecture at DIOXIN '89 in Toronto Curtis Travis presented some mass balance calculations based on mathematical models. He came to the conclusion that the known identified sources contributed by only 10% to the total environmental burden of PCDDs and PCDFs.

Another way to perform similar calculations is by measurements of the ground deposition rate of PCDDs and PCDFs. This can be done directly or indirectly through the analyses of soil, sediment, snow and herbage samples.

The literature is very scarce of data that can be used for such calcula-tions. However, available data indicate that the annual deposition rate is in the order of 2-20 ng TEQ/m^2. Using the value 4 ng TEQ/m^2 and year and the area 450 000 km^2 for Sweden, the result is 1800 g TEQ/year. This value is about one order of magnitude greater than the calculated annual emissions in Sweden, in agreement with the calculations presented by Curtis Travis. The descrepancies can be explained by unidentified sources and/or by long range transport. Another possibility is that the estimation of the annual emissions is based on nonrepresentative samples.

RESEARCH AND REGULATION OF DIOXINS AND RELATED COMPOUNDS IN SWEDEN

U.G. AHLBORG

Institute of Environmental Medicine, Karolinska Institutet,
Box 60208, S-104 01 Stockholm , Sweden

ABSTRACT

This presentation concentrates on the research activities within an established research area sponsored by the Swedish National Environmental Protection Board. The organisation and main research projects will be presented as well as some of the conclusions from the work done so far.

INTRODUCTION

The research department in the Swedish National Environmental Protection Board decided 1987 to concentrate the research activities concerning persistent toxic organic compounds in a in a large project with the acronym PETOS. Working in concert with this project, three other projects with more specialized questions have been running. This three projects are:

* *Seal and seal protection* which deals with the relation between exposure to organochlorine and health effects in the Baltic seal population.

* *Environment/cellulose II* which deals with effects on the aquatic environment in relation to exposure to effluents from pulp and paper mills.

* *National dioxin survey* which maps levels of dioxins and related compounds in the environment in relation to possible sources.

The total annual budget for the four projects amounts to about 3 million US dollars. Added to that comes funding from sources other than the National Environment Protection Board, making a total annual budget of probably more than 5 million US dollars.

PERSISTENT TOXIC ORGANIC COMPOUNDS (PETOS)

PETOS is divided into three subproject areas, i.e. chemistry, ecotoxicology and toxicology. Within each subproject several individual projects are sponsored. Several reports from these individual projects will be presented during the present meeting. Following below, only a few of the results so far will be mentioned.

Chemistry

The main research areas within the chemical project concern

* Synthesis of test compounds as well as metabolites, both cold and labelled material
* Development and improvement of analytical methods
* Studies on the photochemical degradation of dioxins and related compounds
* Studies on the enzymatic formation of dioxins in the environment

An intensive work within the area of synthesis of compounds has made possible many studies both within the chemical subproject as well as in the other two subprojects. Compounds synthesized cover PCBs, PCB-methylsulfones, various chlorinated naphtalenes and many others (Haglund and Bergman, 1989). Among the findings could be mentioned the development of sensitive analytical methods for the analysis of dioxins and PCBs in human mother's milk (Lindström 1988, Norén, 1988). The studies have been able to demonstrate a decline of dioxin levels in Swedish mother's milk during the last 15 years as well as changes in levels of planar PCBs over time (Norén, 1988, Norén *et al.*, 1990).
Another interesting finding is the demonstration that PCDDs and PCDFs may be formed in the environment through a peroxidas-catalyzed reaction with chlorinated phenols (Öberg *et al.*, 1990).

Ecotoxicology

The main research areas within the ecotoxicological project concern

* Mapping of environmental load and transportation
* Environmental transformation
* Bioavailability
* Biomagnification
* Ecotoxicological dose-effect studies

The approach in this area is somewhat different from the other two. It represents a larger single project that still is ongoing. Among the results obtained so far it can be mentioned that it has been demonstrated that the toxic 2,3,7,8-substituted PCDDs/PCDFs increase with increasing trophic level. 2,3,7,8-substituted PCDDs/PCDFs are also biomagnified, both relative to other congeners and in total (Broman *et al.*, 1990). Bioassays are also applied in order to study the influence of other compounds than PCDDs/PCDFs, e g polyaromatic hydrocarbons.

Toxicology

The main research areas within the toxicological project concern

* Toxicokinetics
* Immunotoxicology
* Interaction with vitamin A
* Tumour promotion

* Bioassays for dioxinlike activity
* Levels of organochlorines in exposed groups in relation to health status

Of the multitude of results achieved within this subproject only a few can be mentioned.
In the immunotoxicological field, a system has been developed that tests effects on the immune system using the *Bursa Fabricius* from chicken embryos as model. The system has successfully been applied to environmental samples (Andersson et al., 1990).
Systematical studies within the field of tumour promotion have so far demonstrated that the relative potency of some congeners, using the induction of altered hepatic foci as the endpoint, might differ somewhat from estimates of potency based on other endpoints (Flodström and Ahlborg, 1990). This finding may have implications for the calculation of TCDD-equivalency (see below). Another interesting finding is the fact that the tumour promotive effect of TCDD is influenced both by the vitamin A status of the test animal as well as by the diets used (Flodström *et al.*, 1990).
The only extraordinarily exposed adult population in Sweden identified so far consists of professional fishermen active in the southern part of the Baltic sea and having a high fish consumption. Blood levels of PCDDs/PCDFs in this population is several times higher than in comparative controls. Non-fish eating populations have lower blood levels than average (Svensson *et al.*, 1990). Taken together, these data support earlier assumptions that fish is the main source for human exposure to PCDDs/PCDFs in Sweden. Studies on the health status of these populations are ongoing.

CONTACT PERSONS WITHIN FETOS

Main project leader	Ulf G. Ahlborg, Fax. +46 8 34 38 49
Chemistry	Åke Bergman, Fax +46 8 15 95 23
Ecotoxicology	[illegible], Fax +46 8 15 95 22
Toxicology	Ulf G. Ahlborg, Fax: +46 34 38 49

REGULATIONS

Despite all research activities and all efforts from various governmental agencies in Sweden to reduce dioxin emission and exposure, very limited regulations and recommendations have been applied. Emission limits for municipal solid waste (MSW) incinerators are, however, enforced. For existing MSW plants the emission should be below 2 ng/m^3, for new plants, however, the limit is less than 0.1 ng/m^3, in both cases expressed as TCDD-equivalents according to Eadon.

No recommendations or limitations are given as regards PCDDs/PCDFs in food. Breastfeeding is recommended but forced weight reduction following delivery should be avoided.

Sweden is today using the Nordic TCDD-equivalents (see table 1) and applying a tolerable daily intake of 5 picogram/kg bodyweight as recommended by a Nordic expert group (Ahlborg *et al.*, 1988).

Table 1. Nordic TCDD-equivalents (Ahlborg *et al.*, 1988)

PCDD/PCDF	Nordic equivalents	International equivalents
2378-TCDD	1	1
12378-PeCDD	0.5 (1*)	0.5
2378-subst. HxCDD	0.1	0.1
1234678-HpCDD	0.01	0.01
OCDD	0.001	0.001
2378-TCDF	0.1	0.1
12378-PeCDF	0.01	0.05
23478-PeCDF	0.5 (0.1*)	0.5
2378-subst. HxCDF	0.1	0.1
2378 subst. HpCDF	0.01	0.01
OCDF	0.001	0.001

* Indicates possible new values for the congeners 1,2,3,7,8-PeCDD and 2,3,4,7,8-PeCDF based on recent studies using relative tumour promotive potency as endpoint (Flodström and Ahlborg, 1990)
Note that the value for 1,2,3,7,8-PeCDF differs between the Nordic and the international model

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REGULATION AND RESEARCH ACTIVITY IN GERMANY

U. Fischer-Gundlach
Ministerium für Umwelt, Naturschutz und Reaktorsicherheit
Postfach 12 06 29, 5300 Bonn 1 / F.R.G.

I do not think you have all had the chance to listen to the opening speech given by the State Secretary at my ministry. So I should like to summarize the legislative issues concerning dioxins and furans that have been passed or are still under discussion. The German Federal Government has developed an overall concept for protection against hazardous substances. This concept is supported by a closely-unit network of precautionary measures.

Anticipatory action has been comprehensively extended with the amended Chemicals Act, with the programme for *abandoned contaminated waste and former industrial sites and a whole range* of prohibition, limitation and maximum permitted quantity ordinances. Moreover, measures on the safety of installation, the extension of the Federal Immission Control Act and the environmentally compatible disposal of waste are part of the overall concept to overcome the chemical risk.

