UNITED NATIONS ENVIRONMENT PROGRAMME

UNEP

Chemicals

PROCEEDINGS
UNEP Chemicals Workshop on the Management of Polychlorinated Biphenyls (PCBs) and Dioxins/Furans

Yaoundé, Cameroon 17-20 April 2000

IOMC

INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS

A cooperative agreement among UNEP, ILO, FAO, WHO, UNIDO, UNITAR and OECD

The photograph on the cover page was taken by Murray Newton at the Yaoundé Hilton Hotel in 2000.

This publication is produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals (IOMC)

The Inter-Organization Programme for the Sound Management of Chemicals (IOMC), was established in 1995 by UNEP, ILO, FAO, WHO, UNIDO and OECD (Participating Organizations), following recommendations made by the 1992 UN Conference on Environment and Development to strengthen cooperation and increase coordination in the field of chemical safety. In January 1998, UNITAR formally joined the IOMC as a Participating Organization. The purpose of the IOMC is to promote coordination of the policies and activities pursued by the Participating Organizations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.

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UNEP CHEMICALS

UNEP Chemicals is part of UNEP's Technology, Industry, and Economics Division

UNITED NATIONS
ENVIRONMENT PROGRAMME

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Country Presentations

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Introduction

In anticipation of the POPs negotiations, UNEP organized a series of eight regional/subregional POPs Awareness Raising Workshops to prepare governments and other partners for the negotiations, and to encourage immediate action on POPs at the national and the subregional levels. Representatives of 138 countries participated in the workshops, the proceedings of which have been published in UN languages specific to each region, distributed in hardcopy, and made available on UNEP's homepage at http://www.chem.unep.ch/pops/newlayout/prodocas.htm.

The recommendations of these awareness-raising workshops included the suggestion that UNEP conduct a series of technical workshops addressing training and management needs for PCBs and dioxins/furans. UNEP responded by conducting a series of such workshops during 2000, of which the Yaoundé workshop was the first.

The workshops enabled national experts from each (sub-)region to present to neighboring countries and to the international community their experience and progress in managing PCBs and dioxins/furans. In addition, UNEP and other experts provided information on compiling inventories of PCBs and PCB-containing equipment and waste, managing PCBs in use and as stocks, and options for treating or destroying PCBs. The second part of the workshops was dedicated to dioxins and furans, and especially to informing countries how to identify sources of these unwanted byproducts and how to quantify their releases. Experiences of monitoring programs and needs for reliable dioxin analysis were also presented and discussed.

The aim of the Yaoundé workshop, which was jointly organized with Cameroon's Ministry of the Environment and Forestry, was to encourage and assist the countries of West and Francophone Africa to initiate national action plans and strategies for reducing and/or eliminating releases of these chemicals. The workshop also sought to give countries information that might help them develop their positions on the various issues arising in the course of the negotiations for a global treaty on POPs. Finally, and as is usual for UNEP workshops, one of the most important outcomes was the development of conclusions and recommendations on the region's needs and future actions with respect the anticipated future POPs Convention.

The workshop was attended by approximately 80 government experts and decision-makers from 17 countries of West and Francopohone Africa and by staff of UNEP Chemicals. A number of observers also attended (see attached list of participants). Expert presentations were provided by a few leading experts invited from inside and outside the region as well as from intergovernmental and non-governmental organizations (for details, see attached program of the workshop). The workshop was financed by the Government of the United States of America and by UNEP

These proceedings contain reports from the workshop working groups, country presentations, and other expert presentations. Besides the printed document, the proceedings will be made available to sessions of the POPs Intergovernmental Negotiating Committee (INC) and on the Internet at http://www.chem.unep.ch/pops.

United Nations

JOINTLY ORGANISED BY UNEP CHEMICALS
AND
MINISTRY OF THE ENVIRONMENT AND FORESTRY
OF THE REPUBLIC OF CAMEROON

UNEP
For Life on Earth

Sub-Sahara Africa Regional Training Workshop on Identification and Management of some Persistent Organic Pollutants (PCBs and Dioxins / Furans)
Yaounde, Cameroon, 17 - 20 April 2000

RESOLUTIONS DE L'ATELIER

Recommandations sur les PCB

1. La création d'un Comité National comprenant toutes les parties concernées et intéressées (les représentants des Ministères concernés, des sociétés privées, des Universités, des ONG, des Syndicats et les Médias). Une évaluation des risques et des dangers dans les conditions locales d'utilisation des PCB devra être faite par ce Comité. Le Comité est chargé de mener des actions d'information, de sensibilisation et d'éducation du public, des décideurs politiques sur la gestion des PCB.

2. Les pays africains qui n'ont pas encore commencé l'inventaire des PCB devraient s'inspirer des expériences des pays qui ont des programmes d'actions sur les PCB. A cet effet, le PNUE devrait assister les pays africains qui n'ont pas bénéficié de l'assistance financière du PNUE.

3. La mise en place d'un programme d'action sur les PCB devrait s'intégrer au programme d'action national sur l'environnement.

Recommandations sur les Dioxines et Furanes

A. Niveau National

1. La sensibilisation.

Elle devrait être faite par le même Comité national créé pour les PCB. Cette action de sensibilisation devrait être piloté par le Ministère chargé de l'Environnement. Cette sensibilisation vise les populations et devrait être concomitante àcelle des décideurs politiques.

2. Le renforcement des capacités nationales

Il devrait être mené par :
- l'organisation des ateliers de formation ;
- l'association des instituts académiques (universités, centres de formation et de recherche…) aux actions sur les dioxines et furanes pour la sauvegarde de la santé et de l'environnement ;
- l'association et l'encouragement des institutions qui ont des plans d'action sur les dioxines et les furanes.

3. L'identification de quelques sources potentielles:

- La sciure de bois traitée ou non au pentachlorophénol utilisée à des usages domestiques ;
- L'incinération des déchets ;
- La pratique traditionnelle de fumage de poissons ;
- Le transport automobile ;

- Les fabriques de plastiques ;
- Les produits carnés et laitiers ;
- Les feux de brousses et la biomasse .

4. L'établissement d'un inventaire national

Les participants recommandent l'établissement des inventaires nationaux des sources d'émission de dioxines et de furanes.

5. L'évaluation de l'exposition humaine

La mise en place de projets de recherche sur l'exposition humaine aux dioxines et furanes. Celle-ci devrait se faire en étroite collaboration avec les universités, les instituts de recherche qui pourraient intégrer ces projets dans leurs programmes de recherche. Cette évaluation de l'exposition devrait être élargie à la faune et flore.

6. Le cadre juridique (Conventions de Bâle et de Rotterdam)

L'atelier recommande l'identification de solutions de substitution à la biomasse qui est une des sources potentielles de dioxines et de furanes, lesquelles sont visées par les deux conventions.

B. Coopération Sous-régionale

- La création d'un réseau africain pour l'identification et la gestion des POPs.
- La création d'un centre régional pour les POPs.
- L'appui à la coopération sous-régionale et régionale pour favoriser les échanges d'informations.

C. Besoins d'assistance

L'assistance financière par le PNUE, pour l'inventaire des sources d'émission et l'élaboration des plans d'actions nationaux pour réduire les risques et les dangers liés aux Dioxines et Furanes.

L'assistance technique en matériels de laboratoire d'analyses, d'équipements informatiques, de documents techniques, etc…

D. Durée et finalisation

1. La mise en place du Comité National à court terme.

2. L'élaboration et la mise en œuvre d'un plan d'action national à court et à moyen termes.

E. Création d'un Comité de suivi

La création d'un comité de suivi des recommandations de l'atelier de Yaoundé sur les PCB, dioxines et furanes. Ce comité est composé comme suit :

- Cameroun (pays hôte de l'atelier) ;
- Nigeria ;
- Sénégal ;
- Guinée ;
- Côte d'Ivoire.

Fait à Yaoundé, le 20 Avril 2000

Le Président : **le Cameroun** ;

Le Vice-président : **le Nigeria** ;

Le rapporteur : **la Guinée**.

SUB-REGIONAL WORKSHOP ON IDENTIFICATION AND MANAGEMENT OF PCBs AND DIOXINS/FURANS

JOINTLY ORGANIZED BY

THE UNITED NATIONS ENVIRONMENT PROGRAMME

AND

THE GOVERNMENT OF THE REPUBLIC OF CAMEROON

Yaoundé, Cameroon
17 – 20 April 2000

Final Agenda

Final Agenda
Workshop on Identification and Management of PCBs and Dioxins/Furans
Yaoundé, Cameroon
17 – 20 April 2000

MONDAY, 17 APRIL 2000

I. OPENING SESSION

10:00–11:15	**Status and Context of Global POPs Negotiations**	James B. WILLIS, Director, UNEP Chemicals
	Workshop Objectives, Approach, Expected Outcomes	Murray NEWTON, Scientific Advisor, UNEP Chemicals
	Self-Introduction of Workshop Participants	
	Keynote and Welcome Address	HE Mr. Sylvèstre NAAH Ondoua, Minister of the Environment and Forestry of the Republic of Cameroon
11:15-11:45	**Coffee Break**	

II. IDENTIFICATION AND MANAGEMENT OF POLYCHLORINATED BIPHENYLS

11:45 – 12:30	**Overview: PCBs** Sources, quantities, types, fate and transport, health effects of PCBs	Murray NEWTON, Scientific Advisor, UNEP Chemicals
12:30 - 2:00	**Lunch**	

2:00 - 3:30	**PCB Inventories** Alternative approaches to compiling inventories of PCBs and of PCB-containing equipment. What to look for and where to look. Kinds of PCBs, uses, trade names, placards. **Discussion of country experiences** **Interactive Question and Answer Session.**	Murray NEWTON, Scientific Advisor, UNEP Chemicals
3:30 - 4:00	**Coffee Break**	
4:00 - 6:00	**PCB Management, Treatment, Disposal Issues** Monitoring and maintaining PCB-containing transformers remaining in service. Conducting visual inspection of PCB-containing vessels (e.g., signs of deterioration, leaks). Management, treatment, disposal options; retrofilling and decontamination issues.	William A. WALLACE, USA
6:15 - 7:45	**Welcome Reception Hosted by Government of the Republic of Cameroon**	

TUESDAY, 18 APRIL 2000

III.	**IDENTIFICATION AND MANAGEMENT OF DIOXINS AND FURANS**	
9:00-11:00	**Overview: Dioxins and Furans** Sources, analysis and environmental occurrences of dioxins and furans	Dr. Peter FUERST, Germany
11:00-11:30	**Coffee Break**	
11:30-1:00	**Dioxins and Furans Inventories**	
	Dioxin inventories	Dr. Heidi FIEDLER, UNEP Chemicals
	The Dioxin Toolkit, a standardized approach to establish dioxin release inventories	Dr. Heidi FIEDLER, UNEP Chemicals

1:00- 2:30	**Lunch**	
2:30 – 5:00	**Field Trip**	

WEDNESDAY, 19 APRIL 2000

9:00- 10:30	**Exposure to Dioxins and Furans**	
	Levels in food and in humans	Dr. Peter FUERST, Germany
	Patterns of dioxins and furans, legislation and recommendations, Dr. WHO TDI recommendations Germany	Dr. Heidi FIEDLER, UNEP Chemicals and Peter FUERST,
	Discussion	
10:30 – 11:00	**Coffee Break**	
11:00 - 12:30	**Reduction of Releases of Dioxins and Furans**	Dr. Heidi FIEDLER, UNEP Chemicals
	Techniques and technologies to reduce emissions of dioxins and furans	
12:30 - 2:00	**Lunch**	

IV. REGIONAL PRIORITIES AND NATIONAL STRATEGIES FOR MANAGING PCBs AND DIOXINS/FURANS

2:00 - 3:30	Presentations from selected countries on the approaches taken and progress made in managing PCBs. (Australia, Cameroon, Côte d'Ivoire, Guinea)
3:30 - 4:00	**Coffee Break**
4:00 – 6:00	Country Reports and Discussion

THURSDAY, 20 APRIL 2000

9:00 – 10:30	Working group discussion to identify key problems and national/regional strategies for the management of PCBs	
10:30 – 11:00	**Coffee Break**	
11:00 – 12:30	Working group discussion to identify key problems and national/regional strategies for the management of dioxins and furans	
12:30 - 2:00	**Lunch**	

V. CLOSING SESSION

2.00 – 3:00	**Report of Working Group, Including Strategies for Cooperation**	
3:00 – 5:00	Next steps for follow-up	James B. WILLIS, UNEP Chemicals
	Resolutions of workshop	[Designated delegate from African country]
	Closing speech	HE Mr. Sylvèstre NAAH Ondoa, Minister of the Environment and Forestry of the Republic of Cameroon

Status and Context of Global POPs Negotiations

Mr. James B. Willis, UNEP, Chemicals

Slide 1

Global Action on POPs
Objective and Strategy

Yaoundé, Cameroon
17 April 2000

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WHAT ARE POPs AND WHY ARE THEY A CONCERN ?

- Toxic
- Persistent
- Bio accumulative
- Mobile in the environment

Continued environmental release leads to increasing levels

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ACTION TO DATE ON POPS

- national actions
- regional based agreements
- negotiating POPs treaty

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Global Action on POPs: Objective

- deliberately produced - elimination of production and use
- by-products - reduction in release
- stockpiles

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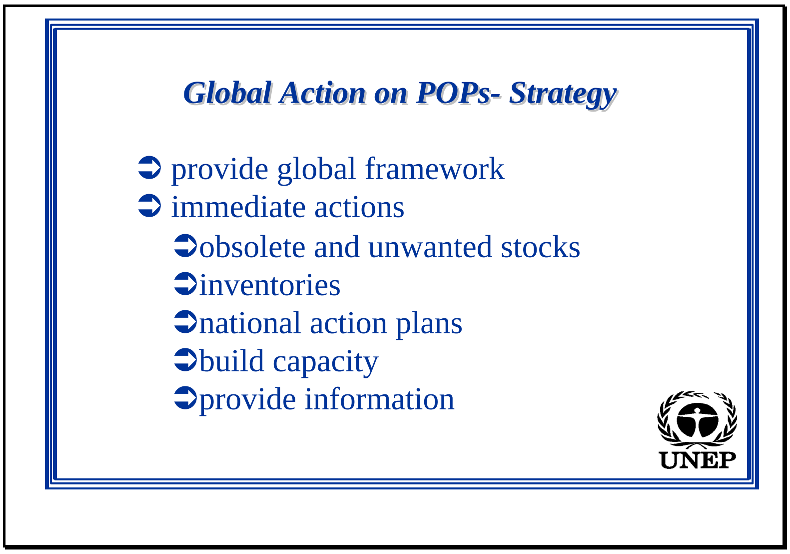

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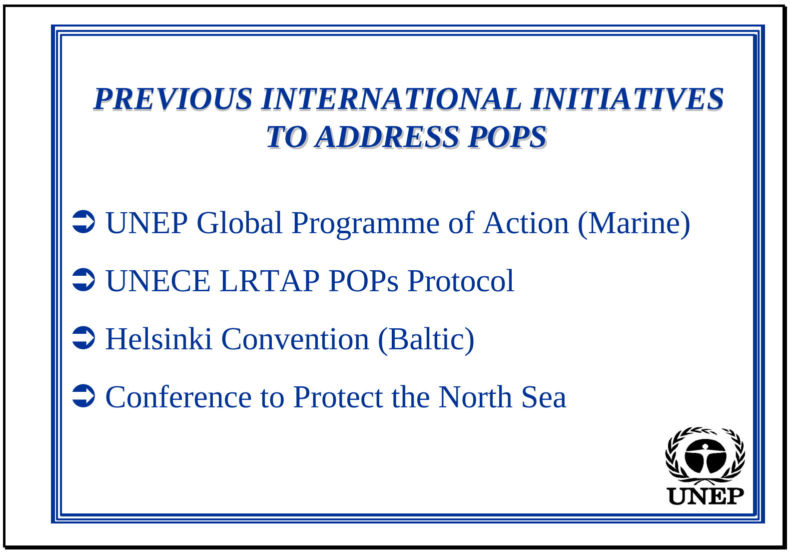

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PREVIOUS INTERNATIONAL INITIATIVES TO ADDRESS POPS (CONT)

- Oslo-Paris Convention (North-East Atlantic
- Barcelona Resolution (Mediterranean)
- Arctic Environmental Protection Strategy
- NAFTA/NACEC Resolution (3 POPs)
- Canada/USA Great Lakes Agreement

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CURRENT NEGOTIATIONS -- WHAT IS BEING NEGOTIATED?

