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File
PCBs

Visit of

MR. MAURICE EASTIN

ENVIRONMENTAL
PROTECTION AGENCY

January 8-9, 1976

MONS 051381

JANUARY 8, 1976

DINNER MEETING

PRESENT FOR MONSANTO:

Earle H. Harbison	General Manager, Specialty Chemicals Division
Robert G. Potter	Director, Functional Products Group, Specialty Chemicals Division
David L. Sliney	Marketing Director, Functional Products Group
William B. Papageorge	Manager, Product Acceptability Process Chemicals Division
Desmond B. Hosmer	Utilities and Environmental Protection Director, MICC
K. Warren Easley	Director Civic Affairs Washington, D.C.
David Wood	Dielectrics Manager Functional Products Group

JANUARY 9, 1976

INFORMATION PRESENTED:

1. Monsanto's program of sales restrictions on PCBs.

2. Environmental aspects of PCBs.

3. Monsanto's PCB replacement program.

4. Environmental acceptability data on Monsanto PCB replacements.

5. Monsanto's effluent control program (at W. G. Krummrich plant).

LABORATORY TOUR:

- Biodegradation
- Analytical Methods for PCBs
- Measurement of dielectric properties of fluids
- Pilot plant for capacitor PCB replacement

W. G. KRUMMRICH PLANT TOUR:

- PCB production facilities
- PCB incineration

JANUARY 9, 1976

MONSANTO INDUSTRIAL CHEMICALS COMPANY

8:30 - 10:30 A.M.

Earle H. Harbison - General Manager,
Specialty Chemicals Division

Robert G. Potter - Director, Functional Products Group,
Specialty Chemicals Division

William B. Papageorge - Manager, Product Acceptability
Process Chemicals Division

J. Coleman Weber - Manager, Product Acceptability
Specialty Chemicals Division

Dr. George J. Levinskas - Manager, Environmental Assessment
and Toxicology
Dept. of Medicine and Environmental
Health

David Wood - Dielectrics Manager
Functional Products Group

K. Warren Easley - Director Civic Affairs
Washington, D.C.

10:45 - 11:45 A.M.

Dr. William C. Hammann - Manager, Research Development,
Functional Products Group

2:00 - 4:00 P.M.

Robert W. Flint - Plant Manager, W. G. Krummrich Plant

Robert A. Pohl - Manager, Manufacturing
Functional Products Group

Arthur E. Leisy - General Superintendent, Manufacturing
W. G. Krummrich Plant

Desmond B. Hosmer - Utilities and Environmental Protection
Director, MICC

J. Coleman Weber - Manager, Product Acceptability
Specialty Chemicals Division

JANUARY 9, 1976

MONSANTO COMPANY LUNCHEON (12 NOON)

C. E. Anagnostopoulos	General Manager, Rubber Chemicals
W. R. Corey	Director, Administration, MICC
J. T. Garrett	Manager, Department of Medicine and Environmental Health
P. R. Graham	Manager, Product Acceptability Rubber Chemicals and Plasticizers
E. H. Harbison	General Manager, Specialty Chemicals Division
S. A. Heininger	General Manager, Plasticizers Division
D. B. Hosmer	Director, Utilities and Environmental Protection, MICC
K. N. Kermes	General Manager, Detergents and Phosphates
J. S. Metcalf	Manager, Product Acceptability Detergents and Phosphates
M. L. Mullins	Manager, Environmental Protection - Utilities - Energy, MICC
W. B. Papageorge	Manager, Product Acceptability Process Chemicals Division
R. G. Potter	Director, Functional Products Group
D. L. Sliney	Marketing Director, Functional Products Group
J. C. Weber	Manager, Product Acceptability Functional Products Group
E. P. Wheeler	Environmental Health Director
W. W. Withers	Company Counsel, MICC
J. J. Zeman	Manager, Commercial Development Functional Products Group

Monsanto Company Program for Controlling the

Entry of Polychlorinated Biphenyls into the Environment

(W. B. Papageorge)

Following the announcement by Swedish investigators that substances found in environmental samples were identified as polychlorinated biphenyls, Monsanto began intensive programs to develop accurate analytical methodology and to establish the toxicological effects with test animals.

