U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 73-159-184

CONTINENTAL CAN COMPANY
WORTHINGTON, OHIO

APRIL 1975

I. TOXICITY DETERMINATION

It has been determined that the substances employed in epoxy powder spraying operations, isopropylidenediphenol epichlorohydrin and benzophenonone tetracarboxylic dianhydride (BTDA), at the Continental Can Company, Worthington, Ohio are not toxic at the concentrations measured during normal operations. This determination is based on results of environmental air measurements in the workplace, medical questionnaire and interviews, pulmonary function testing, and skin patch tests conducted on March 4 and 6, 1974, October 8 and 9, 1974 and November 13 and 14, 1974.

Medical observations and tests indicate a lack of chronic pulmonary effects from repeated exposure to epoxy powders as they are currently used at Continental Can Company. The fact that sustained exposure over the course of the day failed to show any acute changes in pulmonary function testing and that symptomatic individuals showed no acute changes on testing, suggest that only under certain circumstances will epoxy powder produce an irritant effect to the upper and/or lower respiratory tracts. Under these circumstances a cloud of epoxy powder may be generated, thus raising the concentration (of ambient air about cabinets) enough to produce irritation. Since this type of exposure and this type of work, as they relate to the maintenance of the powder cabinets, are intermittent, men should be required to wear an approved respiratory protective device when working in dusty environments. Factors that may be involved in the development of symptoms in addition to the dust exposure include individual susceptibilities, allergic history, history of asthma or hay fever, and cigarette smoking.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch (NIOSH), U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Continental Can Company, Inc., Worthington, Ohio
b) Authorized Representatives of Employees
c) U.S. Department of Labor - Region V
d) NIOSH - Region V

For the purposes of informing the approximately 40 "affected employees" the employer will promptly "post" the Determination Report in a prominent place(s) near where exposed employees work for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees to determine whether any substances normally found in the place of employment have potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health received such a request from an authorized representative of employees regarding exposures to Isopropylidenediphenol-Epichlorohydrin (an epoxy resin) and Benzophenonone Tetracarboxylic Dianhydride (a resin hardener) in the beer can fabricating department where the alleged health hazard exists.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Condition of Use

The Continental Can Company fabricates beer cans for Anheuser Busch Company. The alleged toxic substance is an epoxy powder containing 70 per cent Isopropylidenediphenol Epichlorohydrin (resin) and 29 per cent Benzophenonone Tetracarboxylic Dianhydride (hardener). The epoxy powder is applied by electrostatic charge which covers the bare metal seam of the can, then passes over gas-fired burners to hasten the curing of the epoxy. The cans are then cooled on a conveyor belt.

The company employs one hundred and fourteen (114) men and women of whom 36 (almost exclusively males) are directly employed in the fabrication of beer cans. These 36 people form the population studied in this hazard evaluation and are employed in the following capacities: 27 line maintainers; 7 slitters, and 2 relief operators. Continental Can Company maintains three shifts per day, and of these 36 people, 12 individuals work per shift.

B. Evaluation Design and Methods

1. Preliminary Survey

A preliminary observational survey of the epoxy powder spraying operations was made on December 5 and 6, 1973 to assess the alleged hazard. During this visit eight personal samples were collected. Four air dust samples were collected for total dust and four air dust samples were collected for respirable dust fraction. Of the eight samples collected only two samples recorded measurable mass concentrations.

The two respirable dust measurements reported were 0.6 mg/M^3 and 0.4 mg/M^3. The other six samples were below detectable limits. Size distribution information obtained from bulk and air sample microscopic analyses showed 95% of the particles are less than one micron. No federal standard currently exists for occupational exposure to this epoxy dust.

In conjunction with environmental sampling, 22 employees were briefly interviewed during the first and second shifts for alleged health problems associated with their work environment. At that time, it was deemed necessary that a follow-up survey be conducted and a more in-depth analysis of employee exposures to epoxy powder be carried out. These decisions were based upon: (1) The results of the medical interviews conducted during the initial survey visit in December 1973; (2) the presence of substances in the workplace without a standard; and (3) the need for research dealing with substances that may be used extensively in the can industry in the future.

2. Follow-up Medical and Environmental Surveys

On March 4 and 6, 1974, a follow-up environmental and medical survey was conducted on the first and second shifts. Breathing zone and work area samples were obtained using PVC filters and MSA vacuum pumps operating at 1.5 liters per minute. The filters were analyzed for total dust and the respirable fraction of the dust.