A legally based instrument for implementing international action on certain persistent organic pollutants (POPs), initially beginning with 12 POPs.

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WHICH POPS ARE INCLUDED?

Aldrin, chlordane, dieldrin, DDT, endrin,

heptachlor, hexachlorobenzene, mirex,

toxaphene, PCBs, dioxins and furans

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UNEP GOVERNING COUNCIL DECISION 19/13C (MAY 1997)

Three Key Elements:

1. Begin negotiations of a legally binding instrument on POPs to be concluded by year 2000

2. Develop criteria and a process for including possible additional POPs in the convention

3. Undertake "Immediate Actions"

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TIMETABLE FOR NEGOTIATIONS

- INC1: Montreal (29 June 29 - 3 July 1998)
- INC2: Nairobi (25 - 29 January 1999)
- INC3: Geneva (6-11 September 1999)
- INC4: Bonn (20-25 March 2000)
- INC5: Johannesburg (4-9 December 2000)
- Diplomatic Conference: Sweden (May2001)

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MAJOR ISSUES IN POPS NEGOTIATIONS

- measures to reduce or eliminate releases
- process for adding more POPs
- technical and financial assistance

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STATUS OF NEGOTIATIONS

- 10 deliberately produced POPs proposed for elimination - differing timing
- interim DDT use limited to vector control
- measures on D/F and other byproducts
- measures on stockpiles
- process for adding more POPs accepted

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MEASURES TO REDUCE OR ELIMINATE RELEASES

Goal for intentionally produced POPs is to ***eliminate production and use:***

- aldrin, endrin, toxaphene - at entry into force of the convention
- chlordane, dieldrin, heptachlor, mirex, HCB - some critical uses may be permitted, but reviewed at specified dates

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MEASURES TO REDUCE OR ELIMINATE RELEASES

- DDT: ***elimination of production for all except public health uses*** (*e.g.* malaria) but review the need for remaining uses to see when production may be completely halted.

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MEASURES TO REDUCE OR ELIMINATE RELEASES

PCBs: ***elimination of production for all new uses*** but permit continued use of PCBs in equipment, and

- phase out “as soon as possible”
- may specify a deadline

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MEASURES TO REDUCE OR ELIMINATE RELEASES

By-products:

Promote use of strategies & measures:

- to reduce releases and/or eliminate sources by feasible & practical means
- to prevent formation and release
- to apply BAT for new & existing sources
- national and sub/regional action plans

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MEASURES TO REDUCE OR ELIMINATE RELEASES

POPs wastes:

- strategies for identification of articles, products & stockpiles
- environmentally sound waste destruction
- concern for dioxin & furan generation and POPs release to environment
- technical & financial assistance for less developed countries

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PROCESS FOR ADDING NEW POPS

Industrial chemicals & pesticides screened for:

- ➲ persistence
- ➲ bioaccumulation
- ➲ toxicity
- ➲ potential for long range transport

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FUNDING AND TECHNOLOGY

➲ availability of financial resources and technology recognised as crucial

➲ tentative agreement that use of current mechanisms should be optimised

➲ dedicated mechanism has been proposed, but no agreement

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FUNDING AND TECHNOLOGY (CONT)

- ➲ proposal that GEF be a financial mechanism
- ➲ welcomed by some delegations
- ➲ some concern about GEF's ability to fulfill role

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EXPECTED PROGRESS

INC-5 December 2000, South Africa

Key matters -

1. Resolve funding issues
2. Conclude negotiations
3. Develop any needed resolutions for the Diplomatic Conference

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EXPECTED PROGRESS (CONT)

Diplomatic Conference

21-23 May, 2001 Stockholm

Adopt and sign convention and final act

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Global Action on POPs - Capacity Building and Information Products

POPs Alternatives

PCB Destruction Capacity

PCB Identification

Dioxin/Furan inventories

Workshop Proceedings

Risk Assessment Training

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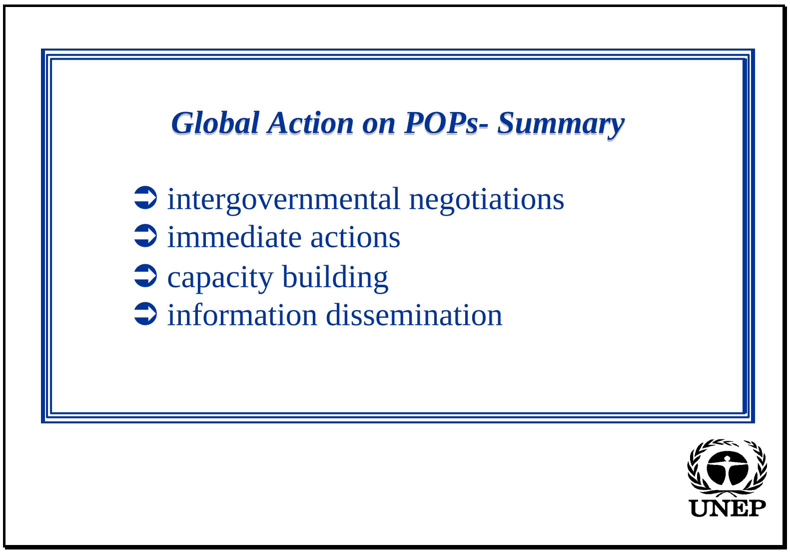

Global Action on POPs- Summary
intergovernmental negotiations
immediate actions
capacity building
information dissemination
UNEP

Overview: PCBs

Mr. Murray Newton, UNEP Chemicals

Slide 1

Overview:
Polychlorinated Biphenyls (PCBs)

United Nations Environment Programme

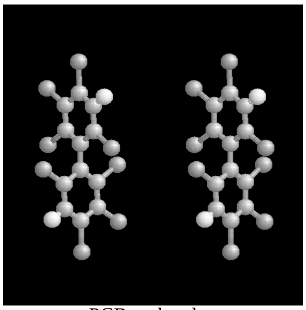
Workshop on the Management of
PCBs and Dioxins/Furans

Yaoundé, Cameroon

17-20 April 2000

Slide 2

OVERVIEW

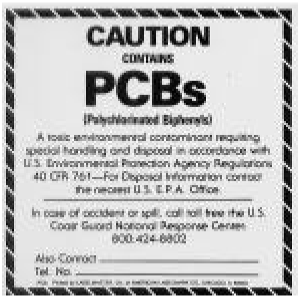


PCB molecule

- Objectives
- Polychlorinated Biphenyls (PCBs)
  - What are they?
  - History and use
  - Environmental fate
  - Health effects
  - Laws, regulations, international agreements

Slide 3

PCBs: WHAT ARE THEY?



PCB mark (U.S.)

- Chemical structure
- Physical characteristics

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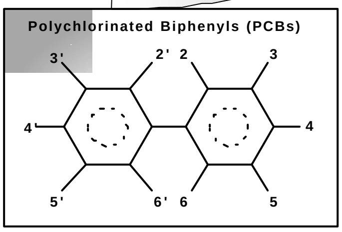
Chemical structure of PCBs

- Polychlorinated biphenyls (PCBs)
- Structure
  - Two benzene rings and 1 to 10 chlorine atoms
  - 209 possible congeners or forms of PCBs
- Produced by reaction of biphenyl and Cl_2 using a catalyst



PCB molecule

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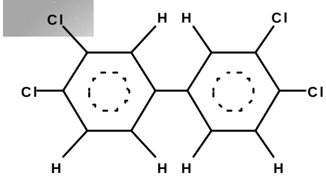
Physical Characteristics of PCBs

- Broad range:
  - light, oily fluids
  - heavy, honey-like
  - heavy greases, waxes
- Non-flammable
- Do not conduct electricity
- High boiling points
- Slightly soluble, heavier than water

3,3',4,4' - tetrachlorobiphenyl



Example of a PCB congener

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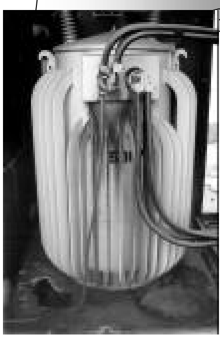
History

- Discovered in the 19th century
- Began manufacture in 1929
- Excellent properties for many applications
  - Non-flammable
  - Does not easily degrade



Leaking PCB Transformer

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Use

- Used extensively from 1929 to 1978
  - Dielectric fluids - transformers and capacitors - 60%
  - Industrial fluids - hydraulics, gas turbines - 15%
  - Adhesives, textiles, printing, sealants, etc. - 25%
- Countries that have manufactured PCBs
  - Austria, China, Czechoslovakia, France, Germany, Italy, Japan, Russia, Spain, U.K., U.S.
- National PCB phase outs took place
  - Late 1970s: Canada, Japan, Sweden, U.S.
  - Early 1980s: France, Germany, Spain, U.K.

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Where PCBs are found

Applications		
Closed	**Partially Closed**	**Open**
Transformers Capacitors Lighting ballasts Motors Magnets	Heat transfer fluids Hydraulic fluids Vacuum pumps Switches Circuit breakers Voltage regulators Liquid-filled electrical cables Liquid-filled circuit breakers	Plasticizers Sealants Adhesives Paints Surface coatings Carbonless paper Inks Lubricants

Slide 9

How Did PCBs Get into the Environment? (1)

- In the past, disposal of PCB wastes into the environment was considered acceptable, legal and hazard-free
- Often disposed of intentionally for dust suppression

Leaking Mineral Oil Transformer

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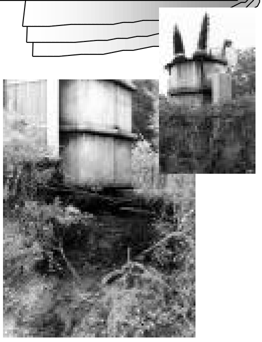
How Did PCBs Get into the Environment? (2)

- Accidental releases
  - Leaks, spills from PCB equipment
  - Waste oil (recycled)
  - Contaminated fuels
  - Disposal in landfills



Leaking PCB Transformer

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How Did PCBs Get into the Environment? (3)

- Other releases
  - Open burning
  - Transformer fires
  - Capacitor explosions
  - Releases from paints, coatings, printing inks, plastics, sealants

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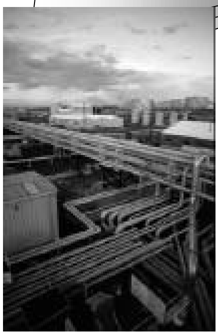
PCBs in Natural Gas Pipelines

- PCBs entered through
  - Migration from other contaminated systems
  - Use of PCB-containing lubricants in turbine compressors, pipeline valves
  - Fogging of pipeline system with PCB-containing oil vapor



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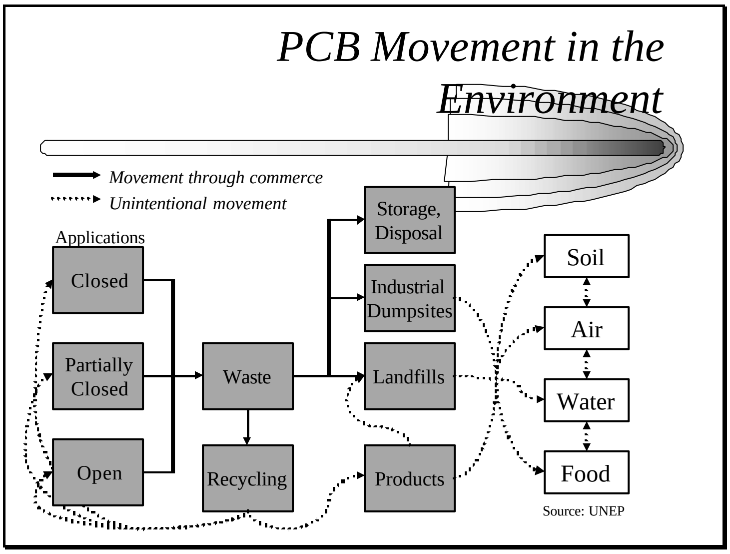

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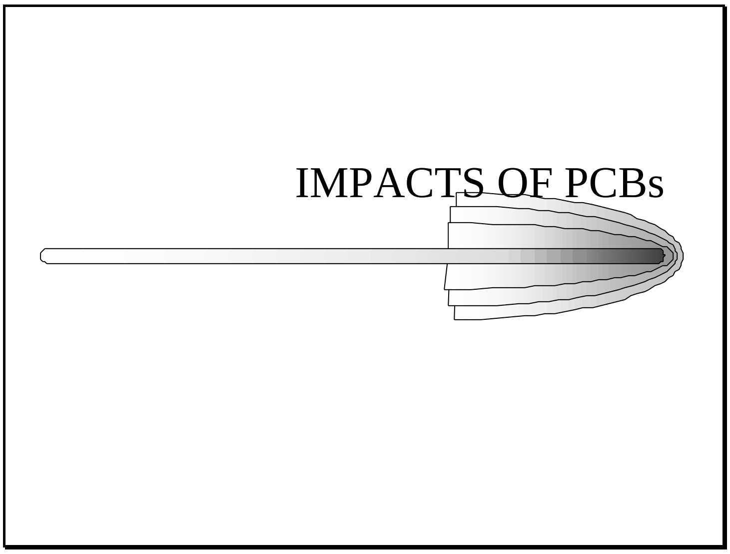

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Health Effects -- Historical Concern

- Early 1930s
  - Chloracne in people working with PCBs
- 1966
  - PCBs found in environmental samples
- 1968: Japan
  - “Yusho” episode
- 1978: Taiwan
  - “Yu-Cheng” disease

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Health Effects

- Acute effects
  - Chloracne, skin rashes, liver disorders
- Chronic effects
  - Chloracne, liver damage, reproductive and developmental effects, immunosuppression
  - Possibly cancer
- PCB degradation products are more toxic

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Laws, Regulations, International Agreements Covering PCBs

- Basel Convention
- POPs Convention
- OECD rules
- Laws, regulations in other countries

Slide 18

International Agreements

- Basel Convention
  - Responsibility of exporting countries to ensure that hazardous waste treated correctly
  - Annex VIII lists wastes containing PCBs
- POPs Convention - Stockholm
- OECD: "Red List"
  - Transboundary movement of wastes
  - PCB-contaminated wastes greater than 50 ppm not suitable for recovery

Slide 19

European Union

- 1996 PCB Disposal Directive (96/59/EC)
  - Inventory
  - Phase out of all PCBs by 2010
  - Exception: transformers containing 50-500 ppm PCBs
    - Can retain in service until end of useful life
  - PCBs defined as mixtures containing greater than 50 ppm PCBs

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Australia

- PCB Management Plan
  - Definitions
    - "Scheduled PCB wastes: greater than 50 ppm"
    - "Concentrated PCBs: greater than 10% PCB"
    - "PCB-free: less than 2 ppm"
  - Established schedules for
    - Survey of PCB equipment by 1 January 1999
    - Removal of equipment with concentrated PCBs from service by 1 January 2002
      - Consign for treatment one year after removal

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United States

- Primary US Laws
  - Toxic Substances Control Act (TSCA)
  - Resource Conservation and Recovery Act (RCRA)
  - Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Management approach (regulated at 50 ppm or greater)
  - Ban PCB manufacture as of 1979, except for R&D
  - Ban processing, distribution in commerce
  - Only certain authorized uses
  - Cleanup of leaks, spills
  - Marking, storage, transport, recordkeeping, disposal rules

Slide 22

SUMMARY

- Objectives
- Polychlorinated Biphenyls (PCBs)
  - What are they?
  - History and use
  - Environmental fate
  - Health effects
  - Laws, regulations, international agreements

Slide 23

Where We Go From Here

- PCB Inventories
- PCB Management, Treatment, Disposal
- Field Trip
- Regional Priorities and National Strategies

- Questions?