Now - to the field of special measures against dioxin pollution:

As far as is known to date main sources are
1. *the production and use of the industrial chemicals PCP (pentachlorophenol) and PCB* (polychlorinated biphenyls) and other processes in the chemical industries,
2. incineration processes of all kinds, in particular improper waste incineration and copper smelting,
3. the use of some special scavengers in leaded petrol.

In all these areas the Federal Government has taken decisive legal measures to reduce considerably new inputs of dioxins into the environment.

In the past, use of PCBs containing dioxin - which are pollutants - made up the largest input into the environment. With the 10th Ordinance amending the Federal Immission Control Act the use of PCBs in open systems was banned in the late seventies. With the Ordinance on the prohibition of Polychlorinated Biphenyls of July 1989 the ban is extended to closed systems.

Another chemical responsible for environmental pollution from dioxin is the pesticide PCP (pentachlorophenol). The production of PCP was stopped in Germany in the early eighties on voluntary basis. The Ordinance on the prohibition of Pentachlorophenol of December 1989 bans the production, bringing into circulation and use of PCP. That means that now for example the *import of PCP-impregnated wood is no longer permitted. Since PCP contains considerable* amounts of dioxins this ordinance will also bring a significant reduction in the input of dioxin into the environment.

ENCLOSURE 3

STATENS NATURVÅRDSVERK
Swedish Environmental Protection Agency

Date | Ref. No. | A

VRD 0002027519

Department of Energy, Transport,
Waste and Water Management
Section for waste management
and site remediation
Sr technical officer Andrew Petsonk
tel. (08) 799 11 65

1993-03-11

Dear Ms. Thompson,

I have received your fax dated March 10, 1993 concerning an appeal by Greenpeace and others of a permit issued by the National Franchise Board for Environmental Protection for partial changes in activities at Hydro Plast in Stenungsund. We are not aware of any document with the exact citation you refer to. I am sending a copy of another document (in Swedish), ie. the opinion of the Swedish EPA in this case as delivered to the Department of Environment and Natural Resources. Our agency did not support the appeal.

Briefly, the appeal requests that:

- The permit should not be allowed to take effect.
- That the permit conditions for the entire facility should be subject to total review, including compatibility with the North Sea Convention.
- That changes should occur with regard to activities which violate the Ordinance on Hazardous Waste.
- That the total environmental effect of the facility and its products be evaluated.
- That the government restrict emissions of chlorinated hydrocarbons from the plant.

SNV 182 1989-10 Utgåva 3

SWEDISH ENVIRONMENTAL
PROTECTION AGENCY

1993-03-11

In our opinion we state the following:

- Hydro Plast will probably be given priority in our ongoing classification of facilities which require permit reviews with an eye toward possible changes.
- Greenpeace raises a number of interesting issues which should be examined during the review process, but which we do not feel are direct hinders to the current permit application.
- We are not aware of any activities at Hydro Plast which violate the Ordinance on Hazardous Waste.

I am sorry that due to current work load I do not have the time to translate the entire opinion in detail, but hope that the above will answer most of your questions.

Sincerely,

Andrew Petsonk
Sr technical officer

Encls.

cc: Åke Undén, Bk

AVRD 0002027521

States EPA
The Industrial Technical Department
Chemical Industry Unit
Ann-Louise Patt

Environmental and Nature Department
103 33 Stockholm

Statement of opinion of the stop motion and appeal of Goran Hermansson of the decision by the government to permit Hydro Plast AB to amend operations of the company's vinylcloride factory in Stenungsunds Community. (M92/610/8).

Background

Parliament gave it's decision 1992-01-10 on Hydro Plast AB's permit according to the Environmental Protection Law to permit the company's vinylcloride factory in Stenungsund to further refine 200 000 tons of chloride per year for manufacturing; highest to be 130 000 tons vinylcloride (VCM) per year and highest 265 000 ton Etheldicloride (EDC) per year.

Goran Hermansson has entered an appeal; representing Green Peace/Sweden and the Agricultural Federation in Goteborg and Bohus Counties.

The Appeal charges:

- that the appealed permit is invalid until further notice.
- a complete review of the conditions according to the Environmental Protection Laws at the Hydros factory in Stenungsund.
- changes in parts of the manufacturing process, today, is in conflict with the order of environmentally dangerous waste.
- a reexamination of the current manufacturing process is inconsistent with the North Sea treaty to halving of these chemical preparations discharges into the North Sea.
- an investigation of the whole manufacturing process and the consequences on the environment, to include i.e. a life cycle analysis of the product.
- the government must immediately take action to restrict the discharge of chloride organic material from the Hyros factory.

The Nature Conservation Department's statement of their opinion. 1991-06-28

- to inspect the conditions at the VCM Factory should be compared to the background of the many valid conditions with bearing upon production, which are considerably higher than those in the current manufacturing permit.
- by testing the conditions, especially at the VCM-factory (who can do the testing) from the PVC factory, i.e. combustion design and the chemical-biological purification is the same. Questions about transportation and noise are common for the whole

design. There does not exist enough information to make a decision as to how the processes at the VCM factory should change.

The Nature Conservation Department recommends that the permit nonetheless be valid until the background of the discharge situation can be examined, and according to the company's application there is no change in the work process. The transportation of Chloride will increase. This change will not increase discharge into the water. Discharge from the storage of EDC will decrease due to the fact that the discharge along with EDC tanks will be cremated. Discharge from boat loading will increase from 3.4 to 5.7-9.3 per year. The production of so called Heavy Ends will increase from ca 1200 ton/year to 1600 ton/year.

The Nature Conservatory decided that it was important that the original conditions for the permit is not binding for a 10-year period and would render an examination of the whole process in the near future. A quote from the Government decision *"This decision does not influence the time, after which the investigation, and condition for the existing process should be according 24 Para. 1, Environmental Protection Law. The notification of terms for a wider investigation according to the same regulation within the time frame which is valid for the terms in the earlier government decision."*

The Nature Conservatory Decision

Below is the Nature Conservatory decision to the parties bringing the appeal

- a complete review according to the Environmental Protection Law of the process for the Hyros factory in Stenungsund.

Nature Conservatory through its government decision 1991-060-13 states as it's mission to establish a 10-year program to oversee the industries i.e. discharge policies. From the environmental outlook the most important, and also most neglected branches and factories shall be cleaned up before 1995. The goal for the program is that every environmentally dangerous process shall be modernized and conform with conditions to clean up the discharge by the beginning of the 20th century.

- large discharge of contaminates, especially such material from earlier environmental goals to be set up.

- worn out or sensitive receptacles
- old permits or terms

The plan shall be established by 1992-07-01. In the spring the Nature Conservatory will decide when the investigation of Hydro Plast AB shall take place, and this is an investigation which will be given priority.

- a reexamination of the current manufacturing process is inconsistent with the North Sea treaty to halving of these chemical preparations discharges into the North Sea.
- an investigation of the whole manufacturing process and the consequences to the environment, including i.e. a life cycle analysis of the product.
- the government must immediately take action to restrict the discharge of chloride organic material from the Hyros factory.

The Nature Conservatory has decided that these problems and questions should be studied. The Nature Conservatory does not question the validity of the permit. The question, however, does not give the Nature Conservatory cause to deny the allowable increase in manufacturing.

- Changes in parts of the manufacturing process today, is in conflict with the order of environmentally dangerous waste.

According to the Nature Conservatory, it feels that the company has not broken the permit regarding dangerous environmental fallout. The export of Heavy Ends stand for now, an investigation by Nature Conservatory will eventually test the earlier decision. Export is forbidden to the company without a permit according to the Environmental Protection Law, no transfer of the waste material to another company unless they have a permit equal to that of Hyro Plast, AB. This is influenced by the Nature Conservatory to overweigh the appeal decision. An eventual ban on export of waste will come thus making the company seek a new permit according to the Environmental Protection Law.

- Appealing this decision further is forbidden

Nature Conservatory had earlier in the year stated that its decision is effective immediately.

Summary

No new evidence has been brought forward to convince the Nature Conservatory to change its earlier decision. The Nature Conservatory recommends the rejection of the appeal and to prevent the motion.

Decision on the appeal is signed by the general director. This commission hearing was taken by L. Lindau. department director I.B. Larsson with Bureau director L. Gipperth and Al-Patt.