Twenty-two (22) male employees from the Beer Can Fabricating Department were evaluated. All were currently working on the first or second shifts and were judged to be suitable representatives because the work is continuous and identical on all shifts. Because all the employees work in the same environment and thus are exposed to the epoxy resin and hardener to a greater or lesser extent, no suitable control group could be selected. The workers, therefore, served as their own controls.

A respiratory questionnaire (modified British Medical Research Council questionnaire)1 dealing with general medical and occupational history and symptoms related to present work exposure was administered to the study group. Three (3) shorter questionnaires were also administered preceding and following the shift of March 4, 1974, and after the shift of March 6, 1974, to determine symptoms already present prior to the shift and those developing during or after the shift.

Pulmonary function tests were performed on all participants prior to and following the shift (both first and second) on Monday, March 4, 1974. Furthermore, the participants were retested after their respective shifts on March 6, 1974. Each test required the employee(s) to perform two (2) practice, forced expiratory volume maneuvers after which at least three similar maneuvers were performed in order to obtain three (3) values reproducible within five per cent (5%). A waterless, high fidelity spirometer was utilized. Analysis of the mechanically recorded graphs provided the following parameters: (1) forced expiratory volume in one second (FEV 1), and (2) forced vital capacity (FVC). Tables II and III contain the results of the pre- and post-shift pulmonary function tests of the men on the first and second shifts. These values do not represent a mean but rather represent the subject's "best" effort derived from the "best" tracing of three maneuvers. Predicted values were derived from formulae based on the data of the VA-ARMY Cooperative Study.[3]

During the March 1974 visit, cutaneous patch testing was carried out utilizing two epoxy resin solutions and an acetone control solution. Five employees who stated that they previously had dermatitis and three control individuals were skin tested. All three test solutions were pretested on male albino rabbits and rabbit skin irritation indices developed.

On October 8 and 9, 1974, a follow-up medical survey was conducted. Thirty-five men employed as line maintainers, body feeders, relief operators and body slitters were specifically questioned with regard to symptoms developing after exposure to epoxy powder. From this group fourteen (14) men, who were judged to be most symptomatic after epoxy powder exposure, were selected for repeat pulmonary function testing which was conducted on November 13 and 14, 1974. Only 12 out of the original 14 were tested. The purpose of these tests was to determine the presence or absence of chronic residual pulmonary dysfunction and not acute effects which had been ruled out by previous pulmonary function testing in March 1974.

C. Evaluation Criteria

No Federal standard currently exists for occupational exposure to epoxy dust. Epoxy hardners are not considered inert dusts.

The American Conference of Governmental Industrial Hygienists (ACGIH) in its notice of intended changes of threshold limits values (TLV) in 1975, proposed 1 mg/M^3 for benzophenone tetracarboxylic dianhydride (BTDA).

D. Evaluation Results and Discussions

1. Environmental

A total of twenty-six air dust samples were collected, twenty-two personal and four general room samples on the first and second shifts at the Continental Can Company, Beer Can Fabricating lines on March 4-6, 1974. The average sampling time was six to seven hours as presented in Table I. The twenty-two personal air dust samples collected for respirable fraction ranged from 0.10 mg/M^3 to 1.23 mg/M^3. The two respirable fraction bulk air samples ranged from 0.89 mg/M^3 to 1.53 mg/M^3, the two bulk air samples for total dust ranged from 0.80 mg/M to 2.61 mg/M^3.

The air dust samples were analyzed by the Division of Laboratory and Criteria Development, NIOSH, Cincinnati, Ohio.

2. Medical

Medical Questionnaire

The respiratory questionnaire dealing with general medical and occupational history and symptoms related to present work exposure was administered on March 4 and 6, 1974. Three (3) shorter questionnaires designed to determine symptoms already present prior to shift and those developing acutely during or after shift were administered.

The sample interviewed consisted of 22 men whose average time in the employ of Continental Can Company was 3 years (range: 2 months to 6 years). Their mean age was 29 years (range: 20 years to 45 years). Of the 22 men, 14 were either active cigarette smokers or had formerly been smokers but were no longer so. Eight men had never used tobacco.

The results of this questionnaire revealed seven (7) men (6 smokers and 1 non-smoker) gave a history of persistent cough, chronic production of phlegm and shortness of breath which are common symptoms and cannot in and of themselves, constitute a diagnosis of chronic pulmonary disease. Without a control group these symptoms cannot be fully evaluated; however, subsequent pulmonary function in these men with exception of one person failed to establish any pulmonary function abnormalities consistent with chronic pulmonary disease.

