INDUSTRIAL HYGIENE SURVEY
OF

Westinghouse Electric Corporation
Bloomington, Indiana

SURVEY DATE

April 19-22, 1977

SURVEY CONDUCTED BY:

Leo Blade
Dave Marlow
Mark Jones

WRITTEN BY:

Mark Jones

DATE OF REPORT

December 1, 1977

Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
Center for Disease Control

PLACE VISITED:	Westinghouse Electric Corporation P. O. Box 341 Bloomington, Indiana 47401
DATE OF VISIT:	April 19-22, 1977
PERSONS MAKING VISIT:	Leo Blade, NIOSH Dave Marlow, NIOSH Mark Jones, NIOSH
PERSONS CONTACTED:	Robert Dyer Supervisor, Personal Relations John Adams Corporate Industrial Hygienist
UNION:	International Brotherhood of Electrical Workers, Local #2031 Association of Bloomington Westinghouse Salaried Employees
PURPOSE:	To conduct an industrial hygiene survey to determine the workers' level of exposure to polychlorinated biphenyls during the manufacturing of capacitors.

INTRODUCTION

Recent literature has linked possible carcinogenic effects to polychlorinated biphenyls. Since this literature is incomplete, the Division of Surveillance, Hazard Evaluations and Field Studies of the National Institute for Occupational Safety and Health has underway an "industrywide" study of industries using polychlorinated biphenyls.

As a result of a walk-through survey conducted by NIOSH at the Westinghouse facility in Bloomington, Indiana on December 4, 1975 and a meeting held with company representatives on January 21, 1977, it was decided that a medical study and industrial hygiene survey would be conducted at the facility. The medical study was conducted during March, 1977. The industrial hygiene survey was conducted by Leo Blade, Dave Marlow and Mark Jones on April 19, 20, 21 and 22, 1977.

During the visit, approximately 58 air samples were collected for evaluation of polychlorinated biphenyls exposures. In addition air samples were collected to evaluate exposures to solvents, soldering fumes, welding fumes and ozone.

DESCRIPTION OF FACILITY

The plant began operation in 1958 as part of the Distribution Apparatus Division of Westinghouse Electric Corporation. The main products of the plant are shunt capacitors, series capacitors, lightning arresters, reclosers and breakers, switches, potential devices and line traps. Production of polychlorinated biphenyls-filled capacitors also started in 1958. Currently the polychlorinated biphenyls used is Aroclor 1016, but from 1958 to 1971 Aroclor 1242 was used.

Currently there are approximately 745 employees at the facility of which approximately 445 are hourly employees. The unions at this plant are Local #2031 of the International Brotherhood of Electrical Workers and the Association of Bloomington Westinghouse Salaried Employees of the Federation of Westinghouse Independent Employees.

There are presently approximately 20 employees in the capacitor operation and engineering lab who have direct contact with polychlorinated biphenyls.

MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAM

The Westinghouse Electrical Corporation has a corporate medical director located in Pittsburgh, Pennsylvania. A local physician, Dr. Steve LuEllen is available at the plant three times a week and on call 24 hours a day. Dorothy Roberts, a nurse, is at the plant during the day shift. Also, all the guards have been trained in first-aid.

Pre-employment physical examinations are given to all the employees. These examinations include audiograms, eye examinations, and urine analysis along with other routine physical examinations. Periodic examinations are given every two years to those employees which are exposed to chemical hazards. This examination includes those tests conducted for the pre-employment examination plus x-rays and blood tests.

There is no industrial hygienist at the plant but a corporate industrial hygienist is available to the plant when needed. The company has collected approximately 40 air samples for evaluation for polychlorinated biphenyls, but no regular monitoring is done.

The safety program at the plant is handled by Robert Dyer, Supervisor Personnel Relations. Personal protection programs presently enforced at the plant are safety glasses, safety shoes, respirators and protective clothing (gloves and aprons).

DESCRIPTION OF PROCESS

There are many different production operations at this facility. The capacitor making operation is the only one using polychlorinated biphenyls. Currently the plant is changing the insulation oil used in the capacitors from polychlorinated biphenyls to isopropyl biphenyl.