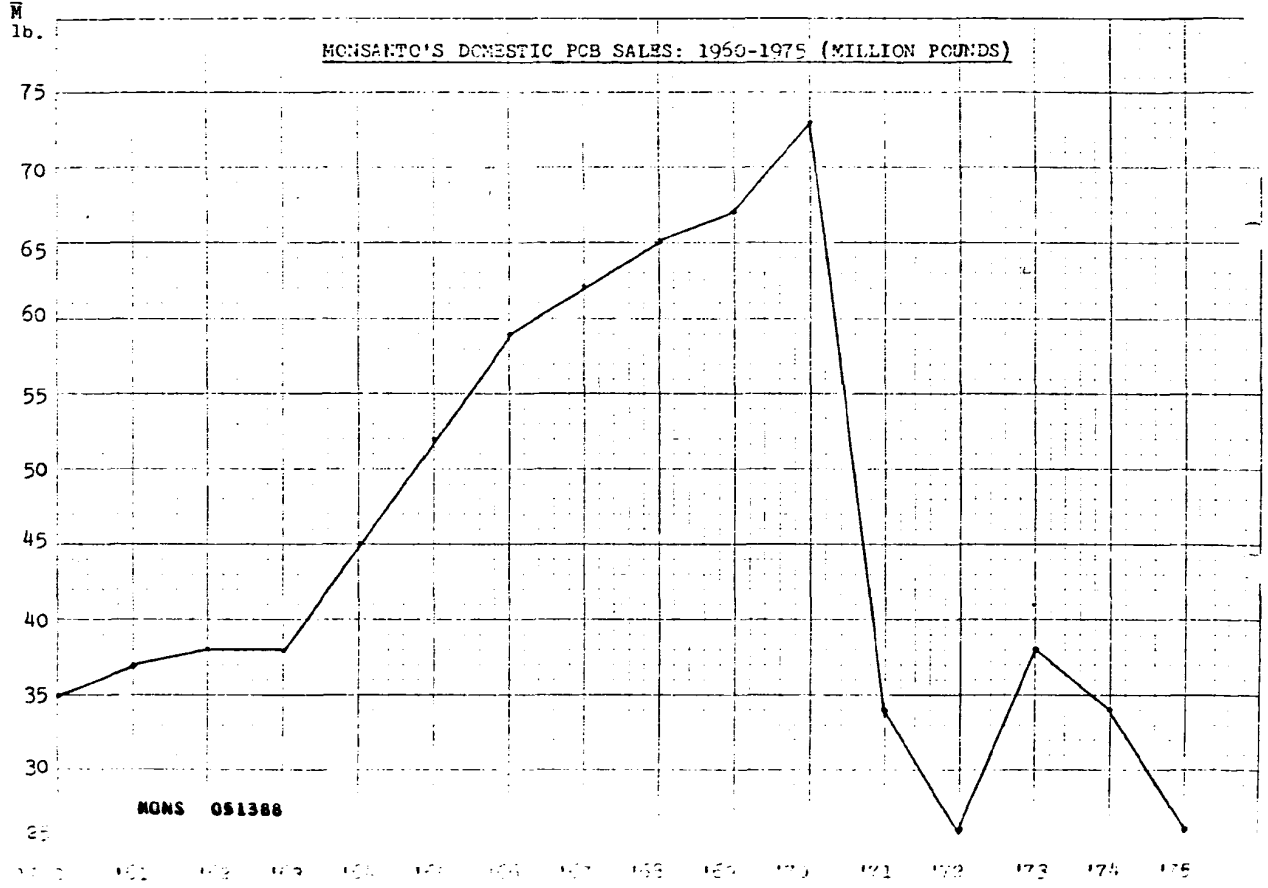
Long before all the data became available Monsanto announced that in 1970 sales of polychlorinated biphenyls to applications which permitted easy entry into the environment would be discontinued. By mid-1971 sales were made only to heat transfer and electrical equipment, applications which were considered "closed systems" and in which fire-resistance offered by polychlorinated biphenyls was considered critical.