STATENS NATURVÅRDSVERK
Industritekniska avdelningen
Kemiindustrienheten
Ann-Louise Pått

Datum
1992-03-27

Åberopas vid korrespondens
SNV:s diarienummer
521-1458-92 Bk

VRD 0002027524

1992-03-31

Miljö- och naturresursdepartementet
103 33 Stockholm

Yttrande över inhibitionsyrkande och överklagande av Göran Hermansson m.fl. av beslut av Koncessionsnämnden i fråga om tillstånd för Hydro Plast AB till ändring av verksamheten vid bolagets vinylkloridfabrik i Stenungsunds kommun (M92/610/8)

Bakgrund

Koncessionsnämnden gav i beslut 1992-01-10 Hydro Plast AB tillstånd enligt miljöskyddslagen att vid bolagets vinylkloridfabrik i Stenungsund vidareförädla 200 000 ton klor per år för tillverkning av högst 130 000 ton vinylklorid (VCM) per år och högst 265 000 ton dikloretan (EDC) per år.

Detta beslut har överklagats av Göran Hermansson m.fl., som företräds av Greenpeace Sverige och Lantbrukarnas länsförbund i Göteborgs och Bohus län. I överklagandet yrkas:

- att det överklagade beslutet tills vidare inte skall gälla
- en total omprövning enligt miljöskyddslagen av samtliga villkor för Hydros anläggningar i Stenungsund
- en förändring av de delar av verksamheten som idag står i strid med förordningen om miljöfarligt avfall
- en prövning av om nuvarande verksamhet är förenlig med Nordsjöavtalets krav på halvering av vissa kemikalieutsläpp till Nordsjön
- en utredning av verksamhetens totala miljökonsekvenser, omfattande bl.a. en livscykelanalys av produkterna
- att regeringen ser till att åtgärder omedelbart vidtas för att begränsa nuvarande utsläpp av klororganiska ämnen från Hydros fabrik

Naturvårdsverket anförde i sitt yttrande 1991-06-28:

- att en översyn av villkoren för VCM-fabriken bör ske bl.a. mot bakgrund av att flera av de gällande villkoren är avsedda för en produktion, som är betydligt högre än den som nu avses i bolagets ansökan
- att det inte är meningsfullt att vid en omprövning av villkor särskilja VCM-fabriken (som är uppe till prövning i detta ärende) från PVC-fabriken, d bl.a. förbränningsanläggningen och den kemisk-biologiska reningsanläggningen är gemensamma, och därmed även villkoren för dessa. Frågor om transporter och buller bör också ses över gemensamt för hela anläggninge
- att det i detta ärende inte finns tillräckligt underlag för att ta ställning ti hur villkoren för VCM-fabriken bör ändras.

ENCLOSURE 4

A

VRD 0002027525

Dioxins in Norsk Hydro's VCM production

Dioxins may be formed as a by-product of the manufacture of vinyl chloride. Dioxin emissions from Norsk Hydro's plant at Rafnes have been investigated. The dioxin flows are shown in ***Figure 11.6.***

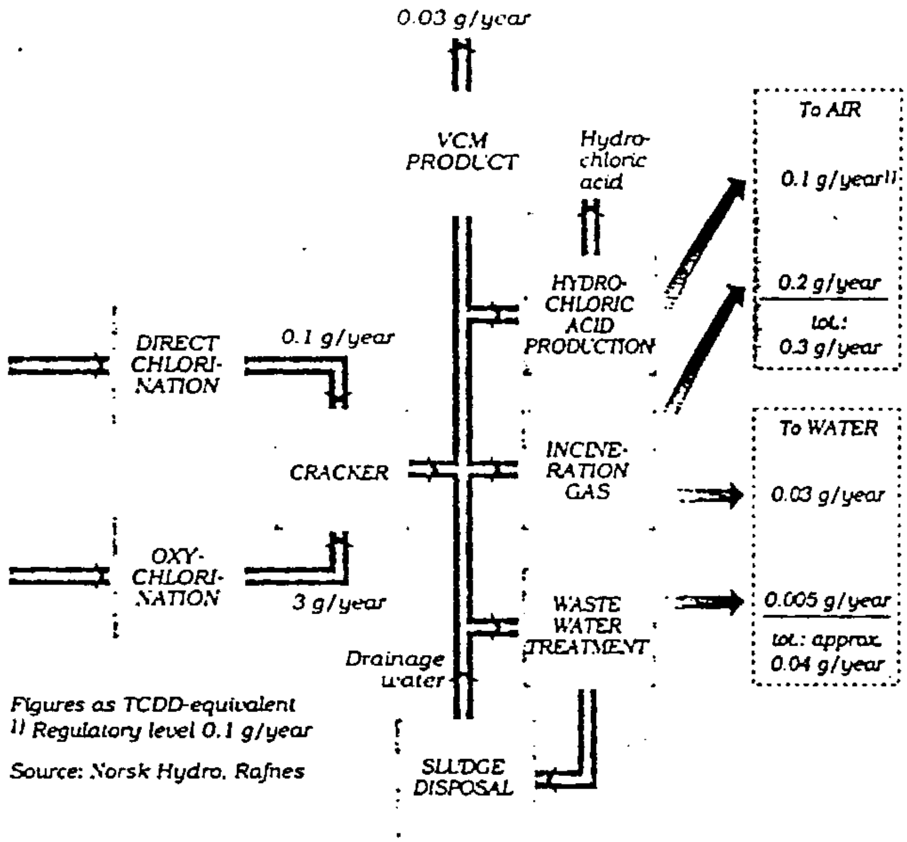

Figure 11.6 Dioxin emission from Norsk Hydro's plant at Rafnes.

Hydrogen chloride

Hydrogen chloride from PVC production and incineration has been identified as a source of atmospheric acidity, sometimes known as "acid rain". In fact there are three major man-made sources of atmospheric acidity in Western Europe. Hydrogen chloride is the least of them, as shown in ***Figure 11.7.***

The major component (69%) of atmospheric acidity is sulphur dioxide. Most of the sulphur dioxide in the atmosphere comes from the burning of fossil fuels to generate electricity. Governments in Western Europe are under pressure to insist on the desulphurisation of power station flue-gases.

Nitrogen oxides provide the second major element in atmospheric acidity (29%). The internal combustion engines used in transport are the main source but, again, combustion and incineration processes make

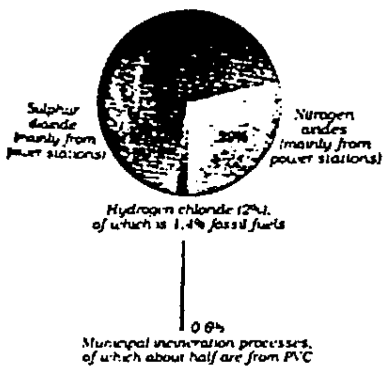

Figure 11.7 The amount and sources

ENCLOSURE 5

- emissions during polymer production;
- health hazards to workers during PVC production;
- the use of heavy metal stabilisers;
- the migration of plasticisers;
- the reaction of PVC to fire;
- the emission of hydrogen chloride when PVC is burnt;
- the degradation of PVC during production and use;
- recycling;
- the environmental accounting for PVC, the "eco balance".

All these items are reviewed in the following chapters.

1.5 PVC COMPARED TO OTHER MATERIALS

The environmental impact of any one material cannot be judged in isolation since the use of alternative materials will not be cost-free either. It is necessary to make comparisons using tools such as life-cycle assessments. These are dealt with in more detail in Chapter 2 and provide a means of estimating the environmental cost of using a material or product throughout its life-cycle. These methods of assessments are still fairly new and internationally agreed standards do not exist. Life-cycle assessment has been more effective in identifying areas of concern rather than in providing overall comparative evaluations of materials or products.

In this book we have naturally concentrated upon PVC and, as far as possible, avoided direct comparison with other materials, except where it has been necessary to make a particular point. In the final chapter, we shall attempt to make an assessment of all the costs and benefits of using PVC.

In the drive towards standardised life-cycle assessments, the differences of environmental impact between the various producers have often been overlooked. As an example, American figures show that some emissions from ethylene plants are more than 100 times higher than the lowest[11]. The end products are the same, the environmental impacts may be very different.

Such considerations have provided a basic problem in writing this book; should we write about PVC and PVC production in general or should we write about Norsk Hydro's products and processes? Certainly, the finished product, PVC, is the same whoever produces it.

though quality and consistency vary from producer to producer. However, the particular production process and the emissions it produces are critically important in deciding the environmental impact of the product. Unfortunately, there are no publicly available data on emissions from other production plants and so we have chosen to concentrate only on Norsk Hydro's emission figures. In spite of the difficulties thus involved in making comparisons, it is our impression that Norsk Hydro's emissions compare well with those of other producers. It is Norsk Hydro's intention to be among the very best producers in terms of emission standards.