Large power capacitors are made at this facility. Bales of foil, paper and plastic film are wound in a dust-free room. The size of the bale depends upon the size of the capacitor being made. A predetermined number of bales are then placed into a metal capacitor box and the top of the capacitor with the connection bushings are put in place. A group of capacitors are banded together and placed automatically in a chamber. The chamber is heated and placed under a vacuum to remove all moisture. The chamber is then flooded with polychlorinated biphenyls in order to fill the capacitors. The residue PCB is then pumped out, filtered, and reused. The capacitors are removed from the chamber and automatically placed on a conveyor system. There is an absorbent material placed under the conveyor system which absorbs the excess PCBs which might spill onto the floor.

INSPECTION OF PLANT

Job	Estimated Number of Workers Exposed	Potential Health Hazards
Welding	10	Aluminum, iron
Soldering	7	PCBs, lead, zinc
Painting	10	Toluene, xylene
PCBs Production	20	Polychlorinated biphenyls, trichloroethylene, 1,1,1-trichloroethane

Ventilation

Many operations use local exhaust ventilation. Enclosed (Apprendix B) is a copy of a letter dated June 7, 1977 to Mr. Robert A. Dyer which included preliminary recommendations for improvements on plant ventilation.

Iron, Aluminum, Lead and Zinc

Air samples were collected for aluminum and iron during the welding operations and for zinc and lead during soldering operations. MSA Model G pumps were used to collect the air samples on a 37 mm/0.8 micrometer mixed cellulose ester membrane filter. The samples were collected from approximately two to four hours at a flow rate of 1.5 &pm. The samples were digested in nitric acid and analyzed by atomic absorption.

Tin

Air samples were collected for tin during soldering operations. MSA Model G pumps were used to collect the air samples on 37 mm/0.8 micrometer mixed cellulose ester membrane filter. The samples were collected from approximately two to three hours at a flow rate of 1.5 &pm. The samples were ashed with nitric acid and sulfuric acid and analyzed by atomic absorption.

Toluene, Xylene, Methyl Ethyl Ketone, Trichloroethylene, and 1,1,1 - Trichloroethane

Air samples were collected for toluene, xylene and methyl ethyl ketone during painting operations and for trichloroethylene and 1,1,1 - trichloroethane during degreasing and cleaning operations. Sipin SP1 and DuPont pumps were used to collect air samples in charcoal tubes. These tubes contain an activated coconut charcoal with a 100 mg primary section and 50 mg back-up section. Samples were collected from approximately one to four hours and flow rates varying from 50 to 200 cc/min. The samples were desorbed with carbon disulfide and analyzed with a gas chromatograph.

Housekeeping

The plant does a good job in keeping most work areas clean.

SURVEY PROCEDURES

General

Air samples were collected for evaluating exposure to polychlorinated biphenyls, trichloroethane, trichloroethylene, lead, tin, zinc, toluene, xylene, MEK, aluminum, iron and ozone. The following paragraphs describe the methods used to collect and analyze the air samples.

Polychlorinated Biphenyls

Both personal and area air samples were collected throughtout the facility. Sipin SP1 pumps were used to collect the air samples in tubes containing a magnesium silicate absorbent called florosil. The tubes have a 100 mg primary section and a 50 mg backup section. Samples were collected from two to seven hours at a flow rate of approximately 200 cc/min. The polychlorinated biphenyls were desorbed from the florosil with benzene and analyzed by using a gas chromatograph with an electron capture detector.

Skin smears were collected on Whatman smear tabs #50 by wiping the forehead, nose and cheek area of each person. The samples were then analyzed by the same procedure.

Ozone

Air samples were collected for ozone during welding operations. MSA Model G pumps were used to collect the air samples in a midget impinger. The impinger contained approximately 15 mℓ of an alkaline potassium iodide solution. It should be noted that the solution should not be exposed to direct sunlight. The samples were collected for 45 minutes at a flow rate of 1 ℓpm. The solution is acidified with phosphoric acid and then determination by spectrophotometric measurement.