In late 1971, Monsanto further announced that sales to heat transfer applications would also be discontinued. Thus, starting in 1972, sales of polychlorinated biphenyls were and continue to be made only to manufacturers of sealed electrical equipment such as capacitors and transformers, applications for which no acceptable alternative fluids were available. In addition, the types of commercial mixtures sold are those which contained the lowest concentration of the more persistent polychlorinated biphenyls consistent with the fire resistance requirements of the applications. Approval by Monsanto of a customer is very carefully considered to establish actual use in sealed electrical applications.

In 1971, following Monsanto suggestions that a government agency be available as a spokesman for regulatory matters relating to polychlorinated biphenyls, the Interdepartmental Task Force for PCBs was formed. In its report, published in May, 1972 the Task Force supported Monsanto's sales policy and agreed that the continued use in sealed electrical systems was warranted pending the development of acceptable substitute materials.

In February, 1973, the member nations of the Organization for Economic Cooperation and Development (OECD) published an agreement relating to the use of polychlorinated biphenyls which is less restrictive than the Monsanto policy but does include acceptance of the continued use of these materials in electrical systems.

The commitment of the manufacturers and users of capacitors and transformers containing polychlorinated biphenyls in the proper use and control of these materials is evident in the formation of an American National Standards Institute committee (ANSI C-107) to develop control guidelines. Guidelines were available in 1973 and final approval obtained in 1974.


M
lb.
MONSANTO'S DOMESTIC PCB SALES: 1960-1975 (MILLION POUNDS)
75
70
65
60
55
50
45
40
35
30
MONS 051388

PENTA- & HIGHER CHLORINATED BIPHENYLS*

	MONSANTO DOMESTIC PCB SALES	PENTA- & HIGHER CHLORINATED BIPHENYL CONTENT
	(MILLION POUNDS)	(MILLION POUNDS)
1970	73	21.7
1975	26	~5.7

*PCB residues found in wildlife are primarily penta- and hexachlorobiphenyls.

(1) Non-dielectric uses: 11.7 million pounds
Dielectric uses: 10.0

(2) Dielectric uses only: ~5.7 million pounds

PCB GRADES PRODUCED

1970	1975
Aroclor® 1221	Aroclor® 1221
Aroclor 1232	Aroclor 1242
Aroclor 1242	Aroclor 1254
Aroclor 1248	Aroclor 1016
Aroclor 1254	
Aroclor 1260	
Aroclor 1262	
Aroclor 1268	

In all cases except Aroclor 1016, the second two digits refer to % by weight chlorine, ie. Aroclor 1242 is biphenyl chlorinated to an average of 42% by weight chlorine. Aroclor 1016 has a chlorine content of ~41-42% chlorine.

PCB GRADES SOLD TO DIELECTRIC USERS

1970	1975
CAPACITORS	CAPACITORS
Aroclor 1242	Aroclor 1016
Aroclor 1248	Aroclor 1221 (only ~60,000 lb.)
Aroclor 1254	
TRANSFORMERS	TRANSFORMERS
Aroclor 1260	Aroclor 1254
Pyranol/Inerteen*	Pyranol/Inerteen**

*In 1970, Pyranol/Inerteen grades were blends of Aroclor 1242 or 1254 or 1260 with additives and (in some cases) chlorobenzenes.

**In 1975, Pyranol/Inerteen grades are blends of Aroclor 1242 or 1254 with additives and (in some cases) trichlorobenzene.

