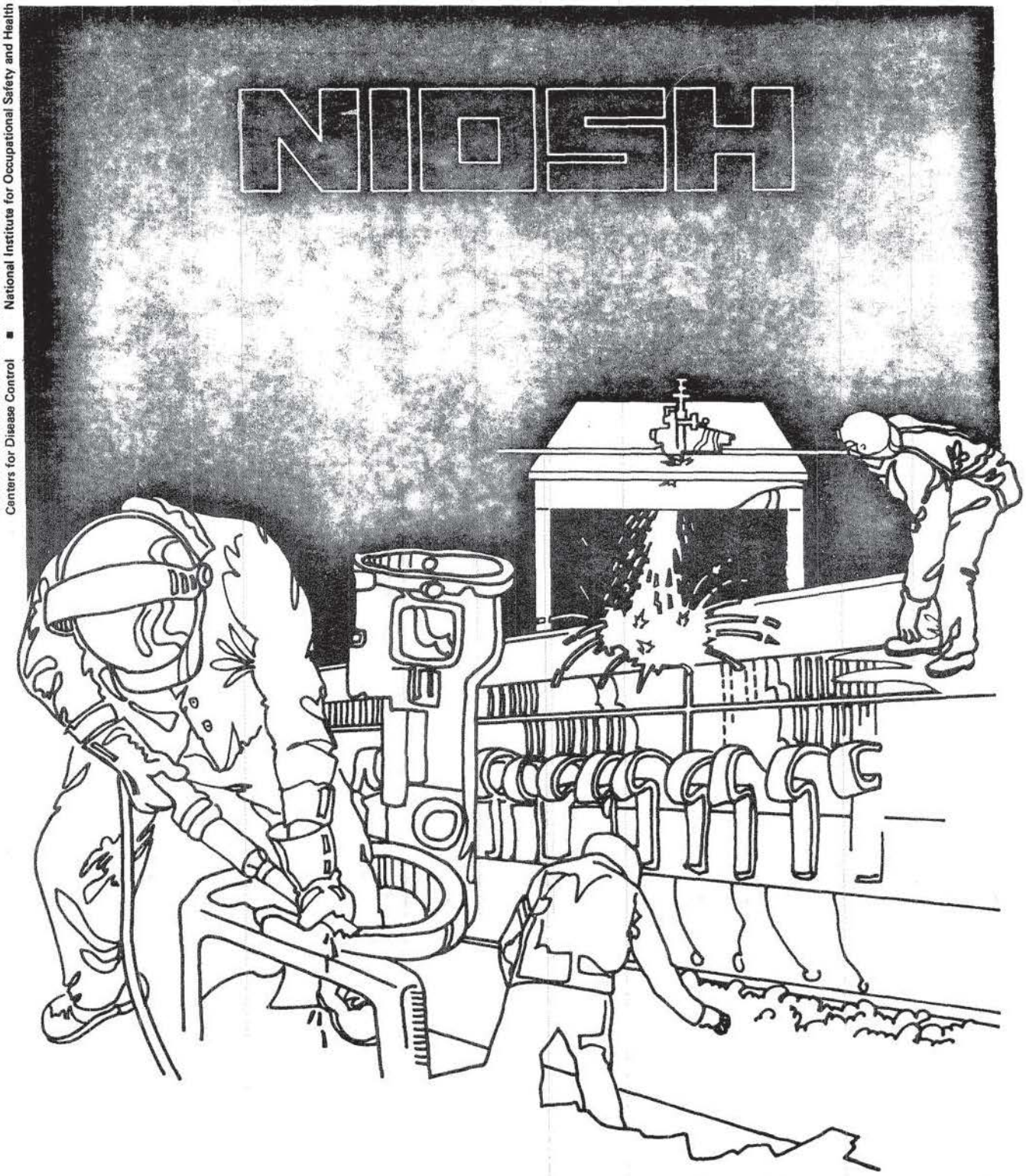
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

79-087-778

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 699(a)(6), which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HE 79-087-778
DECEMBER 1980
KAWECKI BERYLCO INDUSTRIES, INC.
BOYERTOWN, PENNSYLVANIA

NIOSH INVESTIGATORS:
Walter J. Chrostek, IH
Donald L. Slovin, M.D.

I. SUMMARY

On August 9, 1978, NIOSH received a request from the International Chemical Workers Union, Local 619, for a health hazard evaluation at the Kawecki Berylco Industries, Incorporated plant, Boyertown, Pennsylvania. The request alleged adverse health effects, such as dermatitis and upper respiratory irritation, from exposure to fluorides and pneumoconiosis from exposures to carbides. On September 6, 1979, NIOSH personnel conducted the initial walk-through at the plant. Follow-up medical and environmental studies were done in December, 1979, and in February and March, 1980.