Seven men (5 smokers and 2 non-smokers) gave a history of the development of chest symptoms after exposure to epoxy powder. These symptoms included sore throat, dry throat, stuffy nose, runny nose, chest discomfort, chest tightnees, shortness of breath, and cough. Of the 5 smokers, two gave a history of symptoms consistent with chronic pulmonary disease and four gave a history of work related symptoms of "occasional cough". Both non-smokers gave a history of an "occasional cough". Two men who were both active cigarette smokers developed symptoms after exposure to epoxy powder (on the day of the NIOSH visit). Both men complained of dry throat, stuffy nose, chest tightness and shortness of breath. Their pulmonary function tests revealed no significant acute changes in FVC or FEV_1 over the course of the day during which time they developed these symptoms.

Reviewing the past medical histories, it was ascertained that 5 out of 22 workers had a history of skin problems and one man reported a history of "asthma."

A subsequent medical survey concentrating on symptoms developing after exposure to epoxy powder was carried out in October 1974. Thirty-five men were interviewed. From this survey it was learned that 13 men (10 smokers and 3 non-smokers) gave a history of developing chest symptoms after exposure to epoxy powder under certain intermittantly circumstances. The circumstances most frequently mentioned (by 9 out of 13 men) involved: filling or changing of powder boxes, the cleaning out of the powder cabinets, and maintenance of the powder cabinets. The symptoms most frequently noted include dry throat, sore throat, stuffy nose, runny nose, chest discomfort, shortness of breath, cough and occasional wheezing. The only type of respiratory protection available was a cotton surgical mask to be worn over nose and mouth. On the October and November visits, none were in visible use.

Pulmonary Function Results

The data for the 22 subjects studied in March 1974 were compiled and were divided into four groups: group A, 1st shift smokers; group B, 1st shift non-smokers; group C, 2nd shift smokers, and group D 2nd shift non-smokers. (Tables II and III.)

There were no significant, acute changes in FEV_1 or FVC over the course of the day except in one instance (P.G.) where both FVC and FEV_1 decreased by 14% and 13% of predicted, respectively. Such changes are hard to interpret but suggest a less than maximal forced expiration rather than acute airway obstruction. Repeat tests on this individual in November 1974 were entirely normal. Acute airway obstruction was judged significant when the post-shift FEV_1 diminished by more than 10% of the pre-shift value and the FVC remained with 80% of the predicted value. No significant airway obstruction developed in March 1974. In the two individuals who developed symptoms during that NIOSH visit, there were no significant acute airway obstruction as measured by spirometry.

The data for the 12 subjects studied in November 1974 were compiled (Table V) and were divided into two groups: group E, smokers and group F, non-smokers. The predicted values again were derived from the VA-Army Cooperative Study. These data together with the test results found in Tables II and III were analyzed for chronic pulmonary dysfunction. In all instances except two, all observed values for FVC and FEV_1 were within 80% of the predicted values, matched for age, height, sex and race.[3] This suggests there is no chronic intrinsic lung disease. In the two instances noted above, one individual had observed FVC and FEV_1 that were both 79% of predicted and were only slightly abnormal. As we noted above, this type of abnormality is hard to interpret; we were unable to retest this person. In the other individual who was an active cigarette smoker, his observed FEV_1 was 76% of predicted with a normal FVC; however, retesting in November 1974 showed both FVC and FEV_1 to be entirely normal.

Statistical analysis of the pulmonary function data (Table V) revealed no statistically significant differences between pre- and post-shift data for smokers and non-smokers. Moreover, there did not appear to be any significant difference between observed and predicted values of FVC and FEV_1 for the group as a whole.

The results of the medical questionnaires and pulmonary function tests indicate a lack of chronic pulmonary effects from repeated exposure to epoxy powders as they are currently used at Continental Can Company. The fact that sustained exposure over the course of the day failed to show any acute changes in pulmonary function testing and that symptomatic individuals showed no acute changes on testing suggest that only under certain circumstances will epoxy powder produce an irritant effect to the upper and/or lower respiratory tracts. Under these circumstances a cloud of epoxy powder may be generated, thus raising the concentration in the ambient air about the cabinets enough to produce irritation. Since this type of exposure and this type of work, as they relate to the maintenance of the powder cabinets, are intermittent, men should be required to wear an

approved respiratory protective device for working in dusty environments. Factors that may be involved in the development of symptoms in addition to the dust exposure, include individual susceptibilities, allergic history, history of asthma or hay fever, and cigarette smoking.

Skin Test

Five employees who had given a past history of skin disease and three controls were skin patch tested. All those tested had negative results although it must be mentioned that the patch tests applied to the employees were not adequately attached due to the employee's movement and perspiration.