MONS 051391

PCB'S USED IN CAPACITORS

PCB	MAJOR USE PERIOD	% PCB (PENTA-CHLORO- AND HIGHER	% PCB (HEXA-CHLORO- AND HIGHER
AROCLOR 1254	1930-1952	77.0	29.0
AROCLOR 1242	1952-SEPT. 1971	9.0	1.0
AROCLOR 1016	OCT. 1971	1.1	0.1

MONS 051392

EFFECT OF MONSANTO'S PCB SALES RESTRICTIONS

1. Domestic sales of PCBs are ~ 45 million pounds below 1969/1970 levels.

2. Monsanto's remaining product line has been changed to reduce penta- and higher chlorinated biphenyl homologs.

3. In 1970, ~ 22 million pounds of penta- and higher chlorinated biphenyls were present in PCBs sold domestically; in 1975 this was reduced to under 6 million pounds.

4. In 1975, all penta- and higher chlorinated biphenyls are sold only to sealed system uses in capacitors and transformers.

TOXICITY AND ENVIRONMENTAL EFFECTS OF PCBs

(Dr. G. J. Levinskas)

MONSANTO STUDIES

- Aroclor® 1242, 1254 and 1260 studied most extensively.
- Toxicity tests performed were typical in scope of those designed for evaluation and establishment of the safety of direct and indirect food additives.

Conclusions Based on Monsanto Studies

1) As a class, the AROCLOR® products are relatively harmless materials for routine industrial handling under ambient conditions.

2) Threshold Limit Values of 1 mg/m^3 and 0.5 mg/m^3 have been established for materials containing average chlorine values of 42% and 54%, respectively, of the available sites.

3) The no-effect level for these materials in chronic rat and dog feeding studies is about 10 ppm in the diet. No hepatocellular carcinomas were present.

4) The no-effect level on rat reproduction is between 1 and 10 ppm in the diet since higher levels result in low mating indices.

5) No teratogenic or mutagenic effects were observed in studies with rats and mice.

6) In chicken reproduction and teratology studies, AROCLOR 1242, which produced the most severe effects, had a no-effect level of 2-4 ppm in the diet.

7) Acute toxicity to fish varies from less than 1 ppm to greater than 100 ppm depending on the specific AROCLOR and species of fish tested.

8) PCBs containing 3 or less chlorine substituents per molecule are reasonably biodegradable.

MONSANTO'S LONG-TERM TOXICITY STUDIES ON PCBs

Studies Carried Out:

- 2-year (lifetime) feeding to rats
- 2-year feeding to dogs
- 3-generation rat reproduction (2 litters per generation)
- Rat teratology
- Dominant lethal mutagenic studies in mice
- Toxicity/reproduction studies in chickens
- Biodegradation
- Bio Accumulation

Findings (also see conclusions):

1. The highest dietary level (100 ppm) in the lifetime rat feeding studies produced a weight depression at 24 months in females fed AROCLOR 1254 and liver weight increases in all groups except males fed AROCLOR 1242. The important histopathologic changes were present in the livers of animals sacrificed at the end of the study. These consisted of hepatocellular alternations such as focal hypertrophy, cytoplasmic lipid changes and in some animals from the 100 ppm groups, hepatomas or cholangiohepatomas. No evidence of hepatocellular carcinogenicity of the AROCLOR products studied was found.

2. In the dog 2-year studies, some slight decreases in body weight gain were noted. At the highest feeding level (100 ppm), AROCLOR 1260 produced an increase in serum alkaline phosphatase activity and liver weights without concomitant histopathologic changes. However, there was evidence of gastrointestinal inflammatory lesions and ulcerations which appear to be similar to those found by Allen in rhesus monkeys fed AROCLOR 1248.

3. In the rat reproduction studies, none of the AROCLOR products produced adverse effects in the 2 litters of the first generation. In the second and third generations, there was a reduction in the mating index at the two highest feeding levels (10 ppm and 100 ppm). The ability of females to conceive, carry the delivery process to parturition, and to successfully nourish the young was not affected by the three AROCLOR products tested. No changes were produced in the reproductive tracts of either male or female rats by any of the three AROCLOR products.

4. There was no evidence of teratogenic or mutagenic changes with any of the PCBs at maximally tolerated dose levels in rats and mice.