PCB Inventories
Mr. Murray Newton, UNEP Chemicals

Slide 1

COMPILING NATIONAL INVENTORIES OF PCBs

United Nations Environment Programme

Workshop on the Management of PCBs and Dioxins/Furans

Yaoundé, Cameroon

17-20 April 2000

Slide 2

Summary

- Purpose of the inventory
- Inventory process steps
  - Planning
  - Conducting the inventory
  - Communicating the inventory information

Slide 3

Purpose of the Inventory

- Compile accurate list of PCB-containing equipment and materials
  - Identification, location, condition, service history, PCB quantities, disposition
- Assist in ensuring integrity and safe management of PCB-containing equipment
- Ascertain disposal/destruction needs

Slide 4

Inventory Process Steps

- Planning
  - Pre-inventory preparation and communication
  - Selection of the facilities to be inventoried
- Conducting the Inventory
  - Two models
    - *Self reporting*
    - *Physical inspection*

Slide 5

Planning

- Determining the inventory approach
  - Self reporting
  - Physical inventory
- Selection of facilities to inventory
- Communication with the facility managers
- Stakeholder roles

Slide 6

Determining the Inventory Scope

- Determine the regions (geographic) to be inventoried
- Locate areas where PCBs are likely to be found
  - Which facilities are likely to have PCBs?
- Divide areas into logical units to be inventoried
  - Even distribution of work effort
  - Travel considerations

Slide 7

Selection of Facilities to Inventory

- Select those facilities that are likely to have significant quantities of PCBs
- Also consider facilities that may have disposed of PCBs inadequately
  - On site or off site

Transformer

Slide 8

Facilities That Have PCB-Containing Equipment or Materials

- Electric Utilities
- Industrial Facilities
- Railroad Systems
- Mining Operations
- Military Installations
- Residential or Commercial Buildings
- Research Laboratories
- Manufacturing Plants
- Waste Water Discharge Facilities
- Automobile Service Stations
- Landfills

Source: UNEP

Slide 9

Principal Uses of PCBs

• Dielectric fluids (transformers and capacitors)	60%
• Industrial fluids (hydraulics, gas turbines)	15%
• Adhesives, textiles, printing, sealants, etc.	25%

Slide 10

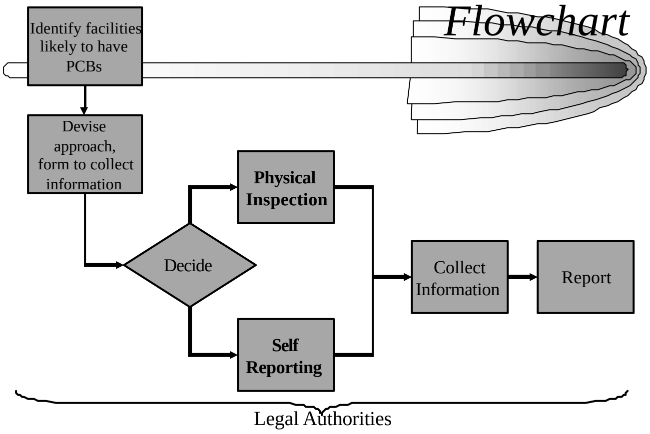
Priority Facilities

- Electric utilities, power stations
- Electronics manufacturing plants
- Petrochemical plants
- Railroad systems
- Transformer or electric equipment repair facilities
- Mining operations

Transformers in an underground mine

Slide 11

Inventory Process Steps Flowchart



Slide 12

Which Inventory Method to Use

Self-reporting or physical inventory?

Considerations:

- Scale of inventory
  - How many facilities?
  - Where are they?
- Complexity of target facilities
- Responsiveness of industry
- Legal authorities

Inspection of a facility located in the mountains of Colorado, USA

Slide 13

Self Reporting

Slide 14

Self-reporting Inventory Form: Possible Contents

- Facility information
  - Name, address, telephone, e-mail
  - Facility point of contact
- Equipment information
  - Location, type, contents
  - "Nameplate" information
- Equipment condition
  - Spills, leaks, damage
  - Inspection/maintenance history

Inspecting a facility with PCB-contaminated equipment

Slide 15

Self Reporting

- Notification/Education
- Transmission of information
- Handling of responses
- Performing spot checks

PCB-contaminated capacitors

Slide 16

Notification/Education

- Send forms and instructions to identified facilities
- Use advertising
- Contact professional and trade associations
- Conduct educational meetings, workshops
- Specify places to call for assistance

Self reporting

Slide 17

Transmission of PCB Survey Information

- To whom should you send the forms?
- How long should you wait for response?
- How should you to follow up?

Self reporting

Slide 18

Handling of responses

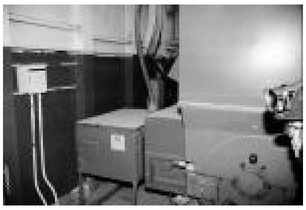
- Check form for completeness
- Enter the information into the database
- Devise a process to ensure the quality of the information

Self reporting

Slide 19

Performing spot checks

- Selecting facilities for a physical inspection
- Using physical inspection procedures



Inspector checking a PCB capacitor

Self reporting

Slide 20

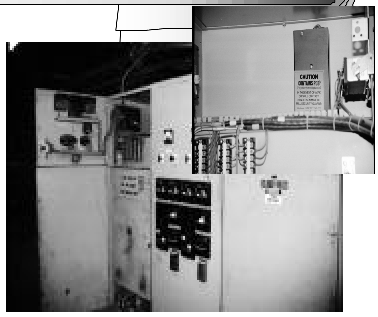
Physical Inventory

- Pre-planning
- Safety considerations
- Conducting the inventory

Slide 21

Pre-planning

- Communicating with facility management
- Selecting personal equipment



PCB-contaminated electrical equipment

Physical Inventory

Slide 22

Communication With Facility Management

- Obtain cooperation of facility managers before conducting the inventory
- Explain the purpose of the inventory
- Schedule the inventory visit
- Discuss equipment locations, if possible
- Learn plant safety procedures

Physical Inventory > Pre-planning

Slide 23

Equipment

- Work clothes
- Work boots
- Gloves
- Hard hat, safety glasses
- Flashlight
- Half-face respirator
- Clipboard, several pens/pencils
- Camera

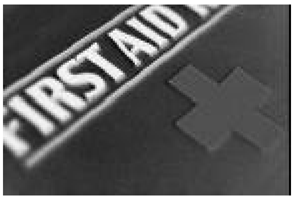
Workers moving drums of PCBs

Physical Inventory > Pre-planning

Slide 24

Safety Considerations

- Learn plant safety rules
- Schedule a plant escort
- Learn what to do when handling PCB-containing equipment



Physical Inventory > Safety Considerations

Slide 25

Learn Facility Safety Rules

- Get a briefing on the facility’s safety rules
- If you are not offered the briefing, ask for it
- If use of safety equipment is required, make sure you know how to use it

Physical Inventory > Safety Considerations

Slide 26

Request a Plant Escort

- Make sure you have someone from the plant guide you through the facility
- Do not lead. Follow them through the facility

Physical Inventory > Safety Considerations

Slide 27

What to do When Inspecting PCB-containing equipment

- Follow their instructions
- Stay with your escort
- Do not touch the equipment
- The inventory information you need can be obtained from the equipment nameplate usually visible from a distance
- If sampling of dielectric fluid is required, let the facility personnel take the sample

Physical Inventory > Safety Considerations

Slide 28

Conducting the Inventory

- Facility entry
- Pre-inventory meeting with facility managers
- Selecting the equipment to be inventoried
- Working with facility managers to conduct the inventory
- Inventorying PCB-containing equipment
- Sampling and analysis
- Completing the inventory form
- Post-inventory meeting

Slide 29

Facility Entry

- Check in at the facility entrance
- Schedule enough time to obtain badges, travel to meeting point

Conducting the Inventory

Slide 30

Pre-Inventory Meeting with Facility Managers

- Explain the purpose of the inventory
- Plan the inventory activities
  - Select the areas and equipment to inspect
  - Obtain equipment service records, if any
- Know safety rules
  - What equipment to wear
  - What to do in case of emergencies

Conducting the Inventory

Slide 31

Selecting the Equipment to be Inventoried

- Must do
  - Transformers
  - Capacitors
- Ought to do
  - Hydraulic fluids
  - Oil-filled electrical cables
- Helpful if you can get information
  - PCB-containing wastes
  - PCB emissions, discharges, soil contamination

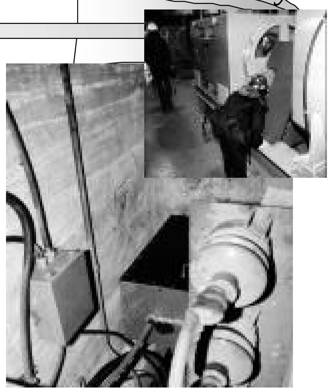
Scrap electrical equipment

Conducting the Inventory

Slide 32

Working with Facility Managers to Conduct the Inventory

- Work with the managers and escorts to locate the equipment
- Note equipment locations on facility map
- Identify equipment locations by what escort calls them



Conducting the Inventory

Slide 33

Inventorying PCB-containing Equipment

- Inspect the equipment
- Inspect equipment service records
- Inspect the condition of the equipment
- Record information on the inventory form
- Check and confirm information with facility escort

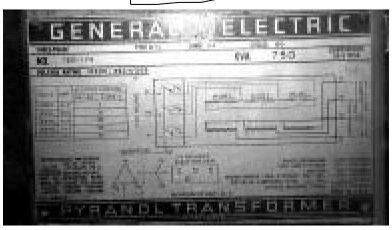
Substation transformer

Conducting the Inventory

Slide 34

Determining if the equipment contains PCBs

- Look for manufacturer's nameplate
- Locate other records or information about the equipment
- Apply assumption rules



Conducting the Inventory>inspecting equipment

Slide 35

Assumption Rules

Situation	*Assumption*
Transformers/Capacitors with no information --	**Assume PCBs**
Transformers with mineral oil dielectric fluid and no other information	**Assume PCB-contaminated**
Switches, voltage regulators, fluorescent light ballasts with no information	**Assume PCB-contaminated**

Conducting the Inventory >inspecting equipment

Slide 36

Inspect Equipment Service Records

- Determine whether the equipment has been retrofilled
  - If yes, ask what they did with the waste fluid?
- If equipment has been retrofilled, ask for service records, tests performed
  - Dielectric fluid tests for PCBs should be done after 3 months of normal operation
  - Determine if PCB concentrations are still below 50 ppm (or specified concentration)

Conducting the Inventory > Inventorying PCB-containing equipment

Slide 37

Inspect the Condition of the Equipment

- Walk all around the equipment
- Look for leaks, spills
  - Oil stains anywhere on "breaks" in tanks
  - Most common point for leaks is at the stopcock
- Look for damage to the equipment

Leaking transformer

Conducting the Inventory > Inventorying PCB-containing equipment

Slide 38

Sampling and Analysis

- Direct sampling of dielectric fluids
  - From equipment
  - From drums, other containers
- Sampling leaks and spills

Collecting a wipe sample

Conducting the Inventory

Slide 39

Direct Sampling of Dielectric Fluids

- Access to dielectric fluids
  - Drain ports
  - Sampling ports
- Sampling procedures

Sampling dielectric fluid

Conducting the Inventory>sampling & analysis

Slide 40

Sampling of Dielectric Fluids: General Rules

- Sample if fluid composition unknown
  - Insufficient information on the markings
  - Equipment has been retrofilled
- Do not sample sealed equipment
- Let facility personnel take the sample
- Follow standard sample storage and preservation procedures (e.g., ASTM D-923)

Conducting the Inventory > Sampling and Analysis

Slide 41

Sampling of Leaks and Spills: General Rules

- Take samples from several points in the spill zone
- Avoid direct contact with the spill material
- Follow sample storage and preservation procedures

Conducting the Inventory > Sampling and Analysis

Slide 42

Testing for PCBs

- Simple screening tests
  - Density
  - Chlorine content
- Laboratory testing for PCBs
  - Gas chromatography with electron capture
  - Compare results against standard chromatograms for known arochlors

Laboratory analysis

Conducting the Inventory >sampling & analysis

Slide 43

PCB Screening Test Kits

- Advantages
  - Time, low cost
  - No false negatives
  - Suitable for oil, soil, water, surface wipes
- Disadvantages
  - May give false positives

PCB screening test kits

Conducting the Inventory > Sampling and Analysis

Slide 44

Completing the Inventory Form

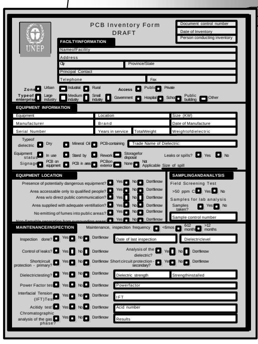
- PCB Inventory Form Contents
- Checking and Confirming Information

Conducting the Inventory

Slide 45

PCB Inventory Form Contents

- Facility information
- Equipment information
- Equipment location
- Sampling and Analysis
- Maintenance/Inspection



Conducting the Inventory > Completing the Inventory Form

Slide 46

Record Information on the Inventory Form (1)

- Header information
  - Date of inventory
  - Name of person conducting the inventory
  - Facility location
  - Address and telephone number
  - Point(s) of contact (Important!)
  - Your inventory reference (control) number

Conducting the Inventory > Completing the Inventory Form

Slide 47

Record Information on the Inventory Form (2)

- PCB equipment and materials inventory table.
  – Identify the location of the equipment
  – Serial number
  – Manufacturer
  – Quantity of PCBs (dielectric fluid)
  – Describe leaks -- location, estimated size

Conducting the Inventory > Completing the Inventory Form

Slide 48

Record Information on the Inventory Form (3)

- Make recommendations to facility owner/operator
  – Existence of leaking equipment
  – Clean up of spills

Conducting the Inventory > Completing the Inventory Form

Slide 49

Checking and Confirming Information

- Share with your escort what you have found and what you are recording on the inventory form.
- Maintain trust and transparency

Conducting the Inventory

Slide 50

Post-inventory Meeting with Facility Managers

- Tell them what you did: areas inspected and inventoried
- Tell them what you found. Share a copy of the inventory form
- Point out problem areas and make recommendations

Conducting the Inventory

Slide 51

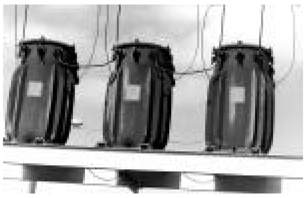
Communicating the Inventory Information

- Where to send the form
- Retaining inventory form copies

Slide 52

Summary

- What has been covered in this session
  - Purpose of the inventory
  - Inventory process steps
    - Planning
    - Conducting the inventory
    - Communicating the inventory information
- Questions?