Generally, we have only referred to the wholy owned Norsk Hydro plants. These are the plants for which we have the best historical data. The PVC plant in Singapore, which is 60% owned by Norsk Hydro, has to comply with the regulations in Singapore which are comparable to Norsk Hydro standards.

1.6 ABOUT THIS BOOK

There are many ways in which to organise a book such as this. We have started with an introduction to life-cycle assessment, and then provided an introduction to plastics and PVC and to the products made from PVC. We go on to talk about the whole life-cycle of the material from raw materials and energy to waste treatment, whereafter we deal with specific problems associated with PVC. Inevitably this book gives a much more thorough treatment of the problems of PVC rather than its benefits, although these are numerous.

We found it hard to decide how detailed the book should be. We have sought to meet the needs of both the interested public and the specialist. We have aimed at producing a text that is understandable to the former while providing references and data for the latter. Having read the book we hope readers will draw their own conclusions about PVC, based on weight of evidence rather than on intensity of emotions.

Throughout the book, issues as they apply to Norsk Hydro are written in italics.

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ENCLOSURE 6

UNITED STATES ENVIRO...
WASHINGT...

SEP 22 1992

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

RD 0002027532

MEMORANDUM

SUBJECT: Assuring Protective Operation of Incinerators Burning Dioxin-listed Wastes

FROM: Sylvia K. Lowrance, Director
Office of Solid Waste

TO: Waste Management Division Directors
Regions I - X

I would like to call your attention to, and provide guidance on, an issue which was brought to our attention recently related to incineration of wastes containing low levels of dioxins. A recent case, and review of incinerator data in general, indicates that a well-operated incinerator meeting the regulatory Destruction and Removal Efficiency (DRE) on a harder-to-burn surrogate compound may have difficulty in achieving high DREs on dioxin itself due to the low levels at which the dioxin is normally present. Although we believe a well-operated incinerator is capable of destroying dioxin to below risk-based levels, we are recommending site-specific testing and risk assessment to confirm protectiveness at individual sites in view of the level of concern over dioxin.

We believe this issue may arise at other sites where it is proposed to burn dioxin-listed wastes. The following is a discussion of the technical aspects of this finding, our interpretation of the RCRA regulations as they relate to this issue, and our recommendations on how this issue should be addressed if encountered.

Technical Background

The low dioxin DRE in this recent case was consistent with our current body of incinerator performance data, which show a very clear trend of decreasing DRE for hazardous constituents with decreasing incoming concentration of the constituents in the waste feed. (That is, the lower the constituent concentration in the waste, the lower the DRE.) The data show that a properly operating incinerator, which reached 99.99% DRE (four nines) on higher concentrations of POHCs, will often achieve less than four nines when the concentration of a POHC (principal organic hazardous constituent) in the waste is less than 1,000 ppm. At this time, we have not determined a definitive scientific explanation for this phenomenon. There appears to be some small level of constituents that remain in the emissions even from well-operated incinerators, possibly due to reformation of these compounds as products of incomplete combustion (PICs). It should be noted, however, that even though the measured DRE decreases at lower POHC concentrations, emission rates of, and thus the risks associated with, these compounds stay relatively constant or decrease at trace levels.

Regulatory Interpretation

The regulations at 40 CFR 264.343(a)(2) require that an incinerator burning hazardous wastes F020, F021, F022, F023, F026, or F027 achieve a DRE of 99.9999% (six nines) for each POHC in its permit, and that this performance be demonstrated in a trial burn on POHCs that are more difficult to incinerate than specified dioxins and furans. The regulations do not specifically set a DRE standard for dioxins and furans themselves. Thus, an incinerator which demonstrates six nines DRE on harder-to-burn POHCs complies with the DRE performance standard applicable to dioxin-listed wastes, even if six nines is not actually achieved on low levels of dioxin present in the waste. Dioxin itself is not likely to be chosen as a POHC because it would normally not be present in the waste at high enough levels to assure sound sampling and analysis, and an accurate six nines DRE calculation.

To assure detection of POHC compounds in the stack to enable the DRE calculation to be performed, and to override any effects of PIC formation on calculated DREs, POHCs are normally spiked into the trial burn waste at high concentrations. We believe that this approach is a sound way of assuring a good test of POHC destruction and removal, which in turn assures that an incinerator is operating at an optimum level of performance. (We believe that PICs should be addressed directly, separate from DRE, as explained below.) However, spiking of dioxin itself to higher levels is not desirable due to its toxicity.

Estimates of risk to public health resulting from PICs based on available emissions data indicate that these emissions do not pose significant risks when incinerators are operated at optimum conditions. Nonetheless, to ensure that emissions of total residual organic compounds, that is, trace levels of unburned organic compounds in the waste plus organic compounds generated during combustion as PICs, do not pose a significant risk, we recommend following the relevant portions of the PIC approach presented in the Boiler and Industrial Furnace (BIF) Rule (56 FR 7134, February 21, 1991), and, when updated, the guidance on addressing PIC emissions from incinerators. This approach involves setting a maximum carbon monoxide or hydrocarbon level to assure that overall PIC emissions are low. The BIF approach also requires testing for dioxin and furan emissions and performing a risk assessment at facilities operating under specific conditions considered to be conducive to production of dioxins and furans as PICs, to be sure these compounds are not present at levels of concern.

Recommended Approach for Dioxin-listed Wastes

Risk assessment:

Given the public concern over dioxin-listed wastes, we believe that it is necessary to perform a site-specific risk assessment as an additional check at facilities proposing to burn such wastes, to demonstrate that the DRE and PIC controls will control emissions of chlorinated dioxins and furans to levels that will not pose a hazard to human health and the environment. The preamble to the January 14, 1985 (50 FR 1978), promulgation of the management standards for dioxin-containing wastes F020, F021, F022, F023, F026, and F027 discusses risk assessments performed over a range of incinerator sizes, dioxin concentrations, and DREs, and appears to indicate that the risk assessments supporting the final dioxin incineration standards assumed six nines as the DRE for dioxin. Since the concentration of dioxins in dioxin-listed wastes is normally very low, the data indicating lower DREs at low concentrations lends uncertainty to the six nines assumption.

For this reason, the risk assessment calculations performed in the course of the dioxin rulemaking may not be representative in some cases. Thus, we believe that it is appropriate to perform site-specific risk assessments for incinerators proposing to burn such wastes with low levels of dioxins, to demonstrate that the performance standards are protective of human health and the environment. Such a site-specific risk assessment should use actual chlorinated dioxin and furan emissions data obtained while the incinerator is burning the low-concentration dioxin wastes.

Testing:

We also believe that in most cases where a facility is applying to burn dioxin-listed wastes, the incinerator should be tested on non-dioxin wastes first to demonstrate six nines DRE on harder-to-burn POHCs prior to testing it on actual dioxin-listed wastes, to assure that the incinerator is operating at optimum performance before dioxin is burned. One situation where burning dioxin-listed wastes may not, in itself, warrant this approach would be where the dioxin concentrations in the waste are so low that, even assuming zero DRE, the stack gas concentrations of dioxin would be nondetectable. In such a situation, the need for dioxin testing would be determined on the basis of whether it is likely to be formed as a PIC. Until the PIC guidance is updated, the BIF rule and the Office of Solid Waste can be consulted for assistance in making this determination. Such testing, if needed, could be done simultaneously with the DRE testing.

To implement the recommended testing approach for a commercial incinerator applying to burn dioxin-listed wastes, dioxin wastes need not be "imported" prior to permitting the incinerator. The trial burn for the incinerator could be used to demonstrate six nines DRE on POHCs more difficult to burn than dioxin. If successful, these data could be used as a basis for the permit. The permit would require that the facility notify the permit authority and test for dioxin emissions when it burns its first shipment of dioxin-listed wastes.

Design and operation:

We would also like to emphasize the importance of assuring that incinerators burning dioxin wastes are designed and operated in a manner to maximize DRE of dioxin and minimize its formation as a PIC. For example, studies on municipal waste combustors have identified a temperature range for particulate matter control devices that is associated with the potential for elevated levels of chlorinated dibenzodioxins and dibenzofurans. The BIF preamble at 56 FR 7162-4 (February 21, 1991) provides a discussion of this issue. We recommend that this factor be taken into account in reviewing or developing specifications for incinerator designs and test plans.