RESULTS AND DISCUSSION

Polychlorinated Biphenyls

The results of the area and personal air samples are presented in Tables I-III and the job descriptions corresponding to the job titles are in Appendix A.

Forty personal and sixteen area air samples were collected. The time-weighted averages ranged from 4 $\mu g/m^3$ for the boilerhouse operator to 162 $\mu g/m^3$ for the capacitor repairman. The peak concentration was 264 $\mu g/m^3$ for a capacitor repairman. The results of the smear samples are presented in Table IV. All the smear samples showed an increase between the morning sample and afternoon sample.

Iron and Aluminum

The results of the personal air samples for iron and aluminum are presented in Table V.

Tin

No detectable limits (80 µg/tube) of tin were found.

Toluene, Xylene, Methyl Ethyl Ketone,
Trichloroethylene and 1,1,1 - Trichloroethane

The results of the personal air samples for toluene and xylene are presented in Table VI. No detectable limits (0.01 mg/tube) of methyl ethyl ketone were found. The toluene time-weighted averages were 1.7 ppm for painters and 0.5 ppm for set up men while those for xylene were 1.6 ppm for painters and 5.3 ppm for set up men.

The results of the trichloroethylene air samples are presented in Table VII. Two samples had concentrations of 289 ppm. Also, two of the samples were saturated.

The results of the 1,1,1 - trichloroethane air samples are presented in Table VIII. The three personal samples had concentrations less than 13 ppm, but the one area sample had a concentration greater than 339 ppm.

Ozone

No detectable limits (2 mg/m^3) of ozone were found.

STANDARDS AND HEALTH EFFECTS

Polychlorinated Biphenyls

The current OSHA standard and ACGIH TLV for chlorodiphenyl (42% chlorine is 1000 µg/m^3 (1 mg/m^3). The NIOSH recommended standard is a TWA of 1 µg/m^3. The dermatological effects and systemic effect on the liver associated with polychlorinated biphenyls are well reported in the literature: however, recent literature has linked possible carcinogenic effects to polychlorinated biphenyls.[1,2,3] Therefore, this standard may not adequately protect the workers health.

Iron

The current OSHA standard for iron oxide (measured as iron) is 10 mg/m^3 while the ACGIH TLV is 5 mg/m^3.

Aluminum

Currently there is no OSHA standard for aluminum, but the ACGIH TLV for aluminum (Al_2O_3) is 10 mg/m^3.

Zinc

The current OSHA standard, NIOSH recommended standard and ACGIH TLV for zinc oxide (reported as zinc) are 5 mg/m^3.

Toluene

The current OSHA standard for toluene is 200 ppm. The NIOSH recommended standard and ACGIH TLV are 100 ppm.

Xylene

The current OSHA standard, NIOSH recommended standard and ACGIH TLV for xylene are 100 ppm.

Trichloroethylene

The current OSHA standard, NIOSH recommended standard and ACGIH TLV for trichloroethylene are 100 ppm.

The health effects that have been associated with occupational exposure to trichloroethylene are depression of the central nervous system, cardiovascular changes and effects in the liver, kidney and skin.[4] However, trichloroethylene has been associated with carcinogenesis in mice as reported by the National Cancer Institute.[5]

1,1,1 - Trichloroethane

The current OSHA standard and ACGIH TLV for 1,1,1 - trichloroethane is 350 ppm. The NIOSH recommended standard is 200 ppm.

The main health effect that has been associated with occupational exposure to 1,1,1 - trichloroethane is central nervous system disorders, but effects on the cardiovascular and respiratory systems in animals have been found.

CONCLUSIONS AND RECOMMENDATIONS

Based on observations made during this survey and the results of the air samples, the following conclusions are drawn and recommendations for improvements made. The author realizes that the use of polychlorinated biphenyls is being eliminated, but it should be noted that these recommendations will limit occupational exposure no matter what fluid is used.