Pole transformers with PCB marks

PCB Management, Treatment, Disposal Issues
Mr. William A. Wallace

Slide 1

Management of PCB Equipment and Liquids Containing PCBs

United Nations Environment Programme

Workshop on the Management of PCBs and Dioxins/Furans

Yaoundé, Cameroon

17-20 April 2000

Slide 2

Summary

- Classification of PCB Equipment, Liquids
- Management of PCB Equipment
  - Identification
  - Operation
  - Marking, inspection, servicing
  - Retrofilling, PCB substitutes
  - Storage, disposal
- Storage of PCB liquids
- Treatment and disposal options

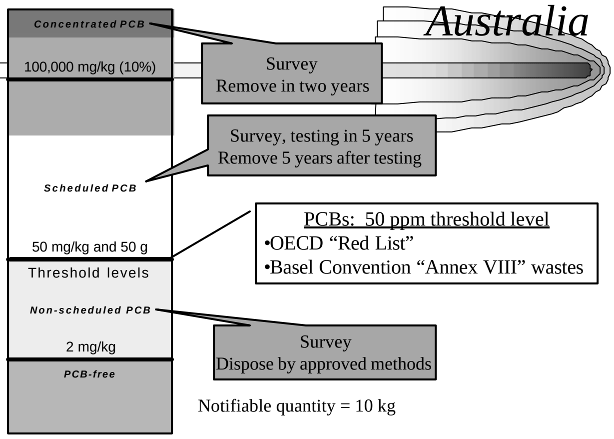
Slide 3

Classification of PCBs

- 50 ppm (mg/kg) is the threshold level for regulation in most countries
- PCB equipment usually contains liquids with high PCB concentrations
  - Greater than 500 ppm
  - Many countries require specific marking, handling, disposal methods

Slide 4

Classification of PCBs in Australia



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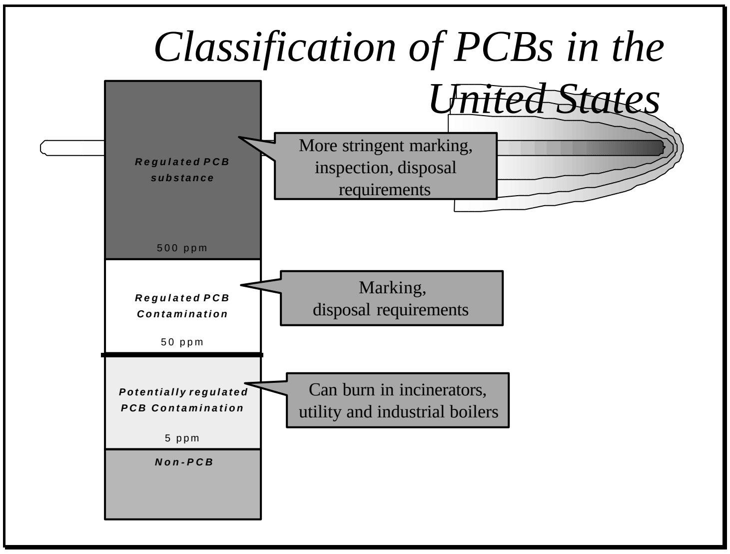

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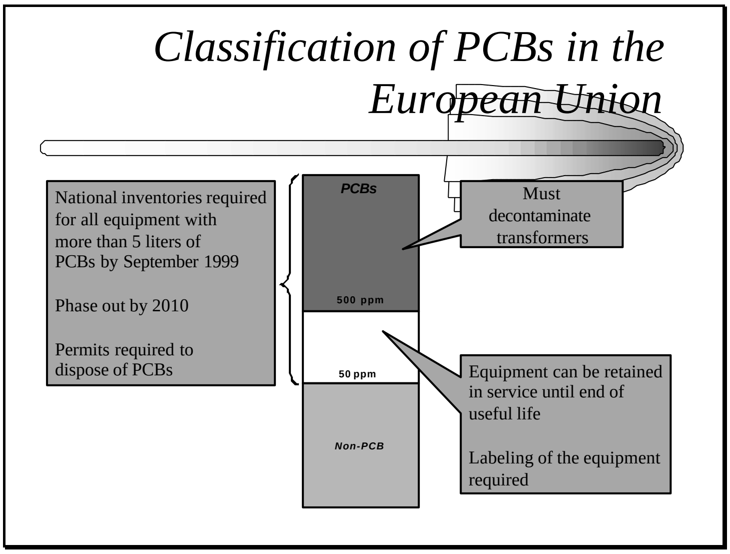


Slide 7

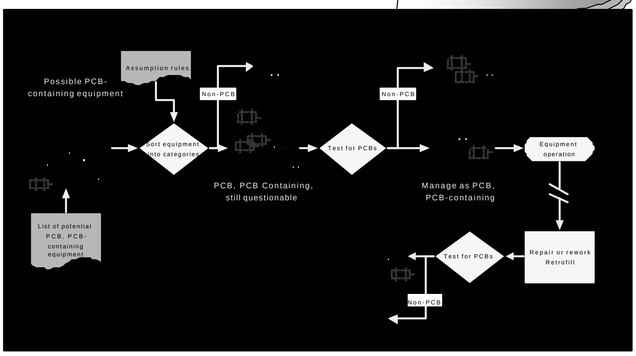
Management of PCB Equipment and Liquids Containing PCBs

- Where are PCBs found
- Determining if the equipment contains PCBs
- Determining the concentration of PCBs
- Operation of PCB equipment
- Disposal of PCB equipment, liquids

PCB Transformer

Slide 8

Management of PCB equipment: Overview



Slide 9

Operation of PCB Equipment

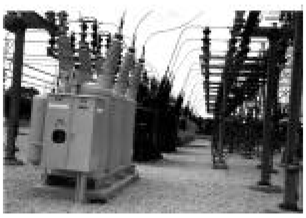
- Types of PCB-containing equipment
- Marking
- Management
  - Inspection
  - Servicing
  - Retrofilling
- Disposal

Transformers out of service

Slide 10

Operation of specific equipment types

- PCB transformers and capacitors
- PCB-contaminated transformers and capacitors
- Oil Switches and voltage regulators
- Electrical light ballasts
- Circuit breakers and reclosers



Transformers in substation

Slide 11

Recommendations for Marking PCB liquid containers, PCB-containing Equipment

- Mark PCB-containing equipment
  - PCB transformers
  - Large PCB capacitors
  - Pole or structure holding large PCB capacitors
  - Equipment containing PCB transformers, capacitors
- Mark drums of PCB oil
- Mark access to PCB equipment

PCB mark (U.S.)

Slide 12

Management of PCB equipment, liquids (1)

- PCB equipment servicing requirements
  - Follow the servicing requirements for transformers
    - Draining and refilling the dielectric
    - Topping off the dielectric
    - Repairing
    - Retrofilling for reclassification
  - Keep equipment intact and not leaking

Draining PCBs from an old transformer

Slide 13

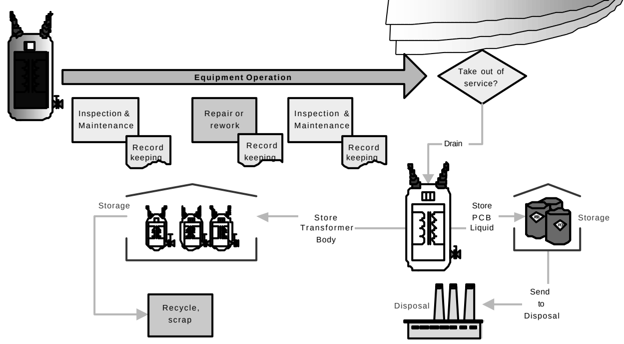
Management of PCB equipment, liquids (2)

- Leaking transformers should be repaired or replaced
- Any PCBs that leak or seep from a PCB contaminated transformers or capacitors should be properly cleaned up and disposed of

Leaking transformer

Slide 14

Inspection and Maintenance: Overview



Slide 15

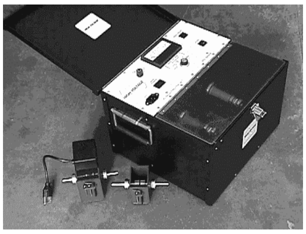
Recommended Inspection Frequencies

Item	Inspection Frequency
PCB Transformers	Quarterly. Annually if PCB concentration is less than 60,000 ppm and/or transformer has secondary containment.
PCB Capacitors	Annually
PCBs and PCB fluids (>50 PPM) in storage for use in servicing equipment	Monthly
PCB and PCB-contaminated switches and voltage regulators	Quarterly. Inspect PCB items (>500 ppm) weekly if near food or feed.
PCB items stored for reuse	Same as if in service
Items in storage for disposal	Every 30 days

Slide 16

Servicing

- Deterioration of insulating oil
- Types of oil tests
- Periodic testing program



Oil dielectric AC test instrument

Slide 17

Deterioration of insulating oil

- Effects of oxygen
  - Formation of acids and sludge
- Effects of moisture
  - Reduces the dielectric performance
- Effect of temperature on moisture
- Oil deterioration
  - Sludge sticks to surfaces through which heat is dissipated
  - May eventually block flow of oil through cooling ducts
  - Reduces cooling efficiency

Slide 18

Types of oil tests

- Dielectric test -- voltage at which the dielectric breaks down
- Acidity test -- acidity of oil
- Power factor test -- indicator of dielectric loss
- Interfacial tension (IFT) test -- Indication of the sludging characteristics

Slide 19

Periodic Testing Program

- Monitor condition of insulating oil by testing
  - Take remedial measures before deterioration
- Testing frequency determined by condition of oil, load conditions
  - Normal conditions: test acidity, IFT, power factor, dielectric once per year
- Idle, oil-filled equipment -- test once per year
- Circuit breakers -- twice per year

Slide 20

Reclassification

- Reducing the concentration of PCBs in the dielectric fluid to reach a new level of classification
- Reduces the risks
- Involves draining and refilling the item with new dielectric fluid
- Needs to be tested after a period of normal operation

Transformer Rework Facility

Slide 21

Residual Liquids Left After Draining

- One month after this 25 KVA transformer was drained, these additional four quarts of residual oil were removed from this transformer.

Slide 22

Retrofilling

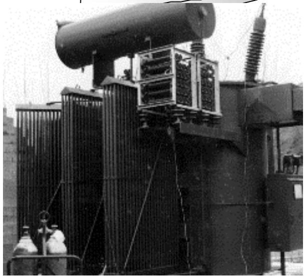
- Perform electrical tests
- Checked for any necessary gasket or bushing replacements
- Flush with new, PCB-free mineral oil dielectric fluid
- Fill with new PCB-free mineral oil dielectric fluid
- Test for residual PCBs

Transformer retrofilling operation

Slide 23

The Decision to Retrofill: Considerations

- Cost
- Equipment usage
- Effectiveness of retrofill process
- Disposal options for PCB liquids
- Liability
- Public perception
- Equipment downtime
- Viability of the replacement fluid



Transformer retrofilling operation

Slide 24

Availability of PCB Substitutes

- PCBs are being replaced by fluids with comparable properties
  - Similar dielectric properties
  - Stability
  - Fire safety
  - Less toxic, persistent
- Two categories: fire resistant, non-flammable

Slide 25

PCB Substitutes

Name	Comments
Less Flammable	
Mineral oils, silicones	Widely used in transformers. Silicone compatible with trace PCBs, mineral oil.
Non-Flammable	
Perchloroethylene (PCE)	Common PCB substitute. Still has many of the properties that caused PCBs to be banned.
Trichlorobenzene (TCB)	Slightly less popular than PCE. Can create dioxins under arcing conditions.
Tetrachloroethylene	Wecosol (trade name). Used for over 50 years. Stable under arcing conditions.

Slide 26

Storage of PCBs

- Storage recommendations
- Design of storage areas
- Storage of leaking articles

PCB storage facility

Slide 27

PCB Storage Recommendations

- Store PCB articles and equipment if:
  - Not leaking
  - In original containers
- Store leaking PCB articles and equipment if:
  - Placed in proper non-leaking PCB containers
  - Place enough absorbent material to absorb the liquids that remain

Temporary PCB storage

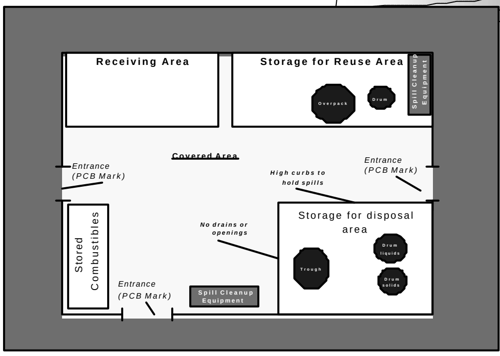
Slide 28

Storage Areas -- Design Considerations

- Covered to prevent rainwater from reaching stored PCBs and PCB items
- Floors with continuous curbing
- No drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from the curbed area
- Not located in the 100-year flood plain

Slide 29

Storage Area: Design Considerations

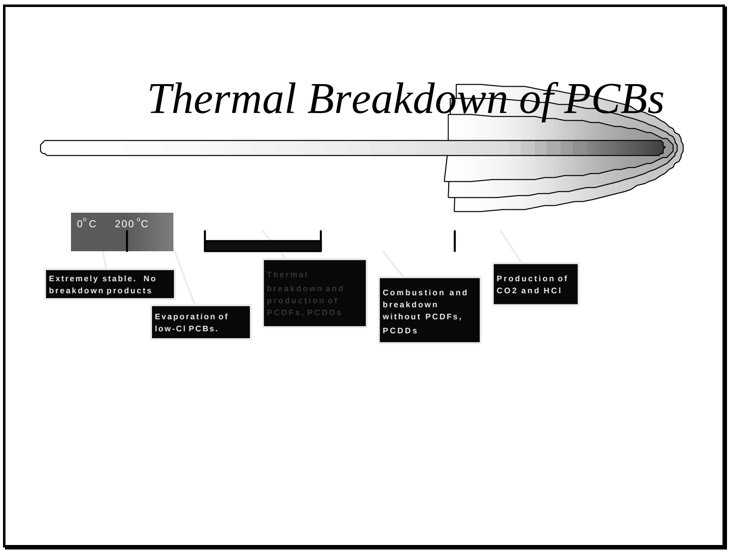


Slide 30

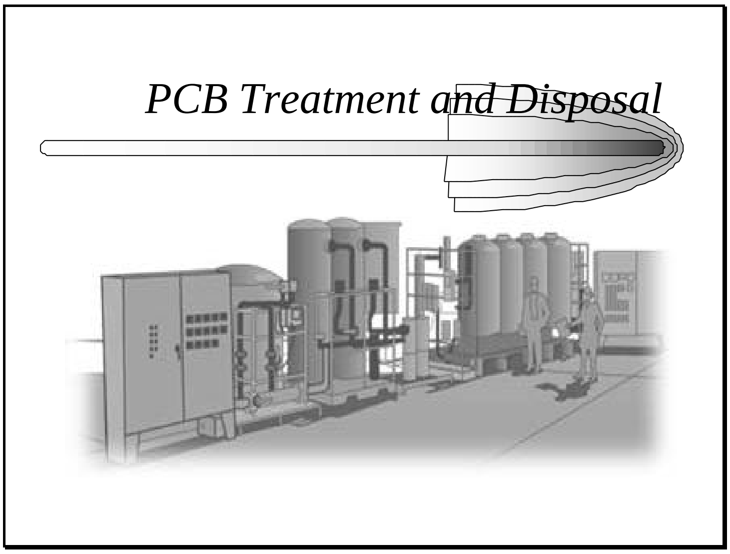
PCB Spills, Leaks and Fires

- Can contaminate surface waters, drinking water supplies, grazing lands, vegetable gardens
- Fires can release PCBs, plus dangerous decomposition products
  - polychlorodibenzofurans (PCDFs)
  - Polychlorodibenzodioxins (PCDDs)