Possible respiratory effects of carbides and diborides were evaluated by questionnaire, pulmonary function tests, and chest x-ray. Workers exposed to carbides and diborides had similar chest x-ray and questionnaire results when compared to other workers. The pulmonary function tests were lower for exposed workers, but not by a statistically significant amount. Production workers who had worked at the plant for more than 15 years had lower lung capacity that other workers.

Health effects of fluorides were evaluated by questionnaire and by measurement of urinary fluorides. Urine fluoride levels were within recommended limits, although higher for exposed workers than for those not exposed. Some workers were found to experience the irritative effects of fluorides, such as nasal irritation and slowly healing cuts.

Personal breathing zone air samples were collected in building 005 for total and respirable dust and titanium diboride. Exposure to carbides was not evaluated, as exposure is very intermittent and of short duration. Exposure to particulate matter and titanium diboride were within the presently accepted limits.

The airborne concentrations of the combined particulate and gaseous fluorides (3161-3600 micrograms per cubic meter(ug/M^3) of air sampled) exceeded acceptable levels during the pumping of hydrofluoric acid from drums and drum washing, and may exceed them during malfunctions (Table VI).

On the basis of the data collected, NIOSH determined that workers involved in pumping of hydrofluoric acid from drums and in drum washing may be exposed to unacceptable levels of hydrofluoric acid. Workers continue to experience irritative effects of fluoride. Air levels of titanium diboride were within presently accepted limits. While pulmonary function tests showed no clear effects of carbides and diborides, a chronic effect on lung function is a possibility. Compared with other workers, those with more than 15 years experience at the plant had lower vital capacity. Medical and environmental recommendations are incorporated in this report.

KEYWORDS: SIC 2819 (Inorganic Chemicals), fluorides, total and respirable dust, titanium diboride, boron carbide.

II. Introduction

Under the Occupational Safety and Health Act of 1970, NIOSH investigates the toxic effects of substances found in the workplace. On August 9, 1979, NIOSH received a request from the International Chemical Workers Union, Local 619 for a health hazard in Buildings 001, 005, 017, 018, 019, 032, and 073 at the Kawecki Berylco Industries plant in Boyertown, Pennsylvania. The request alleged adverse health effects, such as dermatitis and upper respiratory irritation, from exposure to fluorides, and it raised the possibility of pneumoconiosis from exposure to carbides and diborides. NIOSH personnel met with management and union representatives for the opening and closing conferences, performed a walk-through survey and interviewed nine employees. A follow-up medical evaluation was performed on December 12-14, 1979, and environmental studies were done on December 17-18, 1979; February 11-13, 1980; March 4, 1980; and March 27, 1980.

Interim reports were mailed to concerned parties in September 1979, and January 1980. Workers were notified of the results of their medical tests in February and March 1980.

III. Background

In 1978, OSHA performed environmental evaluations at this plant. Certain areas were cited, but the International Chemical Workers Union, Local 619 felt that adverse health effects from fluoride exposure were continuing even in areas which had not been cited. The union also expressed concern that while carbide and diboride are currently assumed to be nuisance dusts, they may be causing pneumoconiosis.

The plant is primarily involved in the production of metals, chemicals and alloys. Basic fluoride chemistry is used to digest ores with hydrogen fluoride to high purity fluorides and oxides. The basic processes include digestion, separation, crystallization, drying, crushing, reduction, alloy production in a foundry, annealing and consolidation into final products.

Building 017 is a drying room where titanium fluoride and zirconium fluoride are dried in a rotary kiln.

IV. Evaluation Design and Methods

A. Medical

Two medical studies were performed as part of this evaluation: one evaluated health effects of carbides and diborides, the other evaluated fluorides.

a) Carbides/Diborides

The carbide/diboride study addressed possible lung effects from exposure to these materials. For the purposes of this study, a worker was considered potentially exposed to carbides and diborides if he or she had worked at any time in the building 005, since this was the building where diborides and carbides are made and boron carbide used.

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Twenty-eight employees were recorded or recollected by management, fellow employees, or themselves, as having worked in Building 005. Of these, twenty-seven are still employed at the plant; twenty six (93%) participated in this study.

Twenty-six workers who had never worked in Building 005 and had, to their knowledge, no other exposure to carbides or diborides, participated as controls.

A questionnaire directed primarily toward the respiratory system was administered to each participant. Each participant also had a chest x-ray and a pulmonary function test. Pulmonary function tests were performed on a Medistor electronic spirometer with a pneumotachograph. Measurements were made of forced vital capacity (FVC), which is the amount of air one can blow out of the lungs after taking a deep breath; and forced expiratory volume (FEV_1), which is the amount of this air expired in the first second. The predicted values for FEV_1 and FVC were calculated for each person according to the method of Morris[1]. Each person was tested at least three times and the values used were from the best effort.