In closing, we would like to note that we believe that well-operated incinerators are capable of meeting the performance standards and destroying dioxin to below risk-based levels. Further, none of our data from hazardous waste combustion devices shows dioxin formed as a PIC at levels of concern. However, given the degree of concern over dioxin, we believe a site-specific evaluation is warranted to demonstrate protective operations at individual sites where dioxin wastes are to be burned.

We discussed this issue with the Waste Combustion Permit Writers' Workgroup during its February, 1992, meeting and on the April, 1992, conference call. We will continue to evaluate data related to this issue and will keep the Workgroup, including OERR contacts, informed. If you need additional guidance on how to address this issue at an individual site, feel free to contact Sonya Sasseville of my staff at (202) 260-3132.

cc: Henry Longest
Bruce Diamond
Waste Combustion Permit Writers' Workgroup

ENCLOSURE 7

VRD 0002027531

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MEMORANDUM

SUBJECT: WTI Screening Level Analysis

FROM: William H. Farland, PhD., Director
Office of Health and Environmental Assessment

TO: Brian Grant
Attorney, Office of General Counsel
Greer Goldman,
Trial Attorney, U.S. Department of Justice

DATE: February 8, 1993

The attached draft represents my office's efforts in responding to your request for a screening level analysis of indirect exposures for dioxin and dioxin-like compounds in connection with the issues defined by Judge Aldrich for the WTI hearing. It uses Region V's "Preliminary Risk Assessment of Inhalation Exposures to Stack Emissions from the WTI Incinerator" for the emissions estimates and the 1992 Workshop Review Draft of "Estimating Exposure to Dioxin-Like Compounds" for indirect exposure assessment methods, as well as certain additional information required for application of the methods. It is not exhaustive in its analysis, nor does it characterize dioxin hazards. It should not be construed as a comprehensive risk assessment and should not be generalized to other sites.

We have used conservative, hypothetical exposure scenarios which relate to plausible but unlikely situations surrounding the WTI site. The resulting exposure estimates lead to upper bound risk predictions which are not likely to underpredict risk. Actual risks are likely to be less and may even be zero.

It is important to note that this analysis has not been subjected to adequate peer review, nor does it represent EPA policy.

ENCLOSURE 8

1ST CASE of Level 1 printed in FULL format.

Arkansas Peace Center; Environmental Health Association of Arkansas; Jacksonville Mothers' and Children's Defense Fund; Vietnam Veterans of America, Arkansas State Chapter; Mothers Air Watch, Plaintiffs-Appellees, v. Arkansas Department of Pollution Control and Ecology, Randall Mathis, Director; United States Environmental Protection Agency, William K. Reilly, Administrator; Defendants; Vertac Site Contractors; Defendant-Appellant; Arkansas Attorney General, Defendant.

Nos. 93-1447, 93-1516, 93-1518

UNITED STATES COURT OF APPEALS FOR THE EIGHTH CIRCUIT

1993 U.S. App. LEXIS 7002

March 17, 1993, Submitted
April 2, 1993, Filed

PRIOR HISTORY: [*1] Appeals from the United States District Court for the Eastern District of Arkansas. Honorable Stephen M. Reasoner, Judge.

COUNSEL: Counsel who presented argument on behalf of the appellant Vertac Site was Daniel J. Dunn, Denver Colorado. Edward J. McGrath and Colin G. Harris, Denver Colorado, and Jim L. Julian and Janie W. McFarlin, Little Rick, Arkansas, appeared on the brief.

Counsel who presented argument on behalf of the appellant EPA was David C. Shilton, Department of Justice, Washington, D.C. John A. Bryson, Ronald Spritzer and Alice Mattice, Department of Justice, Washington, D.C., and Lawrence E. Starfield and Dawn M. Messier, Washington, D.C., appeared on the brief.

Counsel who presented argument on behalf of the appellees Arkansas Peace Center, et al., was Mick G. Harrison, Washington, D.C. Richard E. Condit, Washington, D.C., and Gregory Ferguson, Little Rock, Arkansas, appeared on the brief.

JUDGES: Before McMILLIAN, JOHN R. GIBSON and WOLLMAN, Circuit Judges.

OPINIONBY: McMILLIAN

OPINION:
McMILLIAN, Circuit Judge.

Defendants Environmental Protection Agency (EPA), the Arkansas Department of Pollution Control and Ecology (ADPCE) and Vertac Site Contractors (Vertac) move this court to continue a temporary [*2] stay pending appeal of a preliminary injunction entered at the request of plaintiffs Arkansas Peace Center, Environmental Health Association of Arkansas, Jacksonville Mothers' & Children's Defense Fund, Vietnam Veterans of America Arkansas State Chapter, and Mothers Air Watch shutting down a hazardous waste incinerator located at the Vertac site near Jacksonville, Arkansas. Arkansas Peace Center v. Arkansas Department of Pollution Control & Ecology, No. LR-C-92-684 (E.D. Ark. Mar. 17, 1993). For the reasons discussed below, we dismiss the interlocutory appeals (Nos. 93-1447, 93-1516, 93-1518) of the amended TRO as moot, treat the motions to continue the stay as motions for stay pending appeal, and grant the motions for stay pending appeal of the preliminary injunction.

Some background is necessary to understand the procedural posture of these appeals. On October 28, 1992, plaintiffs filed an action against defendants in federal district court to stop the incineration of hazardous wastes contaminated with dioxin at the Vertac site in Jacksonville, Arkansas. Plaintiffs alleged the incineration was proceeding in violation of certain federal and state regulations concerning [*3] incinerator performance and that incineration would pose an imminent and substantial endangerment to public health and the environment. Plaintiffs sought declaratory and injunctive relief to stop the incineration and to require EPA and ADPCE to prepare a remedial investigation and feasibility study to determine treatment and disposal options other than incineration for the hazardous wastes stored at the Vertac site. On October 30, 1992, the district court granted in part plaintiffs' request for a TRO. The district court did not enjoin incineration of the so-called D-waste (hazardous waste contaminated with extremely low level concentrations of dioxin, less than 12 parts per billion) but did enjoin incineration of the so-called T-waste (hazardous waste contaminated with low level concentrations of dioxin, less than 50 parts per million), except for 5 days of a previously scheduled "trial burn" of T-waste, pending further proceedings.

On January 5, 1993, the district court ordered the parties to submit briefs on the issue of the incinerator performance regulation, 40 C.F.R. | 264.343(a), and held a hearing on February 12, 1993. On February 16, 1993, the district court issued an [*4] amended TRO finding that the incinerator performance regulation required the use of dioxin, not a surrogate chemical substance or Principal Organic Hazardous Constituent (POHC), and enjoined the incineration of any dioxin-contaminated hazardous wastes at the Vertac site (except for the D-wastes already being processed in the incinerator). The district court also scheduled preliminary injunction hearings, certified the regulation issue for interlocutory appeal under 28 U.S.C. | 1292(b), and denied defense motions for stay pending appeal. The amended TRO effectively shut down the incinerator.

Vertac, EPA and ADPCE immediately filed appeals and motions for stay pending appeal, for interlocutory appeal under 28 U.S.C. | 1292(b) and to expedite the appeal. On February 25, 1993, we entered a temporary stay of the amended TRO and on March 2, 1993, following oral arguments by telephone conference call and consideration of additional briefs and memoranda, entered a stay pending appeal of the amended TRO. Arkansas Peace Center v. Arkansas Department of Pollution Control & Ecology, No. 93-1447 (8th Cir. Mar. [*5] 2, 1993). We granted the motions for interlocutory appeal under 28 U.S.C. | 1292(b), expedited and consolidated the interlocutory appeals, and set the case for oral argument on March 17, 1993. We also noted that the district court had scheduled preliminary injunction hearings and requested the district court to transmit its findings of fact and conclusions of law to this court as soon as they were made.

On March 17, 1993, the district court entered a preliminary injunction barring defendants from incinerating drummed hazardous wastes which have not already been shredded in preparation for incineration at the Vertac Site.

After oral arguments on March 17, 1993, we entered a temporary stay of the preliminary injunction, which in effect continued our March 2 stay pending interlocutory appeal of the amended TRO. Defendants have since appealed the preliminary injunction (Nos. 93-1720, 93-1765 and 93-1769), and we requested supplemental briefs on whether to continue the temporary stay pending appeal of the preliminary injunction. We also expedited and consolidated the appeals, requested additional briefs, and set the case for oral argument in June [*6] 1993.

First, we note that the entry of the preliminary injunction has followed and replaced the TRO. The only issue remaining before us is the propriety of the preliminary injunction. For that reason, we dismiss the interlocutory appeals of the amended TRO as moot (Nos. 93-1447, 93-1516 and 93-1518).