Slide 31



Slide 32



Slide 33

Treatment and Disposal Options

- Thermal treatment
  - High temperature incineration
  - High temperature industrial boilers
  - Cement kilns
- Landfill disposal
- Chemical dechlorination

Cement kiln

Slide 34

Landfill Disposal

- For non-liquid PCBs, contaminated soils, spill cleanup debris, transformer carcasses
- Liquid PCBs in landfills are discouraged
  - Landfills leak

Landfill

Slide 35

Landfill Design Considerations

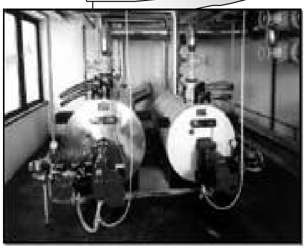
- Site on impermeable soils or use impermeable liners
- Install groundwater monitoring wells
- Protect from floods
- Waste pretreatment

Landfill liner installation

Slide 36

Incineration/Thermal Treatment

- Most appropriate for PCB liquids
- Also use for capacitors, ballasts, soil and debris
- Can use PCB-contaminated oil as fuel in industrial boilers



Industrial Boiler

Slide 37

Thermal Treatment Design Considerations

- High destruction and removal efficiency
  - 99.9999%
- Temperature, residence time
  - 1600° C, 1.5 seconds (2% excess oxygen)
  - 1200° C, 2.0 seconds (3% excess oxygen)
- Automatic feed shutoff
- Flue gas monitoring
- Scrubbers

Incinerator for highly chlorinated hydrocarbons

Slide 38

Chemical Dechlorination

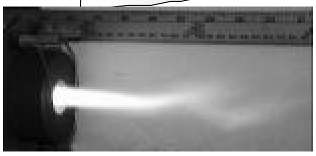
- Mobil treatment of PCB-contaminated transformer oils
- Uses sodium- or potassium-based reagents
- Can reduce PCB concentrations to less than 2 mg/kg

PCB dechlorination process

Slide 39

Plasma Arc Treatment

- Organic compounds are decomposed by intense heat
  - 5000 to 15000^{o} C.
- Thermal plasma field created by directing an electric current through a low pressure gas stream



Slide 40

Thermal Desorption

- Physically separates volatile, semivolatile contaminants with low boiling points from soil
- Some higher temperature units can treat PCBs

OnSite Technology’s Indirect Thermal Desorption Process

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Summary

- Classification of PCB Equipment, Liquids
- Management of PCB Equipment
  - Identification
  - Operation
  - Marking, inspection, servicing
  - Retrofilling, PCB substitutes
  - Storage, disposal
- Storage of PCB liquids
- Treatment and disposal options

National and Regional Dioxin Inventories
Ms. Heidi Fiedler

Slide 1

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National and Regional Dioxin Inventories

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Background - Mandate

- **Decision 19/13 C of February 7, 1997:**
- **Develop a legally binding instrument for implementing international action on 12 POPs**
- **Establish an expert group for the development of science-based criteria and a procedure for identifying additional POPs**
- **UNEP to assist countries to develop national inventories**

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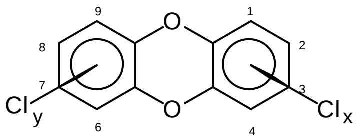
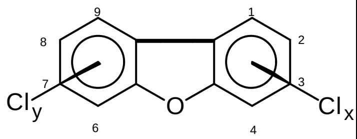
PCDD and PCDF





Polychlorinated dibenzo-*p*-dioxins PCDD	Polychlorinated Dibenzofurans PCDF

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Toxicity Equivalency Factors - TEFs

Congener	I-TEF	WHO-TEF	Congener	I-TEF	WHO-TEF
2,3,7,8-Cl_4DD	1	1	2,3,7,8-Cl_4DF	0.1	0.1
1,2,3,7,8-Cl_5DD	0.5	1	1,2,3,7,8-Cl_5DF	0.05	0.05
			2,3,4,7,8-Cl_5DF	0.5	0.5
1,2,3,4,7,8-Cl_6DD	0.1	0.1	1,2,3,4,7,8-Cl_6DF	0.1	0.1
1,2,3,7,8,9-Cl_6DD	0.1	0.1	1,2,3,7,8,9-Cl_6DF	0.1	0.1
1,2,3,6,7,8-Cl_6DD	0.1	0.1	1,2,3,6,7,8-Cl_6DF	0.1	0.1
			2,3,4,6,7,8-Cl_6DF	0.1	0.1
1,2,3,4,6,7,8-Cl_7DD	0.01	0.01	1,2,3,4,6,7,8-Cl_7DF	0.01	0.01
			1,2,3,4,7,8,9-Cl_7DF	0.01	0.01
Cl_8DD	0.001	0.0001	Cl_8DF	0.001	0.0001

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Sources of PCDD/PCDF

- PCDD/PCDF have never been produced intentionally
- Unwanted byproducts of chemical industrial and combustion processes in trace amounts
- In the past and in industrialized countries, chemical industry was the major source of PCDD/PCDF releases into the environment (PCP, 2,4,5-T, PCB, graphite anodes, wastes, ...)
- Today's major (quantified) releases are combustion processes

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Dioxin Inventories

- Compilation of dioxin inventories from: scientific published literature, government reports WebPages, personal communications, questionnaires
- Only primary sources considered
- Dioxin fluxes given per year
- Dioxin emissions normalized to TEQ (Toxic equivalents)

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Methods to Establish Dioxin Inventories

- **Calculation of annual emission:**

Emission of Source = Emission Factor x Activity Rate

or

Emission of Source = Concentration x Operational hrs.

- **Representative measurements ? ® Nation-wide ?**
- **Total amount of feed processed ?**
- **Releases to air, water, land or with products**

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Major Source Categories

- Iron and Steel: Foundries, sinter and coke plant
- Non-ferrous Metals: Copper, aluminum, zinc, lead
- Waste Incineration: Municipal, hazardous, hospital, sewage sludge, crematoria
- Industrial Combustion Plants: Coal, gas, oil, sludge
- Small Combustion: Domestic stoves - coal, oil, gas, wood
- Road Transport: Leaded and unleaded gasoline, Diesel
- Power Plants: Coal, gas, oil, wood
- Mineral Products: Cement, lime, brick, ceramics, glass
- Others: Car shredders, asphalt, chemical industry, fires

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Germany - 1995	g TEQ/a
Asphalt mixing installations	0.03
Coal combustion	14.2
Fuel combustion	1.59
Ironworks (primary iron production)	0.79
Landfill gas incineration	0.3
Non-Fe metal industry oil combustion	91.6
Pesticides	0.87
Sintering processes	168
Sludge incineration	<0.1
Steel industry	4.9
Traffic emissions	3.1
Transportation	1.6
Hazardous waste incineration	2
Municipal waste incineration	30
Medical waste incineration	0.1
Wood combustion	2.7
Others	2.3
Total	324

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Results I

- **15 national PCDD/PCDF inventories available**
  (2 in draft stage - USA, Sweden)
  Inventory for 'Member States' European Union (17)
  Inventory for UN-ECE countries (38)
- **Based on national measured data *vs*. pure paper exercises (Hungary, Australia)**
- **Few reports on emissions to water, land**
- **Emissions to air in 1995: 10 500 g I-TEQ/a (range: 8 300-36 000 g I-TEQ/a)**

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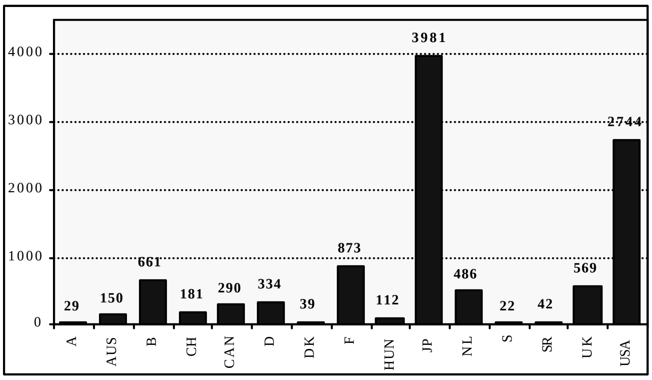
Emissions to Air 1995 (g I-TEQ/a)



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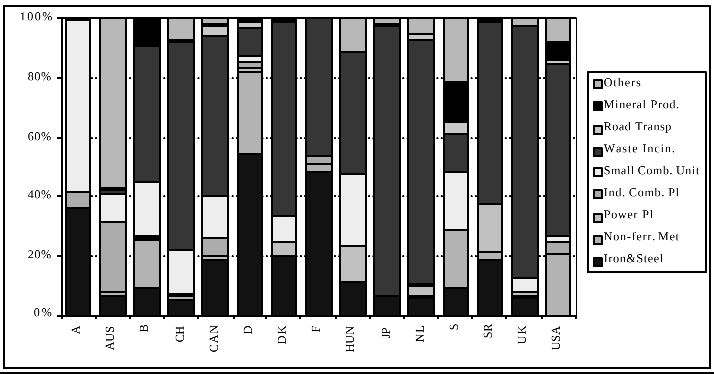
National Emissions per Sector



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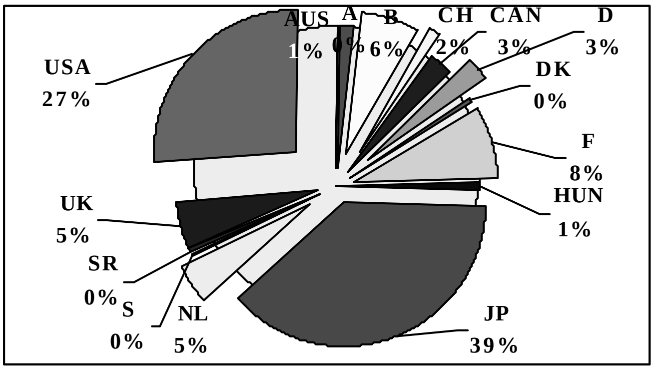
Country-% of Global Inventory



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Conclusions I

- **No harmonized methods to establish inventories**
- **Most inventories cover emissions to air**
- **Less information for land, water, products**
- **Most information from Northern hemisphere**
- **Not quantified sources in developing countries**
- **Best coverage for waste incineration**
  Changes in technology ® Downward trends in industrialized countries
- **Role of reservoirs ?**

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Conclusions II

- **1995 - total emissions to air (15 countries):**
  10 500 g I-TEQ/a (8 300-36 000 g I-TEQ/a)
- **Waste incineration = major source in**
  JP, USA, CAN, NL, DK, UK, F, B, CH
  No importance in S, D, A (AUS)
- **Iron and Steel sector dominating in A, S, D, F**
- **Road transport: No importance**
- **Highly uncertain: Domestic heating, open fires**

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UNEP Chemicals Questionnaire - Responses on PCDD/PCDF

- 68 Returned, 43 address dioxins/furans
- Conform with literature data; additional information:

Croatia (not measured)	**95.5 g TEQ/a**
Finland	**98-198 g TEQ/a**
Norway	**9.2 g TEQ/a**
Republic of Korea: 11 MSWIs	**11 g TEQ/a** to air
(Chang et al. 1998)	127 g TEQ in fly ash

China: very high in fly ash (47 000 ng/kg)
Vietnam: from Vietnam war: ≈170 kg used

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All Published Inventories (g I-TEQ/a)

UNEP	10,514 (28,615)	**15 Countries (1995)**
UNEP +	214 (314)	**4 Countries**
Korea	10.8	**MSWI only**
EU Inventory	5,750 (1,300-20,000)	**17 Countries (1993-1995)**
TNO Inventory	11,300	**38 Countries (1990)**
Brzuzy and Hites	50,000	**Global**

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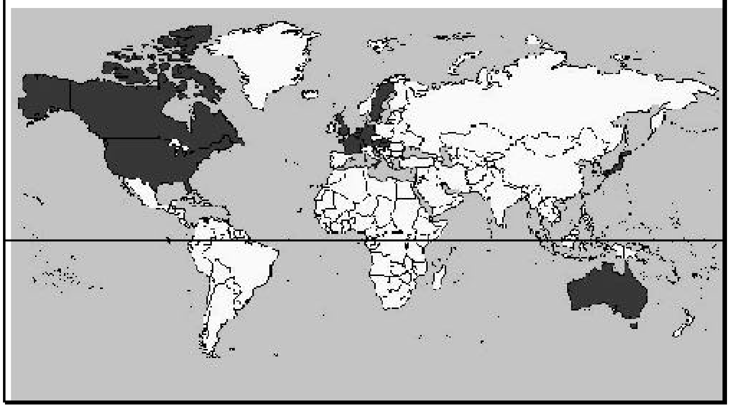
Countries with Dioxin Inventories



The Dioxin Toolkit
Ms. Heidi Fiedler, UNEP Chemicals

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Standardized Toolkit to Establish Dioxin Inventories

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POPs Convention - Byproducts - D3 (draft text)

3. Each Party shall at a minimum [, consistent with its capacity and subject to the availability of technical and financial assistance] [aim to] take the following measures to reduce the [total] releases derived from anthropogenic sources of the persistent organic pollutants that are listed in Annex C, with the [aim] [goal] of their continuing minimization [and [where [technically and economically] feasible] ultimate elimination]:

[Annex C: coplanar and mono-ortho substituted PCB]

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Main Source Categories

- **1 – Waste Incineration**
- **2 – Ferrous and Non-Ferrous Metal Production**
- **3 – Power Generation and Heating**
- **4 – Mineral Products**
- **5 – Transportation**
- **6 – Uncontrolled Combustion Processes**
- **7 – Chemicals and Consumer Goods**
- **8 – Miscellaneous**
- **9 – Disposal / Landfills**
- **10 – Hot Spots**

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5-Step Approach

1 Apply Screening Matrix to identify Main Source Categories

2 Check subcategories to identify existing sources

3 Apply Standard Questionnaire to obtain information on sources to choose the characteristic parameters for emission factors

4 (Semi-)Quantify identified sources with default/ measured emission factors

5 Apply nation-wide to establish full inventory

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National Activities

- Place dioxin inventory on political agenda
- Nominate chairman and create working group comprising all interested parties
- Conduct a national workshop on dioxins / furans
- Compile source information centrally available
- Send out questionnaires to plant owners, agriculture/forestry, industry associations, *etc.*
- Evaluate questionnaires and start inventory

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Screening Matrix

No.	Categories and Subcategories	Air	Water	Soil	Product	Residue
1	Waste Incineration	X				X
2	Ferrous and Non-Ferrous Metal Production	X				X
3	Power Generation and Heating	X		X		X
4	Production of Mineral Products	X				X
5	Transport	X				
6	Uncontrolled Combustion Processes	X	X	X		X
7	Production of Chemicals and Consumer Goods	X	X		X	X
8	Miscellaneous	X	X	X	X	X
9	Disposal	X	X	X		X
10	Identification of Potential Hot-Spots	Supposedly registration only to be followed by site-specific evaluation				