E. Conclusion

Based on the environmental air measurements in the workplace, medical questionnaires and interviews, pulmonary function testing and skin patch tests, it has been determined that concentrations of epoxy powder isopropylidenediphenol epichlorohydrin and benzophenonone tetracarboxylic dianhydride at Continental Can Company, Worthington, Ohio are not toxic to exposed employees at the concentration measured during normal operation. There is, however, some evidence that toxic exposures may occur under some circumstances such as filling or changing powder boxes, the cleaning out of the powder cabinets and the maintenance of powder cabinets.

V. REFERENCES

1. Medical Research Council's Committee on the Aetiology of Chronic Bronchitis: Standardized Questionnaire on Respiratory Symptoms. Brit. Med. J., 2:1665, 1960.

2. Kory, R.C., et al. The Veterans Administration-Army Cooperative Study of Pulmonary Function, Am. J. Medicine, February 1961, pp 243-258.

3. Lapp, N.L., et al. Lung Volumes and Flow Rates in Black and White Subjects, Thorax, 29:185, 1974.

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TABLE I

SUMMARY OF ENVIRONMENTAL RESULTS AT CONTINENTAL CAN COMPANY
WORTHINGTON, OHIO

DATE	TIME	SHIFT	CLASSIFICATION	LOCATION	TYPE OF SAMPLE	AIRBORNE DUST CONCENTRATION mg/M^3* TOTAL DUST	RESPIRABLE FRACTION
3-4-74	7:22am - 2:10pm	1st	Slitter Operator	Line 1	(BZ)	-	0.29
3-4-74	7:33am - 2:23pm	1st	Line Maintainer	Line 1	(BZ)	-	0.18
3-4-74	7:46am - 2:28pm	1st	Line Maintainer	Line 1	(BZ)	-	0.10
3-4-74	7:55am - 2:34pm	1st	Line Maintainer	Line 2	(BZ)	-	0.41
3-4-74	8:06am - 3:23pm	1st	Line Maintainer	Line 2	(BZ)	-	0.29
3-4-74	8:17am - 2:58pm	1st	Slitter Operaton	Line 2	(BZ)	-	0.31
3-4-74	8:28am - 2:50pm	1st	Line Maintainer	Line 3	(BZ)	-	0.34
3-4-74	8:40am - 3:17pm	1st	Slitter Operator	Line 3	(BZ)	-	0.30
3-4-74	8:50am - 3:24pm	1st	Relief Operator	All Lines	(BZ)	-	0.30
3-4-74	9:01am - 2:40pm	1st	Line Maintainer	Line 4	(BZ)	-	0.35
3-4-74	9:10am - 3:05pm	1st	Slitter Operator	Line 4	(BZ)	-	0.54
3-4-74	9:48am - 3:15pm	1st	Relief Operator	All Lines	(BZ)	-	0.37
3-4-74	10:28am - 4:12pm	1st	At Epoxy Sprayer	Line 1 Leg 2	(GA)	0.80**	-
3-4-74	10:28am - 4:12pm	1st	At Epoxy Sprayer	Line 1 Leg 2	(GA)	-	1.53**
3-4-74	3:50pm - 7:15pm	2nd	Line Maintainer	Line 1	(BZ)	-	1.23
3-4-74	3:59pm - 9:05pm	2nd	Line Maintainer	Line 1	(BZ)	-	0.63
3-4-74	4:08pm - 10:40pm	2nd	Line Maintainer	Line 2	(BZ)	-	0.09
3-4-74	4:19pm - 10:52pm	2nd	Line Maintainer	Line 2	(BZ)	-	0.33
3-4-74	4:29pm - 10:15pm	2nd	Slitter Operator	Line 2	(BZ)	-	0.13
3-4-73	4:34pm - 10:53pm	2nd	Line Maintainer	Line 3	(BZ)	-	0.46
3-4-74	4:46pm - 10:56pm	2nd	Line Maintainer	Line 3	(BZ)	-	0.32
3-4-74	4:55pm - 10:50pm	2nd	Line Maintainer	Line 4	(BZ)	-	0.34
3-4-74	5:05pm - 10:24pm	2nd	Slitter Operator	Line 4	(BZ)	-	0.38
3-4-74	5:38pm - 10:31pm	2nd	Relief Operator	All Lines	(BZ)	-	0.41
3-4-74	4:14pm - 10:24pm	2nd	At Epoxy Sprayer	Line 1 Leg 2	(GA)	2.61**	-
3-4-74	4:14pm - 10:24pm	2nd	At Epoxy Sprayer	Line 1 Leg 2	(GA)	-	0.89**