We have treated the motions to continue the stay as motions for stay pending appeal in appeals Nos. 93-1720, 93-1765 and 93-1769. Defendants, as the parties seeking a stay pending appeal, must show that (1) they are likely to succeed on the merits, (2) they will suffer irreparable injury unless the stay is granted, (3) no substantial harm will come to other interested parties, and (4) the stay will do no harm to the public interest. See, e.g., Hilton v. Braunskill, 481 U.S. 770, 776 (1987); James River Flood Control Ass'n v. Watt, 689 F.2d 542, 544 (8th Cir. 1982) (per curiam). We think defendants have met this burden.

Defendants have raised serious and substantial legal issues in these appeals. Without expressing an opinion on the merits of defendants' claims on appeal, we think defendants have shown that they are likely [*7] to succeed on the merits, particularly with respect to subject matter jurisdiction and the district court's interpretation of the incinerator performance regulation. Defendants have also shown that they may suffer irreparable harm unless a stay is granted because their interests include the important public interest in protecting the environment by cleaning up hazardous waste sites. We think the district court characterized defendants' interests too narrowly and plaintiffs' interests too broadly. We also think defendants have shown that a stay will not cause substantial harm to other interested parties and will not harm the public interest. We think granting the stay, and allowing the incinerator to operate, serves the public interest because doing nothing to the thousands of drums of hazardous wastes involves substantial risks of accidental and uncontrolled releases of toxic substances into the environment, whereas incineration destroys the toxic substances. We do not underestimate the environmental problems associated with incineration, but we think defendants have shown that, particularly in light of the EPA's continuous monitoring of air quality at the Vertac site and its [*8] detailed specific risk assessment, which included the assessment of the risks of food-chain and inhalation exposure, a stay will not harm, and may in fact benefit, other interested parties and the public interest.

In sum, we conclude that the balance of equities favors defendants and that the preliminary injunction should be stayed. Accordingly, we grant the stay pending appeal of the preliminary injunction.

VISTA

Request for Facsimile Transmission

DATE 4/21/93

FROM

EMPLOYEE	EXT.
DAVE PENNEY	
LOCATION (CITY)	**ROOM NO.**

TO

NAME	PHONE NO.
VELDON MESSICK	
DEPARTMENT	
LOCATION (CITY)	

NO. OF PAGES EXCLUDING COVER

NOTE—
1. Your originals must have good contrast (dark detail on light background)
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3. 1/2-inch margins on all sides of sheet
4. Number all pages

SPECIAL INSTRUCTIONS

V3-19-5

VRD 0002027542

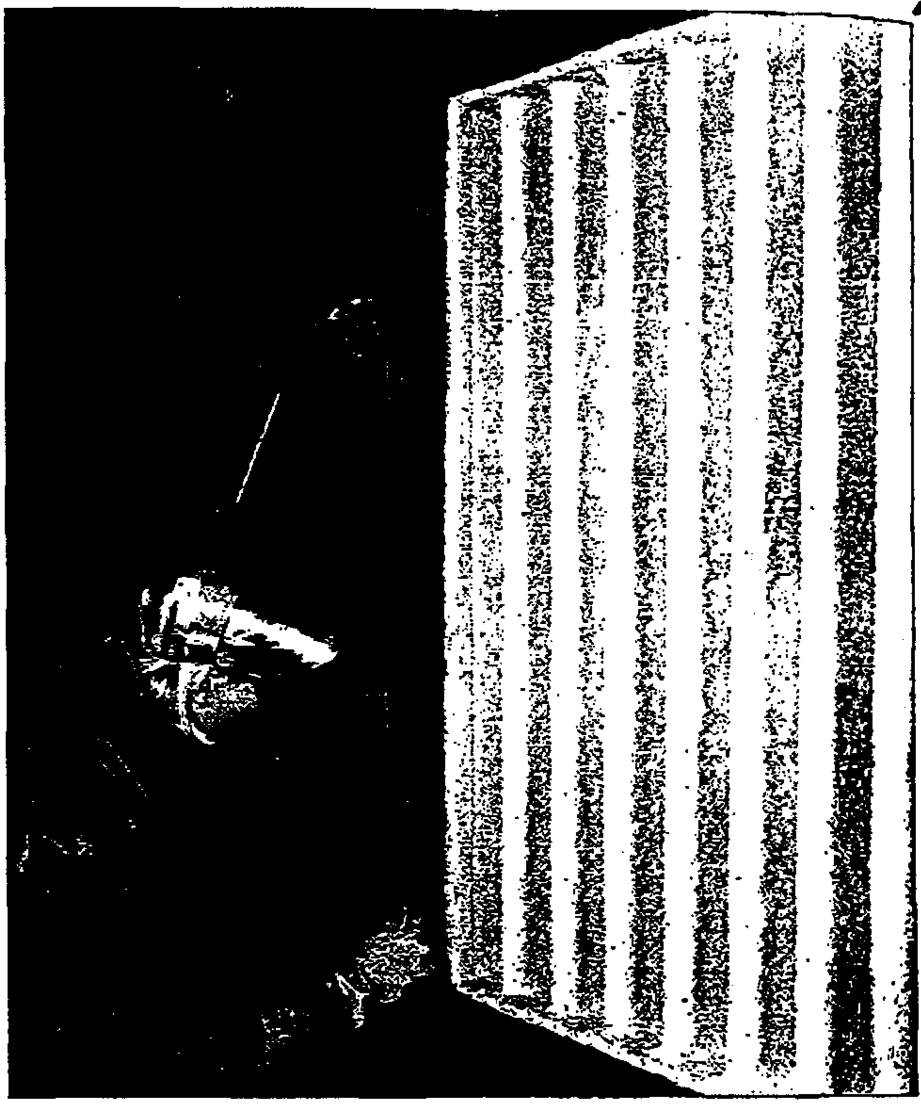
R

1) Note unreferenced ~~Ed~~ statements about PVC pyrolysis + Dioxin emissions

2) We need to have an answer ready to respond to questions on Dioxin + PVC

Dioxin

chemical file



Asbestos diaphragms in the Norsk Hydro Rafnes plant.

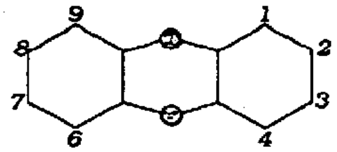
11.5 ISSUES RELATED TO THE USE AND DISPOSAL OF CHLORINE COMPOUNDS

While the whole range of organo-chlorine compounds has been a source of concern, particular attention has been paid to dioxins and furans. These compounds are reviewed below. Other materials are dealt with in earlier chapters.

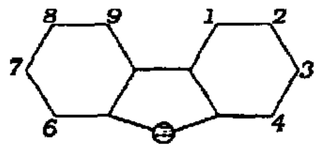
Dioxins and furans

These materials came to the notice of the public and the wider scientific community as a result of the publicity surrounding a number of industrial accidents and the use of contaminated defoliants in the war in Vietnam. They have acquired the reputation of being some of the most dangerous chemicals on earth. The incineration of PVC has been claimed to be a prime source.

DIBENZO-P-DIOXIN



DIBENZO-P-FURANS



The numbers 1-9 represent possible positions for chlorine.

Oxygen

Figure 11.3 Molecule structure of PCDD and PCDF

The nature and toxicity of dioxins

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzo-p-furans (PCDFs) are the two chemical terms used to describe a family of related chemical compounds with the general structures shown in ***Figure 11.3.***

A varying number of chlorine atoms may occupy all or some of the numbered sites shown, giving rise to 75 kinds of PCDDs and 135 PCDFs. The strong interest in dioxins stems from their toxicity to some animal species. This is particularly true of 2,3,7,8 TCDD which has often been called "the most toxic chemical known to man". This is because 2,3,7,8 tetra-chloro-dibenzo-dioxin (TCDD) is fatal to certain species in a single very low level dose. However, there is a wide variation in the susceptibility of animal species to the effects of 2,3,7,8 TCDD. The least susceptible test species is the hamster which is 5,000 times less sensitive than the next most susceptible species, the guinea pig. Man appears to be relatively insensitive.