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Category 1

No.	Categories and Subcategories	Air	Water	Soil	Product	Residue
1	**Waste Incineration**	X				X
	a Municipal solid waste	x	x			x
	b Hazardous waste	x	x			x
	c Medical waste	x	x			x
	d Light weight aggregate (e.g. from shredder)	x				x
	e Sewage sludge incineration	x	x			x
	f Waste wood combustion	x				x
	g Animal carcasses incineration?	x				x

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Category 2

No.	Categories and Subcategories	Air	Water	Soil	Product	Residue
2	**Ferrous and Non-Ferrous Metal Production**	X				X
	a Iron ore sintering	x				x
	b Coke production (using lignite or brown coal)	x	x	X	x	x
	c Steel production (prim., sec.)	x				x
	d Copper production (prim, sec.)	x				x
	e Aluminum production (prim., sec.)	x				x
	f Lead production (prim., sec.)	x				x
	g Zinc production (prim., sec.)	x				x
	h Brass production (prim., sec.)	x				x
	i Magnesium production		x			x
	j Shredder (*e.g.* automobile)	x				x
	k Wire reclamation by combustion	x	(x)	X		x

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Category 3

No.		Categories and Subcategories	Air	Water	Soil	Product	Residue
3		**Power Generation and Heating**	**X**		**X**		**X**
	a	Fossil fuel power plants (coal, oil, gas and co-combustion of waste)	x				x
	b	Biomass power plants (wood, straw, other biomass)	x				x
	c	Landfill, biogas combustion	x				x
	d	Household heating and cooking (biomass)	x		x		x
	e	Domestic heating (coal, wood, oil, gas)	x		x		x
	f	Production of heat/energy in industry	x				x

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Category 4

No.		Categories and Subcategories	Air	Water	Soil	Product	Residue
4		**Production of Mineral Products**	**X**				**X**
	a	Cement kilns (waste/not waste at next level)	x				x
	b	Lime (waste/not waste at next level)	x				x
	c	Brick	x				x
	d	Glass	x				x
	e	Ceramics	x				x
	f	Asphalt mixing	x			x	x
	g	Light weight aggregate kilns	x			x	x

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Category 5

No.	Categories and Subcategories	Air	Water	Soil	Product	Residue
5	**Transport**	**X**				
	a 4-stroke engines (*e.g.* automobiles)	x				
	b 2-stroke engines (*e.g.* mopeds, tuk-tuks, *etc.*)	x				
	c Diesel engines (*e.g.* trucks, busses, machinery, *etc.*)	x				x
	d Heavy oil fired engines (*e.g.* ships, tanks, *etc.*)	x				x

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Category 6

No.	Categories and Subcategories	Air	Water	Soil	Product	Residue
6	**Uncontrolled Combustion Processes**	**X**	**X**	**X**		**X**
	a Fires/burnings - biomass (forests, grassland, fields, farming residues, *etc.*)	x	(x)	(x)		x
	b Fires - waste burning, landfill fires, industrial and other accidents	x	(x)	(x)		x

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Category 7

No.	Categories and Subcategories	Air	Water	Soil	Product	Residue
7	**Production of Chemicals and Consumer Goods**	X	X		X	X
	a Pulp mills	x	x		x	x
	b Paper mills (prim., recycling)	x	x		x	x
	c Chemical industry (chlorophenols, halogenated organics, Cl_2 production, oxy-chlorination processes)	x	x	(x)	x	x
	d Petroleum industry (refineries)	x				x
	e Textile plants (manufacture, finishing)		x		x	
	f Leather plants (finishing)		x		x	

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Category 8

No.	Categories and Subcategories	Air	Water	Soil	Product	Residue
8	**Miscellaneous**	X	X	X	X	X
	a Drying of biomass (green fodder, wood chips)	x				
	b Drying of feed materials (scrap steel) or to steel plant	x				
	d Crematories	x				x
	e Smoke Houses	x			x	x
	f Use of selected pesticides		x	x	x	
	g Use of PCP		x	x	x	
	h Dry cleaning residues		x			x
	i Tobacco smoking					

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Category 9

No.		Categories and Subcategories	Air	Water	Soil	Product	Residue
9		**Disposal**	**X**	**X**	**X**		**X**
	a	Landfill leachate		x			
	b	Sewage/ sewage treatment	x	x	X		x
	c	Open water dumping (*e.g.* into rivers, lakes, oceans)		x			
	d	Waste oil disposal (not combustion)		x	X		

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Category 10

No.		Categories and Subcategories	Air	Water	Soil	Product	Residue
10		**Identification of Potential Hot-Spots**	Supposedly registration only to be followed by site-specific evaluation				
	a	Production sites of chlorinated organics			x		
	b	Production sites of chlorine			x		
	c	Formulation sites of chlorinated phenols (pesticides)			x		
	d	Application sites of chlorinated phenols (pesticides, indoor wood treatments)	x	x	x	x	
	e	Timber manufacture and treatment sites		x	x	x	x
	f	PCB-filled transformers				x	x
	g	Dumps of wastes/residues from categories 1 - 9	x	x	x		x
	h	Sites of relevant accidents		x	x		x
	i	Dredging of sediments					x

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Example Emission Factors

Sec-tor	Sub-cat.	Sub-group	Source Categories	Air	Water	Soil	Product	Residue
7			**Production of Chemicals. Consumer Goods**					
	a		**Pulp mills**			per ton of pulp		
		1	Kraft, free chlorine bleach	0.005	4.5		9	5
		2	Kraft, modified free chlorine	0.005				
		3	ECF, TCF	0.005	0.06		0.1	0.2
		4	Sulfite	0.005			0.5	
		5	TMP				1	
	b		**Paper mills**			per ton of paper		
		1	Free chlorine bleach: cosmetic tissue, shopping bags				5	
		2	Free chlorine bleach: filter papers, newspaper				2	
		3	Sulfite papers				1	
		4	Unbleached papers				2	
		5	Recycling papers				10	

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Results Table

	Activity	Air		Residue	
	t/a	Em. Fact.	Ann. Em.	Em. Fact.	Ann. Em.
		µg TEQ/t	g TEQ/a	µg TEQ/t	g-TEQ/a
Steel					
No	**50000**	**20**	**1.00**	**3**	**0.15**
EAF	**300000**	**1**	**0.30**	**1**	**0.30**

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Output (I)

- Inventories for dioxin and furan releases to/with:
  * Air
  * Water (including sediments as sinks)
  * Land
  * Waste (including sewage sludge)
  * Products

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Output (II)

Inventories based on application of

- Screening matrix: Yes / No decision (existing / not existing) → to identify relevant sectors
- Default emission factors - no questionnaire: → Applying lowest and highest number will give expected range
- Default emission factors - with questionnaire → Detailed inventory
- Own measured data → Detailed inventory

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Output (III) - Evaluation

National inventories (full reports or at any stage) to be sent back to UNEP for:

- Completion of the inventory (assistance required)
- UNEP will compile all information and publish its "global" dioxin inventory
- Follow-up: confirmatory measurements, study of new / badly characterized sources, case studies (depending on funding)

Reduction of Releases of Dioxins and Furans
Ms. Heidi Fiedler, UNEP Chemicals

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Techniques to Reduce Emissions of Dioxins and Furans

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Dioxin/Furan “Life-cycle”

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Main Release Routes

From the Toolkit

- **Main Categories 1-6, 8 are combustion related**
  Major releases Þ Air and Residues
- **Main Category 7 is manufacture/production related**
  Major releases Þ Product and Water
- **Main Categories 9 and 10 are disposal related**
  Major releases Þ Soil and Residue

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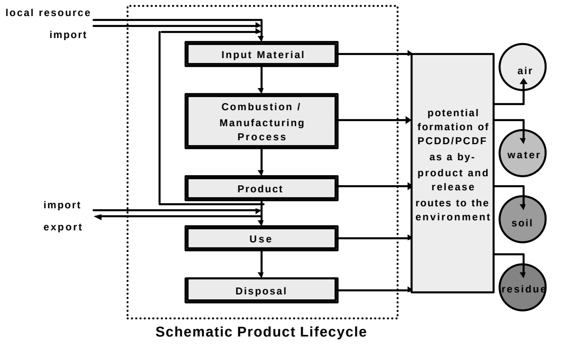
PCDD/PCDF Release Routes



Determination of Potential PCDD/PCDF Release Routes

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"Complete" Source Elimination

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Source Elimination

- Indirect measure
- Ban of chemicals known to be contaminated with PCDD/PCDF:
  Some countries have phased out:
  - 2,4,5-trichlorophenoxy acetic acid (2,4,5-T)
  - polychlorinated biphenyls (PCB)
  - pentachlorophenol (PCP)

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Water

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Contaminated Aqueous Effluents

- **Gravity: settling ponds, addition of clarifiers**
- **Filtration:**
  PCDD/PCDF are bound to particles
  - sand or gravel filters, membrane filters
  - adsorption to active carbon, charcoal, zeolites, ..
  - dispose of solid materials
  Þ contamination stays, moved to another matrix
- **UV-light irradiation (if no particles, turbidity)**
  Þ oxidative breakdown of PCDD/PCDF
  formation of toxic byproducts possible

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Effluents/Products: Primary Measures

- Process modification, *e.g.*
  - change input materials: untreated wood, coal with low VOC content, degreased metals
  - change synthesis pathway (chloranil from hydroquinone)
  - avoid UV light, radicals, alkaline extraction steps
  - avoid high temperatures (> 130 °C)
  - exchange catalysts ($AlCl_3$, $FeCl_3$ not from scrap)
  - establish closed circles (effluent-free)

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Pulp Mills: Substitution of Free Chlorine

- Chlorine bleach used for delignification of fibers
- Bleaching agents:
  - Cl_2 free/elemental chlorine (old process)
  - ClO_2 chlorine dioxide (ECF: elemental Cl-free)
  - O_3, ethanol total chlorine free = TCF
- Chlorine bleach → high PCDD/PCDF concentrat.; chlorine pattern = 2,3,7,8-Cl_4DF, 2,3,7,8-Cl_4DD and 1,2,7,8-Cl_4DF
- Modern technologies: low in PCDD/PCDF, different pattern (Cl_4DD, Cl_4DF not dominating)

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Chemical Industry

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Chemical Processes

- If chlorine is present, avoid:
  - High process temperatures (>130 °C)
  - Alkaline extraction steps (purification)
  - Presence of radicals
  - Presence of UV light
- Potential for PCDD/PCDF contamination:
  Chlorophenols and derivatives (PCP, PCB, 2,4,5-T)
  Chlorobenzenes
- Manufacture of chlorine with graphite electrodes

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Process Modifications

- Manufacture of dioxazine dyes
- Old process:
  Hoechst process: chlorination of phenol
  → hundreds of µg TEQ/kg contamination
- New process:
  Chlorination of hydroquinone → 7 g TEQ/kg
- Germany: drop of annual release from
  100 g TEQ/a to 4 g TEQ/a

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Soil and Sediment

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Soil and Sediment

- Prevent erosion (cover), movement w. water stream
- Size of the problem:
  Identify how much is contaminated (area, depth)
- Excavation of soil/sediment
  - Thermal desorption and combustion of off-gases
  - Thermal treatment of soil/sediment (combustion, pyrolysis = in the absence of oxygen)
- Bioremediation (see next slide)
- Immobilization, encapsulation

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Limitations to Biodegradation

- **Low water solubility of PCDD/PCD**
- **Low mobility in soils and sediments**
- **High adsorption coefficients to organic matter (particles or organisms)**
- **Halogen, nitro and sulfonate substituents inhibit biodegradation (general rule)**

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Bioremediation

- Extracellular enzymes excreted by *e.g.* white rot fungi (*Phanerochaete chrysosporium*) are capable to degrade lignin and chlorinated aromatic substances
- However, the same enzymes also dimerize *e.g.* chlorophenols to chlorinated dibenzo-*p*-dioxins
  = Natural formation of PCDD/PCDF; *e.g.* in compost, forest soils, *etc.*
  (turnover in ppm-range)
- No record for successful field applications
- Not suitable for bioremediation (R&D stopped)

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Air and Thermal Processes

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Pro´s and Con´s in Thermal Processes

- **Requirements for dioxin/furan formation:**
  Presence of: Carbon, Chlorine, Oxygen
- **Favorable for dioxin/furan formation:**
  Presence of catalysts: **copper** ; iron, aluminum
- **Prevention of dioxin/furan formation:**
  - 3 Ts (temperature, time, turbulence)
  - rapid quench of flue gas temperature (<200 °C)
  - Sulfur >= chlorine
  - Continuous operation >> batch-wise /semi-contin.
  - No deposits (soot)

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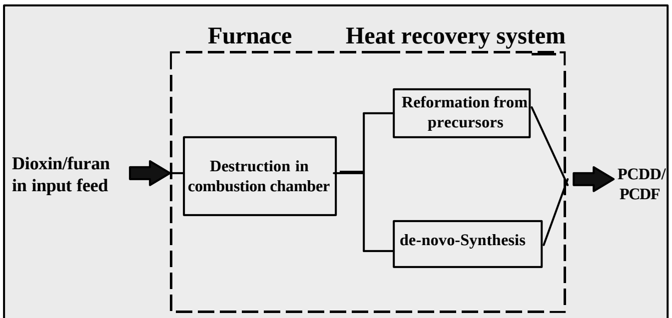
Thermal Formation



Typical thermal production/combustion process

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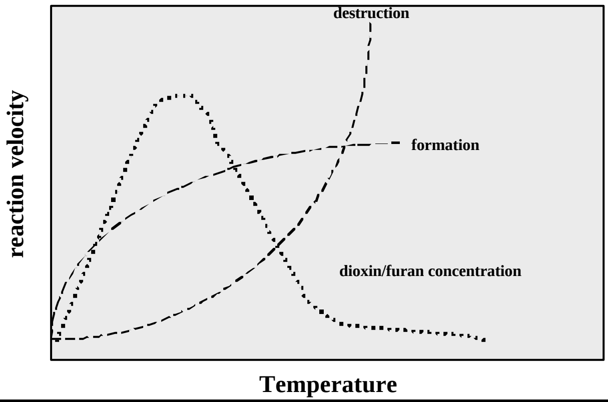
Dualistic Principle of PCDD/PCDF Formation/Destruction



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Formation in Thermal Processes

- PCDD/PCDF formation in gas-phase homogeneous, fast reactions
- PCDD/PCDF formation on particles heterogeneous phase, slow reactions
- Atmosphere: air/oxygen
  pyrolytic (without oxygen)
- Re-Formation of PCDD/PCDF takes place at temperatures 200-450 °C

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Combustion Related Issues

- **Uncontrolled burning** (*e.g.* accidents, open burn.) Material selection, practices, legislation
- **Controlled burning** (*e.g.* 3 T's)
  - * **Small scale** (*e.g.* domestic heating, cars, etc.)
  - * **Large scale** (*e.g.* waste, steel, non-ferrous metal)
    - **® possibilities for intervention**
    - **a) feed materials**
    - **b) operational conditions** (formation mechanism ?)
    - **c) tertiary measures** (APCS, decontamination of residues = slags, ashes)