* - milligrams of particulate per cubic meter of air
** - Bulk air samples - collected at the rate of 9.0 liters per minute
BZ - Personal breathing zone air samples
GA - General area
No Federal Standard for epoxy dust, 1975 proposed TLV for BTDA 1 mg/M^3

TABLE II

PULMONARY FUNCTION TEST - FIRST SHIFT - MARCH 1974

Personal Identification	PRE SHIFT				POST SHIFT			
	FVC	(% Predicted)	FEV_1	(% Predicted)	FVC	(% Predicted)	FEV_1	(% Predicted)
	A. SMOKERS							
1	6.55	(116%)	4.55	(103%)	6.61	(117%)	4.6	(104%)
2	3.95	(91%)	3.20	(92%)	3.80	(88%)	3.3	(96%)
3	5.00	(97%)	3.89	(93%)	5.51	(101%)	4.0	(96%)
4	4.00	(89%)	3.10	(85%)	3.95	(88%)	2.8	(76%)
5	4.21	(91%)	3.6	(95%)	4.2	(90%)	3.5	(92%)
6	4.12	(93%)	3.25	(92%)	4.0	(89%)	3.2	(91%)
7	4.5	(97%)	3.2	(85%)	4.4	(95%)	3.3	(88%)
	B. NON-SMOKERS							
8	5.3	(101%)	4.85	(109%)	5.5	(104%)	4.9	(111%)
9	5.35	(99%)	4.50	(101%)	5.55	(103%)	4.65	(104%)
10	4.05	(79%)	3.3	(79%)	3.95	(77%)	3.33	(79%)
11	5.7	(99%)	4.3	(91%)	5.6	(97%)	4.15	(87%)
12	5.9	(109%)	4.7	(106%)	5.65	(105%)	4.50	(101%)

TABLE III

PULMONARY FUNCTION TEST - SECOND SHIFT - MARCH 1974

Personal Identification	PRE SHIFT				POST SHIFT			
	FVC	(% Predicted)	FEV_1	(% Predicted)	FVC	(% Predicted)	FEV_1	(% Predicted)
	C. SMOKERS							
13	5.3	(91%)	3.6	(77%)	5.21	(89%)	3.9	(83%)
14	5.0	(97%)	4.3	(101%)	4.3	(83%)	3.75	(88%)
15	5.5	(96%)	4.5	(95%)	5.3	(92%)	4.5	(95%)
16	4.9	(101%)	4.1	(103%)	4.8	(99%)	4.5	(113%)
17	5.65	(102%)	4.40	(97%)	5.58	(101%)	4.8	(105%)
18	5.0	(92%)	3.7	(83%)	5.0	(92%)	3.7	(83%)
19	5.05	(91%)	4.15	(92%)	5.0	(90%)	4.0	(89%)
	D. NON-SMOKERS							
20	5.05	(88%)	3.8	(82%)	4.95	(86%)	3.7	(80%)
21	4.4	(90%)	3.65	(90%)	4.0	(82%)	3.45	(85%)
22	6.6	(124%)	5.05	(118%)	6.5	(123%)	5.0	(117%)

TABLE IV

STATISTICAL ANALYSIS FOR MEAN VALUES - MARCH 1974

	Pre Shift FVC	Pre Shift FEV_1	Post Shift FVC	Post Shift FEV_1	
All Smokers	4.91	4.37	4.81	3.80)	No significant difference
Non-Smokers	5.29	4.71	5.21	4.21)	at 5% level
Observed	5.05	3.99	4.95	4.40)	No significant difference
Predicted	5.20	4.23	5.20	4.23)	at 5% level

TABLE V

PULMONARY FUNCTION TEST - NOVEMBER 1974

Personal Identification	OBSERVED VALUES			
	FVC	(% Predicted)	FEV_1	(% Predicted)
	E. SMOKERS			
1	6.80	(121%)	4.60	(104%)
13	5.65	(97%)	4.30	(91%)
16	4.90	(101%)	4.35	(109%)
5	4.47	(96%)	3.75	(99%)
2	3.85	(89%)	3.40	(99%)
14	5.32	(103%)	4.67	(110%)
19	5.14	(93%)	4.38	(98%)
23	7.15	(129%)	6.28	(137%)
24	4.07	(86%)	3.50	(89%)
25	6.43	(109%)	5.45	(114%)
	F. NON-SMOKERS			
8	5.55	(105%)	4.96	(112%)
21	4.21	(86%)	3.80	(94%)