1. The recommendations in Appendix B should be considered.

2. During soldering operations the local exhaust systems that are present should always be used. Many times during our visit they were not used. The system utilized in the soldering operation located where the capacitors come out of the impregnation chambers would be more efficient if a larger duct opening was used to increase the area of capture.

3. The degreasers in the welding and plating areas should be checked for leaks since high concentrations of trichloroethylene were found around the area of the degreaser.

The tanks should be covered when not in use and if necessary an appropriate ventilation system used.

4. Even though some of the iron concentrations approached the current ACGIH TLV it is felt that proper use of existing local exhaust ventilation systems would reduce iron concentrations well below the TLV.

5. As stated in Appendix B, the letter dated June 7, 1977, to Mr. Robert Dyer, proper use of existing engineering and safety systems could greatly reduce worker exposure to hazardous materials.

APPENDIX A

Job Descriptions

Process Control - Insures that the impregnation chambers are working properly.

Boilerhouse Operator - In charge of the boiler room and makes sure furnaces are working.

Heaterman - Pumps polychlorinated biphenyls into and out of impregnation chambers.

Power Test Operator - Makes sure the finished capacitors operate properly.

Final Assembly - Prepares capacitors for shipping.

Solder/Hanger - Solders impregnation holes, moves capacitor to degreaser and then takes capacitor out of degreaser and places it on an overhead conveyor system.

Miscellaneous Assembly - Works in area near impregnation chambers.

Leak Test Operator - Tests capacitor to make sure it does not leak.

Painter - Paints capacitor.

Capacitor Repairman - Works on capacitors that have failed to pass inspections.

APPENDIX B

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

June 7, 1977

Robert Dyer
Supervisor, Personal Relations
Westinghouse Electric Corporation
Box 341
Bloomington, Indiana 47401

Dear Mr. Dyer:

As you requested during my visit to your facility the week of April 18, 1977, I am forwarding to you some preliminary recommendations. These recommendations, along with others, will be included in the final report of the industrial hygiene survey conducted at the Westinghouse facility in Bloomington, Indiana.

1) The ventilation system on the degreaser in area F-30 is not designed for maximum efficiency as it is only activated when the side doors are completely open thereby allowing vapors to escape. It should come on as soon as the doors start to open.

2) The ventilation system at the repair station in area F-30 is inadequate. Even if it did work properly, the vapors would have to flow past the worker's breathing zone to be collected by the exhuast system. Some form of a flanged slot local exhaust ventilation would be more efficient.

3) The hood above the oven in the engineering lab draws the air through the worker's breathing zone. One way to reduce the workers exposure would be to put the oven under a vacuum prior to opening the door. The exhaust ventilation system connected to the oven should turn on as soon as the door is opened.

4) Any exhaust duct located near a window should be properly constructed to prevent reentry of exhaust vapors into the building.

5) The side doors on the painting booth in area A-35 should be kept closed when painting is being done.

6) As was evident during our visit, one of the biggest problems is for workers to properly use the safety equipment which is provided (i.e. use of portable exhaust ducts while soldering and proper use of painting booths). Management and union representatives both need to make sure that workers know how to use the safety equipment provided and then follow up to make sure they are using it.

It should be noted that these are just preliminary recommendations and all final recommendations will be presented in the final industrial hygiene survey report.

Thank you for your cooperation during our recent visit.

Sincerely,

Mark W. Jones
Industrial Hygienist
Industrial Hygiene Section

cc:- J. Adams
C. Simms
K. Martin

MJONES/dm Rm. 537, Post Office Building, Cincinnati, Ohio 6/7/77

TABLE I

SUMMARY OF CONCENTRATIONS OF
POLYCHLORINATED BIPHENYLS (DETECTED AS AROCLOR 1016)
FOUND AT THE WESTINGHOUSE FACILITY
IN BLOOMINGTON, INDIANA ON APRIL 19-22, 1977