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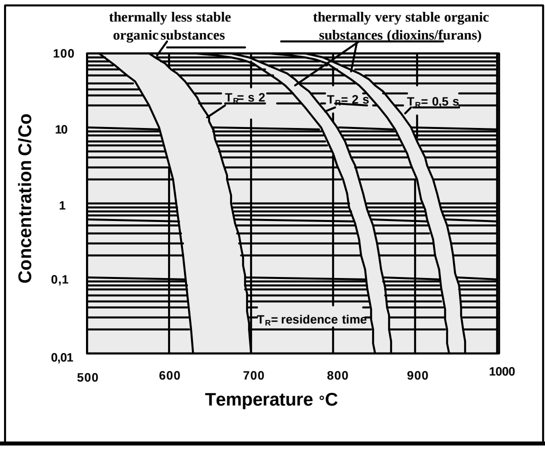
Thermal Destruction in Air



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Automobiles

- Use of leaded gasoline produces highest dioxin/furan emissions
- Lead-free fuels give lower dioxin/furan emissions
- Diesel can produce dioxin/furan emissions (similar to lead-free gasoline)
- Lowest emissions from unleaded gas and catalytic converter

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Reduction Technologies (large plants)

- Principle of BAT: Best available techniques
Best available technologies
- Generally:
BAT identified for new plants can be applied to existing plants (adequate transition periods allowed)
- Choice of measures for any particular case will depend on: economic circumstances, technological infrastructure and capacity, any existing air pollution control measures

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Waste Incineration: Rules of Thumb

- **Turbulence**
  Engineering: ¬ furnace geometry, air, *etc.*
- **Temperature**
  >850 °C, any organic compound will be destroyed (in air)
- **Time**
  Residence time for off-gases: > 2 s @ 850 °C
- **Primary measures such a elimination of chlorine in waste or waste segregation are not successful**

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Air Pollution Abatement Systems

• **Dry removal of particulate matter**	**- cyclone separators** **- electrostatic precipitators (ESP)** **- baghouses / fabric filters**
• **Wet removal of particulate matter and gases**	**- co-current spray scrubbers** **- counter-current spray scrubbers** **- packed bed scrubbers** **- wet ESP (aerosols only)**
• **Gas adsorption/aerosol removal**	**- entrained flow reactors** **- activated char reactors (ACR)**
• **Catalytic destruction/oxidation**	**- selective catalytic reaction SCR)**

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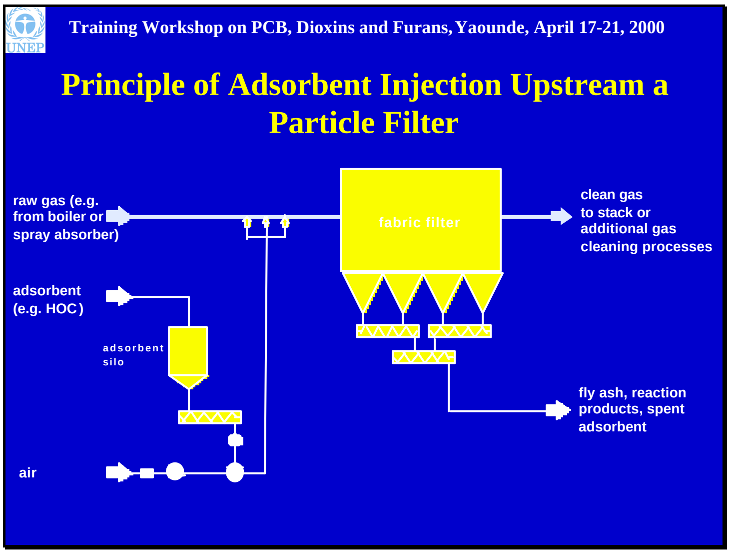

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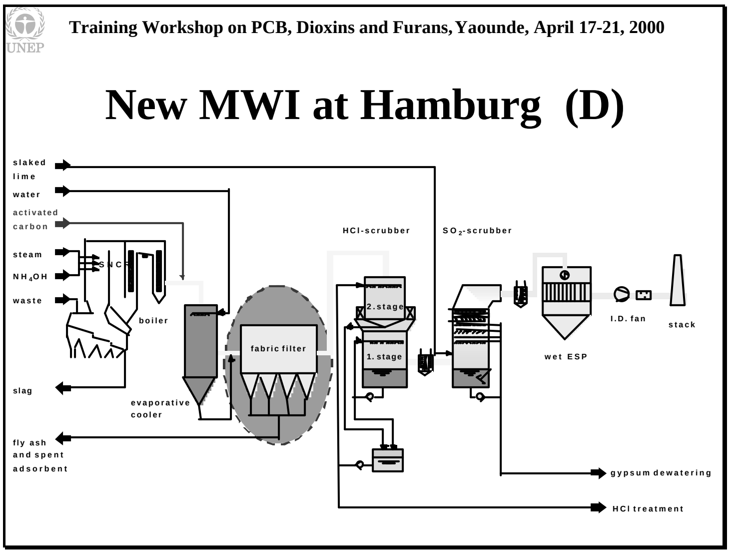

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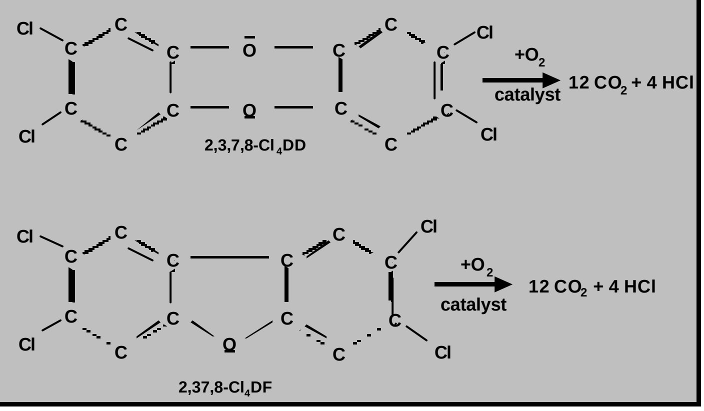
Principle of Catalytic Destruction



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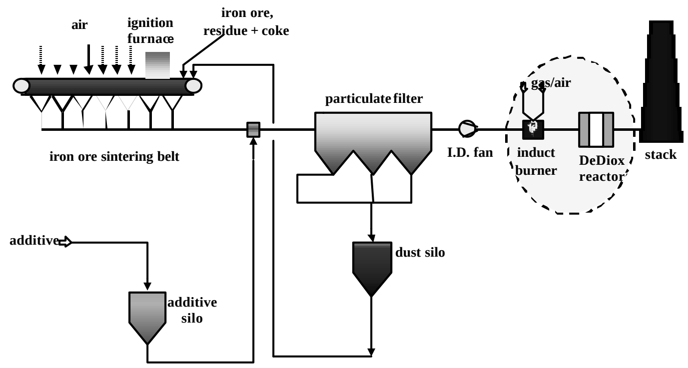

Iron Ore Sintering Plant Process Flow Scheme

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Parameters Critical for Formation

- **Precursors *vs. de novo* synthesis**
  (chlorophenols *vs.* organic C or C_2 compounds)
  *** Which is dominating?**
  *** Under what conditions? (gas phase, hetero-geneous phase, O_2-rich, O_2-deficient, …)**
  *** Toxification of catalyst (*e.g.* Deacon reaction)**
  *** Role of input, *esp.* chlorine**
  *** Residence time, temperature, turbulence, ….**

PCB Management in Australia

Professor Ian D. Rae, University of Melbourne
Consultant to UNEP Chemicals

Contents

1. Prelude

The PCBs were never manufactured in Australia, but 30,000 tonne (approximately) was imported up to 1975. Thereafter, PCBs were removed from much of Australia's large electrical equipment and replaced with mineral (paraffin) oil. Much of this PCB was exported for incineration, but no account was made of the quantities. Some equipment, at the end of its useful life, went to landfills. Surveys in the 1990s have located approximately 10,000 tonne of PCB in equipment which is in use or in secure storage, and a PCB Management Plan has been developed to assist in the safe handling and eventual destruction of the PCBs. A copy of this Management Plan was made available to each national delegation at the Yaounde workshop.

At first, government officials and expert consultants drew up a plan to build a High Temperature Incinerator (HTI) to destroy PCBs and other hazardous wastes, as is commonly dome in Europe and North America. There was significant opposition to this proposal from members of Australia's environment movement and from resident sin areas where such a facility might have been located, and so the HTI proposal was abandoned. The contentious nature of the debate surrounding the HTI proposal served to sensitise political leaders and the broader public to the dangers posed by PCBs and other organochlorines.

For readers to understand what comes next, I need to explain that international matters such as import and export of hazardous materials are controlled by Australia's national government, but the legislation and day-to-day regulation are in the hands of the six states (and two territories). Many state powers were retained by the Australian colonies when they federated in 1901, and despite some transfers of powers to the national government most environmental legislation is still the prerogative of the states.

2. National Action

In the early 1990s, the national government agreed to ban the export of PCBs, in accordance with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, which was under development at that time. This stance of national isolation forced the development in Australia of alternative technologies, since the national council of environment ministers (ANZECC) agreed not to support the building of a HTI. The ministers also began the process of getting a PCB Management Plan, by appointing a national working group under my independent chairmanship. The group included representatives of governments (national, state and local governments), industries, environment groups, and trade unions.

The national working group prepared background reports on the properties and uses of PCBs, Australia's likely holdings, possible destruction technologies, and early drafts of a management plan. These were distributed to 3000 people who had asked to be on the mailing list, and many of these people were able to attend public consultation meetings which were held in state capital cities. Although the attendees were only a small proportion of Australia's 18 million population, they included significant opinion-makers in the community.

An inventory of PCB holdings was prepared by the electricity industry, which provided information about quantities of neat PCB and about solutions (in mineral oil) of various concentrations of PCB. The industry, during the period under consideration here, has been undergoing privatisation and has felt the need for transparency in disclosing to new owners and shareholders any liabilities such as those which might arise from environmental concerns, including their possession of PCBs. This inventory lacks the extensive detail proposed by UNEP Chemicals as the common framework for PCB inventories, and probably constitutes what one delegate at Yaounde called a 'pre-inventory'. Nonetheless, the Australian data were sufficiently detailed for cost estimates to be made for treatment if this was required down to specified concentration levels, as discussed below in Section 4.

3. Inventories

Before I discuss briefly the PCB Management Plan which emerged from this process, I wish to draw attention to one of its features, the construction of inventories by the states. During the five years since the Plan was adopted by the ANZECC ministers, detailed inventories have been slow to appear. Only a few states have enacted specific PCB regulations - in my own state, Victoria, this happened only in February this year, following an incident when PCB-enriched oil was burned in a cement kiln without permission - and holders of PCBs have been reluctant to provide details to state governments until legally obliged to do so. On the other hand, new holdings outside the electricity companies - in mines, for example, and in fluorescent light ballasts in older buildings - have been reported and in many cases destroyed by Australia's alternative technologies. These involve chemical reactions, some of which have already been mentioned at the Yaounde workshop, and including those in the plasma-arc furnace, several types of hydrogenation, chemical reduction as in base-catalysed dechlorination, and the indirect thermal treatment being used to treat contaminated soil at the Sydney Olympics site. A table showing the cost of establishment and the treatment capacities of these technologies is attached. Each technology has its application to particular types of PCB waste, unlike the HTI which is more nearly omnivorous and cheaper to operate although more expensive to establish.

4. Features of the Management Plan

The following features of Australia's PCB Management Plan would probably need to be covered in any management or action plan, although of course the details of concentrations, timelines and other factors would be decided by the country which develops the plan:

4.1 Definition of the waste. Material containing more than 50 mg/kg PCB must be treated so as to reduced the level to 2 mg/kg or less, at which concentration the material is regarded as ‘PCB free’ (perhaps an unfortunate description chosen by the Australian working group!). Material containing 2-50 mg/kg may be consigned to suitable combustion facilities.

4.2 Timelines Removal of PCBs from sensitive locations was to occur quickly, with longer times allowed for remaining PCB material, especially while electrical equipment remained in service. Eventually all to be removed after 13 years (by 2008).

4.3 Storage Strict requirements were placed on security of storage.

4.4 Destruction facilities Limits were set for emissions to air of dioxins/furans (0.1 ng/m^3 TEQ), and of PCBs (0.4-1 µg/m^3), and for discharge of liquids (0.1-0.4 µg/L PCB). It was recognised that best available technology should be employed.

4.5 Transport A manifest system was required so that successive ownership of wastes could be followed and a certificate of destruction could be issued, with copies held by the original generator of the PCB waste, the transport company, the destruction facility, and the regulatory authority (government).

4.6 Inventories Inventories showing the amounts of PCBs held, and amounts destroyed, are to be maintained by the states. Information from the inventories was to be made publicly available, preferably on regulatory authority web sites.

4.7 Environmental monitoring This was expected to take place as part of broader monitoring programmes for pesticides residues and industrial chemicals, on a nationally consistent basis. Over time, possibly one or two decades, this was expected to reveal decreases in environmental PCB levels.

4.8 Education and training Programmes of education and training are to be maintained, especially for workers (such as electricians and demolition contractors) who are likely to encounter PCBs in their workplaces.

4.9 Review The PCB Management Plan is to be reviewed after five years of operation, with participation in the review by all of the original stakeholder groups.

5. Concluding Remarks

The Australian experience is unlikely to be transferable directly to other countries, but the factors considered in the PCB Management Plan will arise everywhere and will need to be addressed in appropriate ways. Some important points which emerged, and which might be helpful to other countries preparing management plans, are:

- the electricity industry, as the major holder of PCBs, is an excellent position to prepare inventories;
- private holders (and not the government) are expected to meet the costs of removal and destruction of PCBs;
- broad stakeholder involvement is essential in the development and review of the PCB Management Plan;

- there is no ‘quick fix’ because time amounting to several tears is needed to develop an action plan, and to implement it and fund it;
- new holdings of PCBs will be discovered after the initial inventory is drawn up, as various industry sectors become aware of their responsibilities;
- in the absence of an High Temperature Incinerator, alternative technologies can be employed to destroy PCBs. These are generally on a smaller scale, and cheaper to build, but are more specialised and less versatile than the HTI. However, they do not produce dioxin and furans as by-products which require extensive off-gas treatment;
- where cement kilns are used to destroy PCB-containing material, great care is needed in handling this auxiliary fuel and in monitoring off-gases. The important point to remember is that the major reason for operation of the kiln is cement production, not destruction of hazardous waste.

6. Treatment Facilities for PCBs

Technology	Establishment Cost \$US x 10^6	Capacity tonne’year	Charge \$US/tonne	Typical Feed
Incinerator range	50	50,000	~300 Europe 200-3000 US	Broad
Plascon gases (plasma arc)	1	450	<2000	Liquids,
Base catalysed dechlorination	0.2	2200	~4000	Solution in paraffin
Ecologic OCPs hydrogenation	10	1000	4000-6000	PCBs,
Sodium alkoxide solutions reaction	?	?		PCB (in-line)

We in Australia would be happy to share further details of our experience with interested parties.

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Sub Sahara Africa -Region Training Workshop on Identification and Management of PCBs and Dioxins/Furans

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Jointly organised by the United Nations Environment Programme and The Government of the Republic of Cameroon

Yaoundé, Cameroon, 17 – 21 April 2000

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A Case Study on the Management of PCBs in the Electricity Supply Industry in Cameroon

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Assisted by:

Mr. Essouma, MINMEE, Yaounde

Dr. Abi Charles, University of Yaounde 1

February 2000

Background

Cameroon is essentially an importer of most chemicals. National statistics on trade in chemicals, show that organohalogens in particular account for 2.6% of total imports in 1997, while pesticides account for 2.5% of total import value in the same year (Dept. of National Accounts, MINEFI, 1998).