Chest x-rays were interpreted by a radiologist "B" reader according to the UICC/Cincinnati Classification of Radiographic Appearances of Pneumoconoisis.

b) Fluorides
To evaluate the effects of fluorides, a questionnaire concentrating on symptoms often found with hydrogen fluoride exposure (nosebleeds, nasal septal perforation, eye and upper respiratory tract irritation, slowly healing cuts, skin problems) was administered to forty-two employees working, at the time of this survey, in Buildings 001, 017, 018, 019, and 032. For each of these employees a urine sample was analyzed for fluoride by the method described by Tusl.[2]

Controls for the questionnaire were chosen from among employees who had had little or no occupational exposure to fluorides. Most of these worked in the research and development (R&D) section of the plant.

Controls for the urinary fluoride testing were chosen from among employees not exposed to hydrogen fluoride within the six month prior to testing. Most of these worked in the R&D section, the rolling mill, or the wire mill.

B. Environmental

a) Carbides/Diborides
Employee exposures were evaluated in Building 005. Personal breathing zone samples were collected side-by-side, one total dust sample and one respirable dust sample on opposite lapels. They were collected with MSA model G pumps operating at 1.7 liters-per-minute (LPM) and closed face cassettes containing 2.0 um polyvinyl chloride filters. A nylon cyclone preceded the respirable filter. These samples were subsequently analyzed gravimetrically. Following this analysis, these samples were submitted to a qualitative and quantitative analysis by x-ray diffraction (XRD).

Qualitative Analysis

Each FWSB filter was mounted on an XRD holder and was analyzed qualitatively by scanning 16-52° 2θ using copper x-ray radiation. The resulting x-ray patterns were compared to the pure patterns of titanium diboride, (TiB_2) boron carbide (B_4D) and titanium dioxide (TiO_2). Only the titanium diboride pattern was present in every sample except in the two blanks. The area sample taken at the removing-charge operation (#4817) showed the presence of TiO_2 in addition to TiB_2.

Quantitative Analysis

Each filter including the blanks was washed in a low temperature radiofrequency plasma asher. The ash was suspended in isopropanol dispersed ultrasonically and redeposited on 0.45 um silver membrane filters. Each filter was analyzed quantitatively by scanning the secondary TiB_2 peak 33.50 -- 34.80° 2θ. The area counts were converted to micrograms from the TiB_2 calibration curve.

b) Fluorides (particulate and gaseous)
Personnel exposed to gaseous and particulate fluorides were evaluated by utilizing breathing zone samples. The samples were collected on 0.8 micron mixed cellulose ester filters and alkali filters utilizing personal sampling pumps (1.5-1.7 LPM).[3] These samples were subsequently analyzed by NIOSH method P&CAM No. 212[3]. The limit of detection was 2 micrograms per sample.

V. EVALUATION CRITERIA

A. Medical
Carbides/Diborides
For some pneumoconioses a chest x-ray will often demonstrate the presence of disease, while for others pulmonary function tests are required. If the effect of the dust or of tissue damage is largely of the kind termed "restrictive", a decrease is expected in the total lung volume, which is reflected by a decrease in functional vital capacity (FVC), while if the effect is obstructive (asthma-like), a decrease in the FEV_1 and FEV_1/FVC, that is, a decrease in the ability to blow air out of the lungs quickly, would be expected. FEV_1 and FVC are expressed as a percentage of the normal value predicted for the age, height, and sex of the individual, 80% or greater of the predicted value being considered normal. FEV_1/FVC should be at least 70%.

B. Environmental
The following environmental standards for this evaluation were taken from three sources, viz OSHA, NIOSH, and ACGIH. Since carbides and titanium diboride do not have specific standards, they are regulated as "inert" or "nuisance" dusts (less than 1 percent quartz).

SUBSTANCE	OSHA[4]	NIOSH[5]	ACGIH[6]
Nuisance Dust*	15		10
Fluoride (as F)**	2500	2500	2500
Fluorine**	200		2000
Hydrogen fluoride (as F)**	2000		2000

*Denotes milligrams of cantaminant per-cubic-meter of air sampled.
** Denotes micrograms of contaminant per-cubic-meter of air sampled.

VI. Toxicity

A. Carbides/Diborides

Pneumoconiosis may be defined as the presence of inhaled dust in the lungs and the tissue reaction of the lungs to this dust.[7] This reaction can be benign, can cause asthma-like symptoms (for example, cotton dust), or can cause fibrosis (scarring) in the lungs (for example, asbestos and silica).