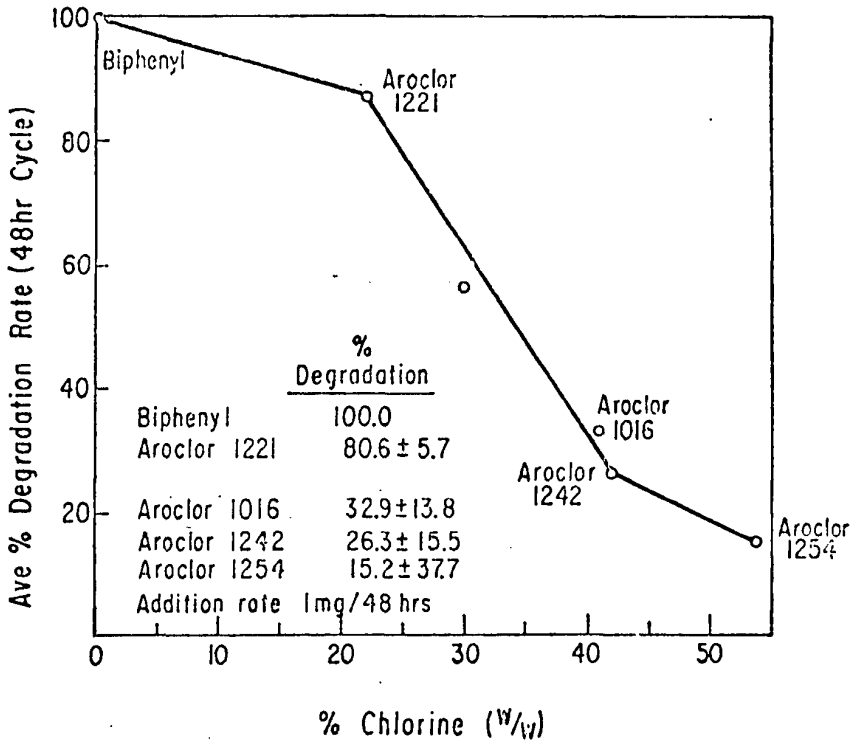
5. In the chicken toxicity/reproduction study, AROCLOR 1260 was without effect at all test levels. AROCLOR 1242 and 1254 at 100 ppm in the diet decreased egg hatchability. In fact, poor hatchability of eggs was found from hens fed 8 ppm of AROCLOR 1242. In addition, AROCLOR 1242 at 10 and 100 ppm and AROCLOR 1254 at 100 ppm were associated with reduced eggshell thickness. Chick viability was affected by both substances at a dietary level of 10 ppm.

COMMENTS ON MONSANTO FEEDING STUDIES COMPARED TO STUDIES BY OTHERS

1. The conclusion that "no evidence of hepatocellular carcinogenicity of the AROCLOR products was found" in the two-year rat feeding study was reached only after extensive re-evaluation of the original liver slides as well as additional liver sections from all of the animals after the Kimbrough results on AROCLOR 1260 became known to us. The slides were read independently by Dr. D. Gordon of Industrial BIO-TEST Laboratories, Professor W. Richter of the University of Chicago, and by Professor P. Pour of the Eppley Institute for Research in Cancer. In addition, Dr. Pour evaluated the Kimbrough slides and does not agree with the reported findings.

2. Barsotti and Allen have reported that 2.5 ppm of AROCLOR 1248 in the diet of rhesus monkeys adversely affected reproduction. This approximates a dosage of 100 µg/kg/day. It is higher than the safe human intake (1 µg/kg/day) estimated by FDA from human data when it promulgated its tolerances for PCBs in food.

Semi-Continuous Activated Sludge Degradation of Polychlorinated Biphenyls



MONS 051398

MONSANTO PCB REPLACEMENT PROGRAM
(D. Wood)

INTRODUCTION

Key Stages

1) Voluntary termination of sales to open and semi-closed applications.

2) Transition to more biodegradable Aroclor 1016 for capacitor industry.

3) Closely monitored sales to closed electrical system applications.