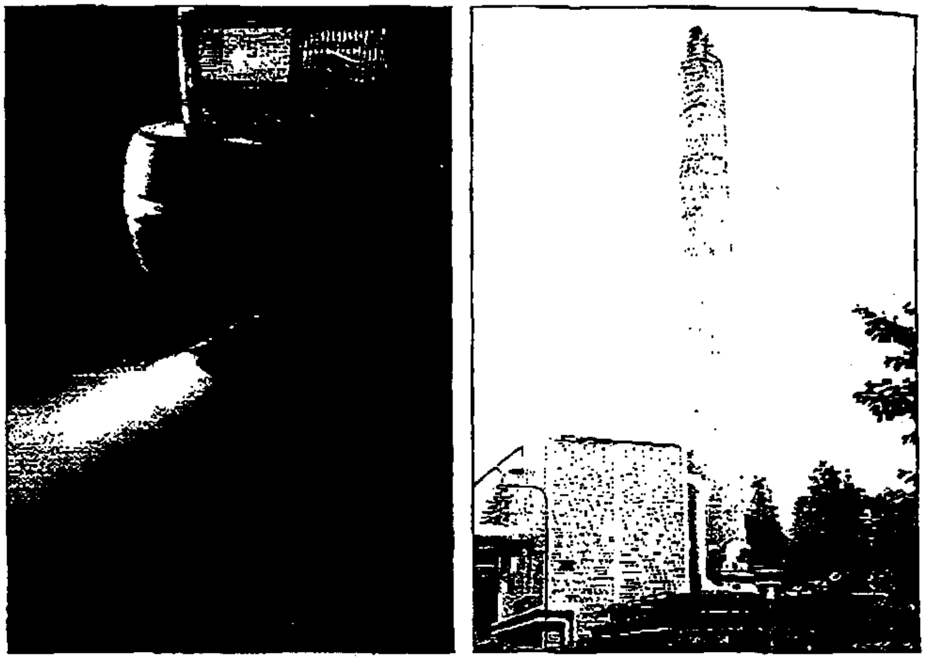
Several human communities are known or believed to have been exposed to unusually high levels of dioxins, often as a result of industrial accidents. The health of the exposed groups has been studied in order to assess the adverse effects of dioxins. Severe exposure has been found to cause chloracne, an unpleasant and disfiguring skin condition which may persist for many years. Transient liver damage and conductive impairment of peripheral nerves have also been reported[19]. No other long-term effects have yet been clearly demonstrated. However, it should be noted that it may take up to 25 years to develop cancer.

A few dioxins other than 2,3,7,8 TCDD have been shown to have significant animal toxicity. In discussing these other dioxins it has become accepted that their toxicity should be compared with that of 2,3,7,8 TCDD. When the toxicity of a mixture of dioxins is calculated, the contributions of the individual dioxins are 'weighted' by comparison with that of 2,3,7,8 TCDD. Weighting factors have been calculated by a number of workers and these are listed in ***Appendices 11-1.***

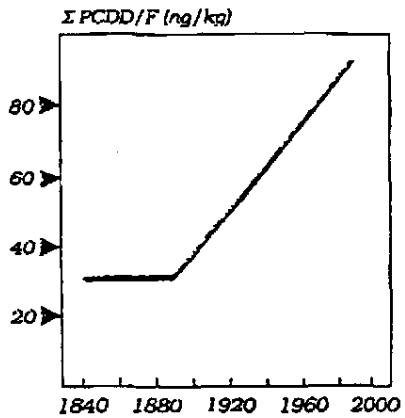
The World Health Organisation (WHO) and a number of national governments have assigned tolerable daily intakes for dioxins in the range 0.006-100 picograms of 2,3,7,8 TCDD per kilogram of body-weight per day (A picogram is only one million millionth of a gram). This is a very wide range, based on varying interpretations of the same basic data. However the acceptance of even these tiny intakes indicates that these medical authorities feel there is a threshold intake value below which dioxins are unlikely to be carcinogenic[20]. This contrasts with some earlier opinions which held that even one molecule of dioxin could initiate cancer.

The detection of dioxins

Methods to measure dioxins at very low concentrations in air, water, soil or foodstuffs have developed rapidly. It is now possible to measure them at much lower concentrations than is possible with almost any other material. They are regularly measured in concentrations down one hundredth of a picogram (10^{-14} grams). and in selected cases down to 10^{-15} grams. (The thickness of a playing card is about 10^{-15} of the distance between the earth and the sun.)



Examples of combustion processes producing dioxins.



Σ PCDD/F trends in the Broadbalk plough layer depth soil samples between 1846 and 1986.

Source:
Increases in the polychlorinated Dibenzo-p-dioxin and - furan content of soils and vegetation since the 1840's. Kjeller LO, Jones KC, Johnston AE, Rappe C. Environ. Sci. Technol., vol. 25, No. 9. 1991.

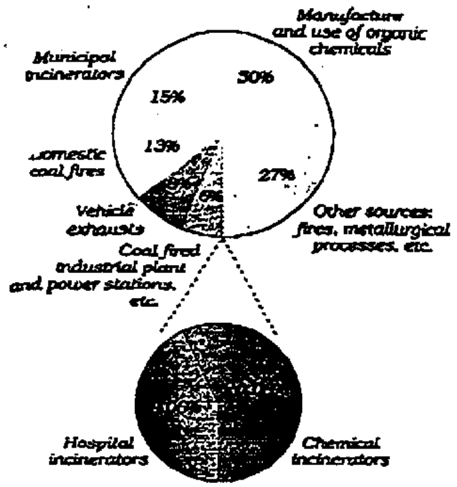
Figure 11.4 Dioxin content in British soil samples

Sources and occurrence of dioxins and furans

The major human intake route appears to be through the food-chain, especially through fat-containing foods such as fish and milk. Minute quantities of dioxins can be found throughout the environment. Their origins continue to be the subject of considerable research. While many of the sources are modern processes they are also produced in processes which have affected humans for thousands of years. ***Figure 11.4*** shows the dioxin levels (in parts per trillion) found in soil samples in Southern England – dating back to 1840[21].

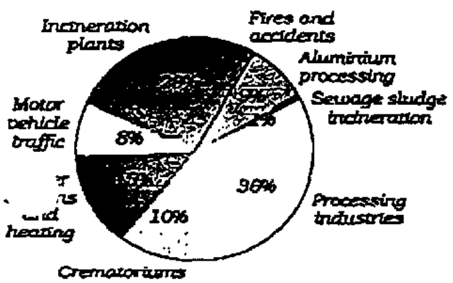
They are produced as unintentional contaminants of the products of a variety of chemical operations. Examples are the bleaching of paper pulp, the manufacture of wood preservatives and herbicides and other processes involving chlorine and oxygen.

Many combustion processes also produce dioxins. Examples include wood burning, metal smelting, internal combustion engines, cremation. straw burning and older municipal waste incineration processes. Continuing research is revealing new sources.



Source:
Department of the Environment, UK.

Figure 11.5 a) Estimated relative contribution to total TCDD formation in UK



Source:
Obermeier T.
"Impact of waste Incineration on Dioxin emission in Berlin".
Warmer Bulletin. February 1992.

Figure 11.5 b) Total dioxin formation in Berlin

A UK review[22] has listed all the known sources of dioxins in the UK atmosphere. An updated estimate of the relative importance of the various sources is shown in ***Figure 11.5 a***[22] and ***Figure 11.5 b.***

PVC and other sources of dioxins

It has become clear that all combustion processes and many chemical processes where even trace levels of chlorine are present may lead to the formation of minute quantities of dioxins. Hence the manufacture and use of PVC can in some circumstances be expected to lead to the formation of dioxins. Laboratory scale pyrolysis of PVC formulations gives rise to detectable levels of dioxins. The significance of this in the everyday use of PVC is not clear.

Reference ?

PVC in municipal solid waste typically contributes 50% of the chlorine present. A number of full scale studies have looked at the effect of that PVC on dioxin emissions[23,24,25,26,27]. Their principal conclusion was that the removal of all PVC from the waste would have no significant effect upon dioxin emission. This result could be expected because the total chlorine content of the small quantity of dioxins produced in such incinerators is only a small fraction of the chlorine in the waste with or without PVC present. However, a Danish study[28] concluded that the quantity of dioxins formed during incineration of refuse was influenced by the proportion of PVC present. To define the situation better, a joint incineration research project is in progress at the University of Umeå in Sweden and at the Centre for Industrial Research in Oslo, funded by ECVM.

Whatever the influence of the composition of the incinerated waste, it is clear that the most significant reductions in dioxin emissions from incinerators can be achieved by optimisation of combustion conditions and by installing flue gas cleansing systems[29].

Because of this, national and European legislation has been developed to define the conditions under which Municipal Solid Waste should be incinerated so as to minimise hazards to public health. This legislation is likely to cause the closure of many existing UK incinerators.