PERSONAL AIR SAMPLES			
Job Title	Number of Samples	Range ($\mu g/m^3$)	TWA ($\mu g/m^3$)
Process Control	2	34-100	67
Boilerhouse Operator	2	N.D.* - 8	4
Heaterman	3	42-74	59
Power Test Operator	4	48-98	71
Final Assembly	4	N.D. - 46	28
Solder/Hanger	7	69-222	153
Miscellaneous Assembly	4	61-171	115
Leak Test Operator	3	N.D. - 50	37
Painter	4	18-82	52
Capacitor Repairman	7	69-264	162

*N.D. - Non detectable (limit of detection 0.01 µg/tube)

TABLE II

CONCENTRATIONS OF POLYCHLORINATED BIPHENYLS
(DETECTED AS AROCLOR 1016) AT THE
WESTINGHOUSE FACILITY IN BLOOMINGTON, INDIANA
ON APRIL 19-22, 1977

PERSONAL AIR SAMPLES					
Job Title	Date	Total Sampling Time (min.)	Total Volume (liters)	Concentration ($\mu g/m^3$)	TWA ($\mu g/m^3$)
Process Control	4/21	451	87.9	100	67
"	4/20	462	89.0	34	
Boilerhouse Operator	4/20	377	79.9	N.D.**	4
"	4/19	388	83.1	8	
Heaterman	4/20	393	78.7	42	
"	4/19	418	80.8	74	59
"	4/21	437	76.3	61	
Power Test Operator	4/20	444	90.5	48	
"	4/21	446	82.9	82	71
"	4/20	346*	69.2	51	
"	4/21	431	86.2	98	
Final Assembly	4/21	449	91.5	46	
"	4/19	436	90.9	19	28
"	4/20	438	86.8	34	
"	4/19	220*	44.0	N.D.	
Solder	4/20	387	83.0	132	
"	4/19	445	84.1	69	
"	4/19	458	90.7	125	
Hanger	4/21	473	84.9	216	153

TABLE II (CONTINUED)

PERSONAL AIR SAMPLES					
Job Title	Date	Total Sampling Time (min.)	Total Volume (liters)	Concentration ($\mu g/m^3$)	TWA ($\mu g/m^3$)
Solder/Hanger	4/21	478	93.4	170	
Solder	4/19	452	88.9	122	
"	4/21	477	94.8	222	
Miscellaneous Assembly	4/20	461	86.3	171	
"	4/19	440	92.1	88	115
"	4/21	474	85.7	136	
"	4/19	443	92.9	61	
Leak Test Operator	4/20	458	81.0	50	
"	4/19	467	90.4	28	37
"	4/21	50*	10.0	N.D.	
Painter	4/20	453	85.5	72	
"	4/19	460	100.5	18	52
"	4/19	269	53.7	27	
"	4/21	460	89.0	82	
Capacitor Repairman	4/20	478	89.0	247	
"	4/21	462	96.2	264	
"	4/21	460	68.8	142	
"	4/20	462	86.1	133	162
"	4/19	460	92.4	80	
"	4/19	321*	64.2	69	
"	4/20	462	84.8	168	

*Calculated on assuming a flow rate of 200 cc/min. and the known volume
**N.D. - Non-detectable (limit of detection 0.01 µg/tube)

TABLE III

CONCENTRATIONS OF POLYCHLORINATED BIPHENYLS
(DETECTED AS AROCLOR 1016) AT THE
WESTINGHOUSE FACILITY IN BLOOMINGTON, INDIANA
ON APRIL 19-22, 1977

AREA AIR SAMPLES					
Location	Date	Total Sampling Time (min.)	Total Volume (liters)	Concentration (mg/m^3)	Concentration ($\mu g/m^3$)
Winding F-18	4/21	362	77.8	0.05	47
Office Area	4/22	454	84.6	0.03	26
A-20	4/21	338	74.6	0.03	29
A-35	4/21	353	76.6	0.01	5
G-44	4/21	356	72.0	0.03	26
F-41	4/21	360	71.4	0.05	52
E-50	4/21	368	75.6	0.07	71
D-40 (Arresters)	4/22	435	85.6	0.08	80
D-20	4/22	408	79.3	0.02	20
F-40	4/27	431	77.9	0.15	146
B-44	4/22	436	79.0	0.07	65
D-11	4/22	453	82.9	0.06	60
B-11	4/22	450	75.3	0.05	50
A-40	4/22	439	92.1	0.05	53
B-30	4/22	430	88.2	0.08	77
B-20	4/22	448	83.9	0.08	78