The following examples illustrate the stakes:

- Pesticides and industrial chemicals are used in agriculture and industrial production, respectively. Both activities account for 45.5% of value-added of the economy; pesticides are used by 24% of the active population in agricultural activities. For example, as of June 1998, 55 operators (all in timber industry – export of logs and Veener and sawn timber plants) for a total export volume of about 1.15 Million m3 contributing to about 37 Billion FCFA in revenue, and providing about 25,000 jobs in the forestry sector.

- PCB (Arochlor 1254), is used in great quantities by the electricity supply industry or ESI (as transformer coolant fluid) and in paint, ink manufacture. The ESI accounts for 18% of the GDP or 14% of value-added to the economy;

- PCP is used in the forestry sector as a wood preservative, for treatment against fungal attack of timber and sawn wood that are destined for export, as well as treated wood that is used for the manufacture of furniture

- PCB in transformers is usually recovered and refilled, during routine maintenance operations.

In terms of National Control Actions on the substances, one notes that no specific regulation exists on PCB; it is imported under the general trade license scheme for goods and services.

II - End-Use of PCB in Electrical Industry

⇒ In Cameroon, the National Electricity Corporation (**SONEL**) is the main user and owner of PCBs. The corporation uses PCBs in electric power transformers and switched-capacitor voltage regulators.

⇒ The main classes of PCBs used are *Arochlor 1254*, *Pyralene* (Arochlor 1016) and **UGILEC** 'mineral' oil. ***UGILEC 121 (*****monomethyl-***dichloro-diphenyl* **methane*****) and*** *UGILEC 141* **(monomethyl-***tetrachloro-diphenyl* **methane*****), or Mineral Oils, and PCB cogeners such as Arochlor 1016 which contains 65% wt./wt. of TriChloroBenzene (***TCB***z)***

⇒ The distribution of transformers that use the various classes of PCBs, and estimates of leakage are shown in the following table, noting that leakage occur during repair or change of oil operations. From the estimates of loss (based on raw data from activity of SONEL, 1996, 1997), we computed the estimated loss by type of equipment and the overall loss which is at 3.14% of total quantity in use, as detailled out in the following table.

Table 1: 1997 estimates of PCB loss into the environment from electrical equipment

Electrical Equipment / (number in service)	**Type of PCB in use**	**Volume of PCB in use (Tonnes)**	**Estimated annual loss (fraction) , loss estimates in Tonnes**
High Voltage transformer / (**39**)	Pyralene	58.50	(2.75%) 1.61
Medium voltage (distribution transformer) / (**548**)	Pyralene, Arochlor 1254	438.40	(3%) 13.152
Low voltage (pole mounted transformer) / (**1,917**)	Ugilec, Pyralene	766.80	(3.25%) 24.921
Voltage regulators and insulators / (**79**)	Arochlor 1016, Ugilec Oil	4.74	(1.80%) 0.08532
TOTAL / (2,583)		**1,268.44**	**3.14% or 39.768**

Source: computed from SONEL's Annual Activity reports (1996, 1997)

III - Current Practice of Disposal of PCB and PCB contaminated wastes

⇒ No specialised waste disposal sites exist in Cameron for PCB wastes and contaminated equipment. However, a PCB (uncontrolled) waste disposal site (landfill) was identified along the Edea-Douala road. At this site old transformer carcass, insulators and capacitors were found on the dumpsite.

⇒ At the Makepe (Douala) incinerator and uncontrolled landfill site, one could find industrial solid wastes such as heat exchangers and old electrical equipment such as power transformers and capacitors that contain PCBs. In the absence of sampling equipment and having no traces of the waste generator, we could not obtain data of the type/categories of PCB as well as quantities contained in such equipment.

⇒ *Both sites are unmonitored for leaching of PCB contaminants into the soil; but it is known that local soil at both sites have been contaminated by PCBs over the years, and that due to heavy surface runoff due to rains, the sediments of neighbouring streams are also PCB-laden.*

B - Waste management/Disposal Operations of PCBs

⇒ Presently, the disposal of PCBs wastes at the national level is very expensive. Records from one local industry that intend to dispose of PCB-containing equipment and equipment in Europe indicates a cost of about 10 Million FCFA or US$16,700 per Tonne. 52% of the disposal cost is attributed to thermal incineration at high-temperature and effluent monitoring for emissions of Furans and Dioxins.

⇒ The absence of appropriate collection and disposal sites, as wastes are stored in drums, and hardware equipment are kept in stores, that have not been designed to reduce leakage and human contact.

⇒ On the other hand, it is feasible and practicable to institute measures aimed at curbing run-off of waste to surface water and agricultural soil and penetration into ground water.

⇒ The leakage of PCBs into the soil during routine or curative maintenance operations is an often occurrence at transmission and distribution platforms where transformers containing PCBs are found.

C - Exposure Issues

The routes and kinds of Exposure **to the environment and human health, as observed and estimated at one site, are as follows:**

- Estimates of total losses to the soil during routine and unforeseen maintenance operation is about 3.5% by mass per year;

- A total of 40 maintenance technicians working in shifts of 8 persons per shift, during 5 hours per shift, are involved in refilling and maintenance operations;

- No waste treatment facility occurs at the site, spilled oil goes into the soil and it is washed away into nearby drainage gutters;

- The major routes of exposure are as follows:
  - To the workers- by dermal contact;
  - To the environment (soil and sediments) through surface runoff and leaching.

IV - Operational Measures for Improvement

To ensure proper management of PCB wastes, it will henceforth be important to institute the following measures:

Environmental issues

- A National Data base or Inventory of the locations, owners/generators, quantities, and conditions of storage of wastes;

- An inventory of polluted/contaminated sites, for delimitation to human use, in view of future clean-up operations;

- To deal with the problem of absence of viable alternative, undertake a national study for stock management, phase-out of expired stock;

- Improve network management of electrical loads with a view to reduce the number of explosion incidents of transformers that lead to uncontrolled leakage of PCBs;

- Reducing leakage of PCBs into the soil during routine or curative maintenance operations is a very effective reduction measure for PCBs. In electricity transmission and distribution platforms with transformers, it is important to isolate the surfaces of such sites with impermeable material to PCBs of the work areas of electrical transformers and restricting access to the area is equally a feasible and practicable measure aimed at localising PCBs waste for easy waste management. Very little cost is required to implement this measure.

- Undertake a study to cover administrative and first assessment cost (of foreign and national infrastructure), in view of collection, transport, storage and destruction.

Human Health Issues

- With regards to reducing human exposure to PCBs, repair/maintenance personnel should fully understand and apply safety information on the chemical, and obtain specific training in risk communication. The training should involve among others, reading risk information contained in the Material safety data Sheets (**MSDS**), handling and disposal operations, accident reporting, and first aid actions.

- ❑ Secondly, the training specified above should be made mandatory in all use sectors, for which Worker syndicates and Trade Unions need to ensure implementation at the level of General Management. The technical staff and workers representatives will then be able to ensure the day to day application of the measures; for example, instructing the employees and making sure that they put on effective protective equipment provided by the company.

INVENTAIRE DES POLYCHLOROBIPHENYLES (PCB) ET DES EQUIPEMENTS EN CONTENANT EN COTE D'IVOIRE

Par: Zadi Dakouri
Le Point Focal des POPs et
Coordonnateur National des PCB en Côte d'Ivoire,

CONTEXTE

Aujourd'hui, un des problèmes environnementaux majeurs que le monde doit affronter est celui de la question des déchets dangereux provenant des industries, des ménages et des hôpitaux etc…

Ainsi, la communauté Internationale a adopté sous les auspices du Programme des Nations Unies pour l'Environnement (PNUE) un instrument juridique de portée mondiale intitulée « *Convention de Bâle sur le contrôle des mouvements transfrontières des déchets dangereux et de leur élimination* ».

La Côte d'Ivoire a ratifié le 13 Juillet 1993 cette importante convention.

Forte de cet engagement juridique et de son tissu industriel relativement important, la Côte d'Ivoire a bénéficié en 1998 d'une assistance technique et financière du Secrétariat de la Convention de Bâle en vue de mettre en place un projet pilote pour la gestion rationnelle des PCB et des équipements en contenant. Ce projet pilote comprend deux parties :

1. La première phase

Elle a débuté par un atelier d'information et de sensibilisation de tous les partenaires institutionnels (Environnement, Santé, Emploi, Energie, Transport, Douanes etc…), privés (la Fédération de la Chambre de l'Industrie, Compagnie Ivoirienne d'Electricité, etc..) et la société civile (les Organisations non Gouvernementales, etc..).

Cet atelier nous a permis d'obtenir de la Compagnie Ivoirienne d'Electricité une liste de tous ceux qui détiendraient des transformateurs en Côte d'Ivoire, leurs localisations et leurs adresses, etc…

Cette démarche est très importante dans la mesure où la Compagnie Ivoirienne d'Electricité gère toute la distribution d'électricité de la Côte d'Ivoire.

Ensuite, nous avons procédé au confinement et au rassemblement au sein d'un secteur aménagé pour les circonstances appartenant à la Compagnie Ivoirienne d'Electricité d'un échantillon représentatif d'équipement contenant des PCB de 45 tonnes obtenus d'une société industrielle appelée Gestoci.

Un comité de pilotage qui consiste à définir les principaux axes de gestion des PCB a été mis en place. A savoir :

a) inventaire de PCB et des équipements en contenant ;
b) mise en place d'une replementation ;

c) formation des techniciens du service de l'inspection des installations classées pour l'inventaire des PCB ;
d) formation des douaniers et des techniciens de maintenance de la Côte d'Ivoire ;
e) création d'un site de stockage des transformateurs, des condensateurs identifiés, etc…

2. Deuxième phase

Cette deuxième phase fait suite à la signature du protocole d'accord signé entre le Gouvernement Ivoirienne et le Secrétariat de la Convention de Bâle en février 2000 pour une assistance financière et technique de 34,900 $US.

Les objectifs de cet accord consistent à mettre en œuvre les principales stratégies arrêtées en 1998 à savoir :

- l'inventaire des PCB et des équipements en contenant ;
- la formation des inspecteurs pour l'inventaire ;
- mise en place d'une réglementation ;
- formation des douaniers et des techniciens de maintenance.

Au cours de cet atelier de Yaoundé (Cameroun) qui a lieu du 17 au 21 Avril 2000, ce qui nous concerne c'est la méthodologie de l'inventaire des PCB et des équipements en contenant qui entrain de se dérouler en Côte d'Ivoire.

A cet effet, l'expérience de la Côte d'Ivoire, loin d'être parfaite peut permettre à certains de nos pays frères de mettre en place une politique d'inventaire.

I. <u>Les dispositions préalables de l'Inventaire</u>

A) Un atelier d'information et de sensibilisation du public c'est-à-dire du public directement concerné par le problème des PCB et du grand public a eu lieu à Abidjan en Février 2000, regroupant tous les partenaires institutionnels (Energie, Environnement, Santé, Douanes, Transport, etc…), privés (Fédération Ivoirienne de l'Industrie, CIE, etc…) et la société civile (ONG, etc…).

Monsieur le Ministre en charge de l'Environnement de la côte d'Ivoire a ouvert cet atelier en présence d'un représentant du Secrétariat de la Convention de Bâle. La radio et la télévision ont été associées au déroulement de cet atelier pour informer le public en français et en langues vernaculaires.

B) Formation des Inspecteurs du service de l'inspection des installations classées, de quelques agents du Centre Ivoirien anti-pollution (CIAPOL) et de quelques représentants des sociétés privées (CIE, société de maintenance etc..) et de la société civile.

Nous mettons ainsi l'accent sur le principe de participation qui consiste à ce que tous ceux qui sont concernés par un problème environnemental puissent être associés aux prises de décisions.

Au cours de cet atelier de formation supervisé par un expert international mis à notre disposition par le Secrétariat de la Convention de Bâle, on a élaboré une fiche d'inventaire adaptée aux réalités locales.

C) Nous avons acheté des équipements de sécurité pour les inspecteurs en vue de faire cet inventaire (lunettes, gangs, vêtements etc..) et nous avons passé un contrat d'assurance pour les inspecteurs en cas d'accident au cours de cet important travail.

Nous avons établi des ordres de mission pour chaque inspecteur, signés soit par le Directeur de Cabinet soit par le Ministre chargé de l'Environnement.

D) Les sources d'information.

A ce niveau, il y a deux sources retenues à savoir :

- la compagnie de distribution et de production ;
- les sociétés de maintenance.

La Compagnie Ivoirienne d'Electricité (CIE) nous a remis une liste de ses clients moyenne tension. Nous avons alors su par le biais de cette information qu'il y a 6 000 transformateurs en Côte d'Ivoire dispersés inégalement sur le territoire national. Nous avons réparti les sites identifiés par zones où nous avons alors affecté des inspecteurs.

Mais auparavant, nous avons adressé des correspondances à tous les détenteurs de PCB et des équipements en contenant en côte d'Ivoire en y mentionnant la date de l'inventaire et les raisons de cet inventaire. Certains ont répondu à nos correspondances et d'autres non.

La ville d'Abidjan est de loin la zone où il y a beaucoup de transformateurs par rapport au listing de la CIE à nous fournie par cette société de distribution d'électricité.

II. L'INVENTAIRE PROPREMENT DIT

Nous avons envoyé les inspecteurs dans chaque zone identifiée pendant les cinq premiers jours de chaque semaine et cela trois fois déjà. Ceux-ci nous ramènent les fiches d'inventaire tous les soirs et chaque matin avant d'aller sur le terrain, nous faisons le point de la situation et nous corrigeons nos faiblesses aux vues des difficultés rencontrées sur le terrain.

III. SAISIE DES DONNEES RECUEILLIES

Nous procédons automatiquement à la saisie des données à l'ordinateur dès réception des fiches d'inventaire.

IV. RESULATS ACTUELS

L'inventaire en cours de réalisation en côte d'Ivoire a porté sur une sélection de 600 établissements dont l'acquisition de transformateurs est antérieure à 1984.

Nous avons jusqu'à présent sélectionner 354 transformateurs. On peut les répartir ainsi:

- des transformateurs à huile minérale ;
- des transformateurs secs ;
- des transformateurs PCB (en nombre important de 147) ;
- des transformateurs non identifiés ;

Les transformateurs identifiés jusqu'à présent, appartiennent au secteur privé et au secteur public.

Cinquante (50) transformateurs ont fait l'objet d'un dépistage PCB et seront soumis à un analyse par un laboratoire de la place.

Le Gouvernement Ivoirien a confectionné un film relatif à cet inventaire, depuis le début du lancement de celui-ci.

CONCLUSION

Pour réussir une telle mission, il faut des moyens humains formés pour les besoins de la cause et des moyens financiers adéquats.

Il faut être assez communicateur pour amener les responsables des industries identifiées à faciliter l'accès de leur entreprise aux inspecteurs.

Actuellement les moyens financiers mis à notre disposition ne suffisent pas pour un inventaire complet des PCB et des équipement en contenant sur tout le territoire Ivoirien.

Notre regard est donc tourné vers le PNUE pour nous aider dans ce sens.

Merci.

Le Point Focal des POPs et
Coordonnateur National des PCB en Côte d'Ivoire,
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United Nations

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JOINTLY ORGANISED BY UNEP CHEMICALS
AND
MINISTRY OF THE ENVIRONMENT AND FORESTRY

Sub-Sahara Africa Regional Training Workshop on Identification and Management of some Persistent Organic Pollutants (PCBs and Dioxins / Furans)
Yaoundé, Cameroon, 17 - 20 April 2000

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