Dioxins have been detected in the emissions from accidental domestic fires. The contribution of PVC to these emissions has been the subject of a major study[23]. This study cites the case of a wooden warehouse at Holmsund in Sweden used to store PVC polymer, additives and PVC flooring materials. The warehouse was burned out and an estimated 400–500 tonnes of PVC were consumed. The weather conditions at the time of the fire trapped the fire gases at a low level beneath a temperature inversion. The ground around the warehouse was covered in snow and it was easy to take samples indicating total dioxin formation. From the 400–500 tonnes of PVC consumed, it was estimated that 3 mg of TCDD equivalents were produced.

★ — reference?

Several reports have shown that burning wood can also be a source of dioxin emissions[25,31]. It appears that the dioxin content of wood smoke is substantially lower than that of PVC smoke. Having said that, a study[31] has shown that the total dioxin emissions from wood-burning stoves in Denmark are on about the same level as those from the country's municipal waste incinerators.

Various metal smelting and recycling processes are known to be sources of dioxins, including the recovery of copper from scrap cable[32]. Since scrap metal may be contaminated with chlorine-containing cutting oils and the fuel used may contain traces of chlorine, it is not known with any certainty to what extent the presence of, for example, PVC-coated scrap in steel making, affects the emissions noted. In copper smelting, the presence of PCB residues from recovered transformer windings, as well as other contaminants from, for example, chlorine-containing elastomers, again make it difficult to assess the precise role of PVC in dioxin formation.

The uncontrolled burning of cable scrap to recover the metal is to be discouraged, since copper is known to catalyse the formation of dioxins when chlorine-containing substances such as PVC are incinerated. Such burning is prohibited in some countries to avoid the emission of various noxious substances. PVC insulation on cable scrap can instead be stripped off mechanically and used in a variety of applications including cable bedding, footwear and flooring.

The effect of acid rain on nature can be severe.

Dioxins in Norsk Hydro's VCM production

*Dioxins may be formed as a by-product of the manufacture of vinyl chloride. Dioxin emissions from Norsk Hydro's plant at Rafnes have been investigated. The dioxin flows are shown in **Figure 11.6.***

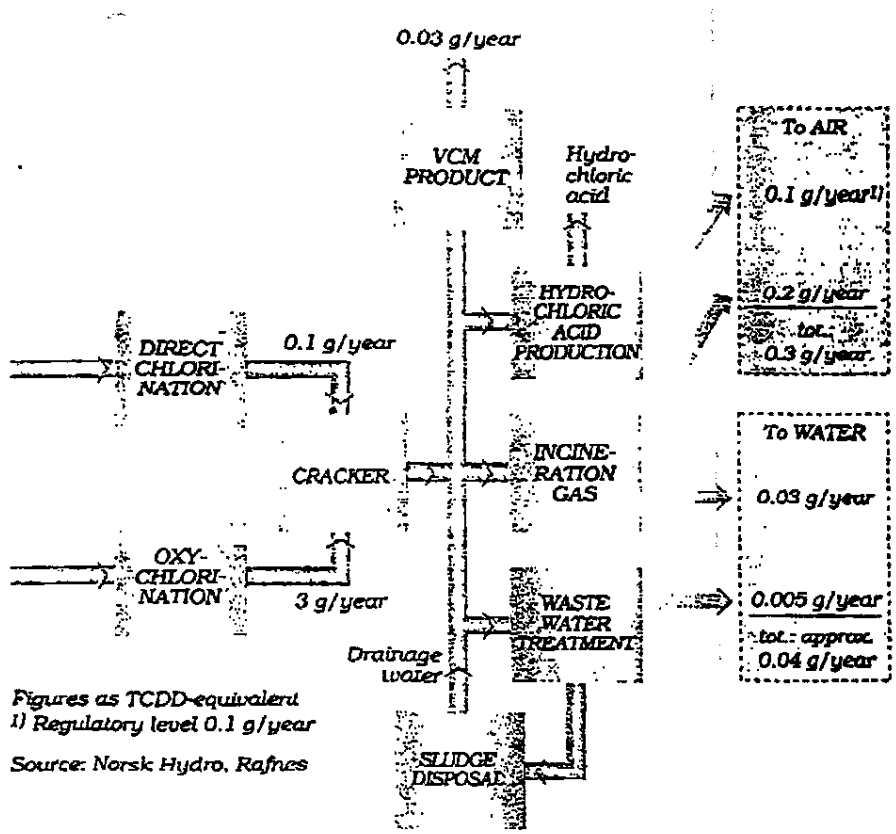


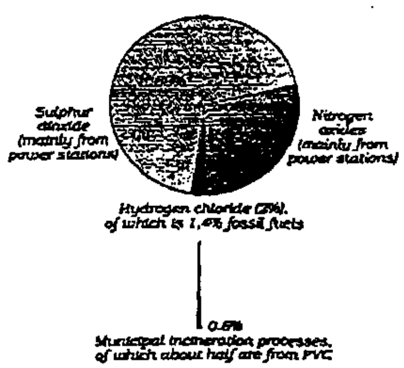
Figure 11.6 Dioxin emission from Norsk Hydro's plant at Rafnes.

Hydrogen chloride

Hydrogen chloride from PVC production and incineration has been identified as a source of atmospheric acidity, sometimes known as "acid rain". In fact there are three major man-made sources of atmospheric acidity in Western Europe. Hydrogen chloride is the least of them, as shown in ***Figure 11.7.***

The major component (69%) of atmospheric acidity is sulphur dioxide. Most of the sulphur dioxide in the atmosphere comes from the burning of fossil fuels to generate electricity. Governments in Western Europe are under pressure to insist on the desulphurisation of power station flue-gases.

Nitrogen oxides provide the second major element in atmospheric acidity (29%). The internal combustion engines used in transport are the main source but, again, combustion and incineration processes make major contributions.



...re 11.7 The amount and sources of acid gas in Western Europe

Hydrogen chloride represents 2% of total acidity and. of that 2%, some 1.4% arises from the chlorine content of fossil fuels such as coal and oil. The other 0.6% derives from industrial and incineration processes, and about half of this. in turn, was calculated in 1986 to derive from the PVC content of the domestic waste stream[30]. However. new EC regulations for incinerators have led to a reduction of hydrochloric acid emissions from municipal waste incinerators. It is therefore reasonable to believe that the incineration of PVC now contributes less than the 1986 figure of 0.3%.

Hydrogen chloride is very soluble in water and is rapidly absorbed by soil. water and plant surfaces. It may be a significant pollutant closer to emission sources. Local scorching of vegetation and corrosion of steel structures and paintwork are typical examples of hydrogen chloride damage. However, with the exception of such localised damage it is unlikely that hydrogen chloride has effects on the growth of forests or the acidification of soils and lakes and rivers[30].

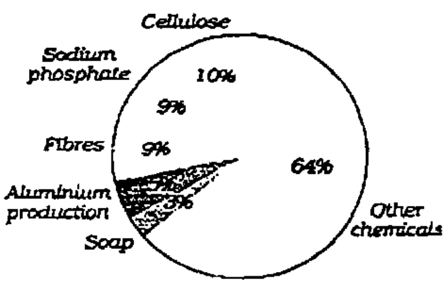


Figure 11.8 Usage of caustic soda

11.6 THE CHLORINE-ALKALI BALANCE

As indicated earlier, the electrolysis of brine produces not only chlorine but also a similar quantity of caustic soda (sodium hydroxide solution). Both are important raw materials serving very different sectors of industry. ***Figure 11.8*** shows the usage pattern for caustic soda. Unfortunately the demand for these materials is seldom in step. Until 1985 there was a shortage of chlorine and an oversupply of caustic soda. Since then environmental concern has led to a much reduced usage of organo-chlorine solvents and CFCs. Consequently chlorine supplies now exceed consumption and caustic soda is in greater demand. While the world demand for chlorine is expected to increase over the next few years, the rate of that increase will probably be lower than for most commodity chemicals. On the other hand the increase in demand for caustic soda is forecast to be at least in line with general economic activity and maybe higher. This level of demand is likely to bring an increase in the price of caustic soda. If the demand were met solely through the electrolysis process, then the surplus of chlorine would grow too.

Under these conditions alternative routes to caustic soda, at present more expensive than electrolysis, would become viable. The most likely route would be that employing natural deposits of trona (sodium carbonate or soda ash) as the basic raw material. Two or three pilot plants have been set up in the USA near to large trona deposits, to explore both the economics and the likely environmental impact of the process.

In the meantime, and in the foreseeable future, the manufacture of PVC is an important application for some 30% of the chlorine produced. Reductions in the amount of PVC produced would add to present problems of maintaining the chlor-alkali balance.

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