TABLE IV

RESULTS OF SMEAR WIPES COLLECTED AT THE
WESTINGHOUSE FACILITY IN BLOOMINGTON, INDIANA, ON APRIL 19-22, 1977

Job Title	Weight Before (µg)	Weight After (µg)
Solder	8.94	677
Solder	1.17	107
Hanger	2.40	39.1
Solder	6.46	14.0
Hanger	5.89	150
Heaterman	2.64	
Miscellaneous Assembly	0.00	9.84
Capacitor Repairman	0.85	240
Capacitor Repairman	8.94	35.6

TABLE V

ALUMINUM AND IRON CONCENTRATIONS
FOUND AT THE WESTINGHOUSE FACILITY, BLOOMINGTON, INDIANA
DURING WELDING OPERATION ON APRIL 19-22, 1977

Job Title	Date	Total Sampling Time (min.)	Total Volume (liters)	Aluminum Concentration (mg/m^3)	Iron Concentration (mg/m^3)
Welder	4/22	187	280.5	.57	--
"	4/22	237	355.5	.82	--
"	4/21	173	259.5	.62	--
"	4/21	209	313.5	.64	--
"	4/20	201	301.5	.70	--
"	4/20	147	220.5	.30	.22
"	4/22	191	286.5	.21	.12
"	4/21	164	246	--	3.25
"	4/19	149	223.5	--	3.49
"	4/22	256	384	--	1.28
"	4/20	200	300	--	5.00
"	4/20	155	232.5	--	1.76
"	4/19	180	270	--	N.D.

N.D. - Non-detectable (limit of detection 2.0 µg/filter)

TABLE VI

TOLUENE AND XYLENE CONCENTRATIONS
FOUND AT THE WESTINGHOUSE FACILITY
IN BLOOMINGTON, INDIANA ON APRIL 19-22, 1977

Job Title	Date	Total Sampling Time (min.)	Total Volume (liters)	Toluene		Xylene	
				Concentration ppm	TWA ppm	Concentration ppm	TWA ppm
Painter	4/20	358	40.5	3.3		2.6	
"	4/21	157	8.2	2.6		0.3	
"	4/22	248	12.0	0.9		0.4	
"	4/22	191	9.2	4.0	1.7	1.7	1.6
"	4/22	238	10.3	N.D.*		4.5	
"	4/22	169	6.0	N.D.		N.D.*	
"	4/22	248	12.0	0.7	0.5	0.4	
Set-Up Painter	4/22	179	7.8	0.7		9.1	5.3
"	4/22	249	12.4	0.4		2.6	

*Non-detectable (limit of detection .01 mg/tube)

TABLE VII

TRICHLOROETHYLENE CONCENTRATION FOUND
AT THE WESTINGHOUSE FACILITY IN BLOOMINGTON, INDIANA
NEAR DEGREASING OPERATIONS ON APRIL 19-22, 1977

Area	Date	Total Sampling Time (min.)	Total Volume (liters)	Concentration ppm
Degreaser - Plating Area	4/20	201	46.1	145.0*
Degreaser - Welding Area	4/19	176	16.0	289.6*
Degreaser - Plating Area	4/22	255	13.9	140.3
Degreaser - Plating Area	4/22	191	10.5	61.8

*Tube was saturated

TABLE VIII

1,1,1-TRICHLOROETHANE CONCENTRATIONS FOUND AT THE WESTINGHOUSE FACILITY IN BLOOMINGTON, INDIANA ON APRIL 19-22, 1977

Job Title/Location	Date	Total Sampling Time (min.)	Total Volume (liters)	Concentration (ppm)
Casting Assembly	4/21	190	11.3	12.4
F-30	4/19	129	16.5	339.3*
Hanger/Degreaser F-30	4/22	94	5.0	8.1
"	4/22	233	12.8	6.7

*Tube was saturated

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