→ 4) Allocation of increased research resources since 1969 to seek and develop effective replacements for capacitor and transformer use.

CAPACITOR PROGRAM

A. Research objectives must relate to beneficial characteristics of chlorinated biphenyls.

Dielectric Constant and Dielectric Strength

Affect - Size of capacitor - Design of equipment using capacitors - availability of other components, e.g., paper/foil.

Stability (Thermal/Chemical/Oxidative/Hydrolytic)

Affect - Reliability and life of capacitors.

Fire Resistance

Affect - Safety

Consistent International Quality and Availability

Affect - Worldwide solution of PCB replacement.

Applicable in all existing PCB applications

Affect - Complete solution.

AND

Good Environmental Compatibility.

B. RESULT

MCS-1238, a blend of synthetic hydrocarbon with a dielectric constant modifier.

1. Dielectric Constant/Strength - Equivalent Aroclor 1016. ✓

2. Stability - Sufficient to give long capacitor life. ✓

3. Fire resistance - Not flammable, but less fire resistant than Aroclor.

4. International Quality/Availability. ✓

5. Span of existing PCB applications. Theoretical ✓

6. Environmental Compatibility. To Date ✓

C. FURTHER DEVELOPMENT

1. Monsanto - Complete Environmental Screen.

   - Establish Production.

2. Capacitor Industry
   - Complete Capacitor trial programs.

3. Capacitor Users/Capacitor Industries/Agencies

   - Accomodate by modification of capacitor design/system design reduced liquid fire resistance.

TRANSFORMER PROGRAM

(Askarel usage approx. 1 M gals. per year vs. Mineral Oil 75-90 M gals per year)

A. Research objectives relate to benefits of chlorinated biphenyls.

Fire Resistance

Affect - Safe installation of 100-1,000 gallons of liquid under thermal/electrical stress.
a) inside buildings
b) in underground urban substations
c) in generating stations (electrostatic precipitators)
d) under railroad cars, e.g., rapid transit systems.

Environmental Compatibility

Heat Transfer Characteristics

Electrical Insulation Properties

Dielectric Strength

Stability

Compatibility with Chlorinated Biphenyl

B. RESULT

A synthetic hydrocarbon with a viscosity modifier.

C. FURTHER DEVELOPMENT

Monsanto is just beginning to submit evaluation quantities of this material to the transformer industry and starting environmental screening program.

D. MAJOR PROBLEM

Objective quantitative assessment of the relationship between fluid properties and the "fire safety" of the transformer installation.

There is a need for cooperation in this area between:

- Transformer manufacturers
- Transformer users
- Insurance groups
- Department of Transportation
- Building code regulators
- Fluid suppliers, etc.

Government support would be helpful in resolving this problem.

ENVIRONMENTAL ACCEPTABILITY OF MONSANTO'S

PCB REPLACEMENT FOR CAPACITORS (MCS 1238)

(J. C. Weber)

TESTS COMPLETED

1. Acute Tests

   - LD_{50} Male and Female Rats
   - Skin - Albino Rabbits - 24 hours exposure
   - Eye - Albino Rabbits - 24 hours exposure

2. Vapor Inhalation (Male Rats) - Ambient Temperature

3. Sub Acute
   28 day Feeding Study Rats

4. Bio Accumulation Rats

5. Toxicity - Aquatic Organisms
   96 hr. TL 50 Bluegill
   96 hr. TL 50 Trout

6. Biodegradability
   - Primary Biodegradation (Simulation of a Secondary Sewage Treatment Plant)

   - Ultimate Biodegradation
     CO_2 Evolved in 35 days is 52% of theory

FURTHER TESTS ON MCS 1238

	Completion Date
- 6 Tests	March, 1976
- 2-Year Feeding Studies	June, 1978

BIO ACCUMULATION

- Aroclor 1016 shows less bio accumulation than Aroclor 1242

- MCS 1238 shows essentially no bio accumulation in rats

FAT TISSUE RESIDUE LEVEL VS. TIME

Table 4

25 PPM FEED LEVEL FOR RATS