Tungsten carbide is known to cause a pulmonary fibrosis (hard metal disease), generally thought due to cobalt which is a constituent of the tungsten carbide.[8] Titanium diboride and boron carbide have been considered relatively non-toxic. However, a Russian investigator reported finding pulmonary fibrosis and fatty degeneration of the liver in animals to which titanium diboride was administered intratracheally. Similar, though milder, effects were found using boron carbide. No such effects were found when zirconium, chromium, or titanium carbide were administered.[9] The author hypothesized that the fibrogenic effect of titanium diboride and baron carbide was due to the boron. Thus, the toxic status of these two materials is, at present, uncertain and awaits further study. At present the recommended permissible exposure level is that for a nuisance dust.

B. Fluorides

Fluoride is highly irritating, causing skin burns, eye irritation, and other mucous membrane effects such as nosebleeds and perforation of the nasal septum. Instances of acute pulmonary absorption have caused pulmonary edema and death. Chronic absorption of fluoride can cause osteosclerosis, which is seldom disabling. There are no other known chronic effects of fluoride absorption in adults.

VII. Results

A. Medical

a) Carbides/Diborides

Results of the pulmonary function tests are listed in Table I. For the purpose of analysis, potentially exposed workers were divided into groups as follows:

Group I - those production workers who had worked in Building 005 for more than four months (9 workers);

Group II - those workers in Group I whose work in Building 005 was performed at least two years prior to the study, that is, prior to December, 1977 (7 workers);

Group III - research and development workers who had spent time in Building 005 (13 workers).

Listed in column four are the 26 R&D and production workers not exposed to carbides and diborides who were used as controls. In column five are listed the production workers among these controls. There were no statistically significant differences when Groups I, II, and III were compared to controls for age and smoking (student t test).

FEV_1 and FVC were lower for production workers who had worked in Building 005 (Groups I and II) than for R&D workers (Group III) or for controls. Also, pulmonary funcion test results were better for R&D workers exposed to carbide/diboride than for production workers exposed to these materials. None of these differences were statistically significant, however.

Pulmonary function tests were also analyzed according to work history, as shown in Table II. Workers in the production areas are listed according to how long they worked at the plant, and are compared to all R&D employees. Thus, the comparisons in this table do not involve exposure to carbides or diborides. It will be noted that the mean FEV and the mean FVC for workers with 16 or more years of service are below normal (that is, less than 80% of predicted). Moreover, these two means are significantly lower than the means for R&D workers. FEV_1/FVC is similar in these two groups.

Also listed on Table I are the numbers of employees who answered "yes" to questions about chronic cough and phlegm. There are no statistically significant differences between each group and controls for the answers to these questions.

Of the 52 chest x-rays taken, 44 (85%) were read as normal. Of the remaining eight films, four were abnormal as a result of past medical conditions probably unconnected with occupation (inflammatory changes, granulomas, cardiac enlargement). The remaining four x-rays had the following findings:

1. pleural thickening
2. emphysema
3. small nodule of unknown cause
4. a few small rounded and irregular opacities less than 3 mm.in diameter (UICC/Cincinnati classifications type q and s for rounded and irregular opacities, respectively, with profusion 0/1 for both types).

Two of these four occurred in workers who had worked in Building 005. Another was an x-ray of an R&D worker who had worked in Building 005. The remaining x-ray was of an employee who had worked mostly in Building 032, 019, and master alloys.

b) Fluorides
All urine fluorides were below the NIOSH recommended limits of 4.0 mg/l in a preshift urine.

Table III lists the results of urine fluorides according to the building where the employees were working. While the means are within recommended limits for all buildings, they are significantly higher in the exposed workers than in controls.

Bottled water at the plant had a fluoride concentration of 0.057 mg/l. Two water samples from Boyertown had 0.055 mg/l of fluoride, indicating that these water samples were not fluoridated. Therefore, while well water in the area was not tested, fluoride in drinking water probably had little effect on these results.

For the questionnaire, participants were queried as to the presence or absence, during the two days preceding the study, of various symptoms. The results of their answers to some of these questions are summarized in Table IV.

Workers in K-cell (032) complained of eye irritation significantly more often than did controls ($p=0.0093$ Fisher's Exact Test).

Workers in the drying room (017) had slowly healing cuts significantly more often than did controls ($p=0.00667$ Fisher's Exact Test).

Workers in Building 032 had nasal stuffiness significantly more often than did controls ($p.=0.0097$ Fisher's Exact Test).

No significant differences were found in comparing nosebleeds, sore throats, wheezing, chest pain, nausea, or skin rashes.

B. Environmental
a) Carbides/Diborides
The results (Table V) showed that the employee total carbide/diboride dust exposure ranged from 5.07 to 7.76 milligrams per cubic meter of air sampled (mg/M^3) which compared very well with the OSHA result, taken in August 1978 of 7.41 mg/M^3. Respirable dust concentrations ranged from 0.37 to 1.10 mg/M^3.

The results (Table V) of the environmental sampling for titanium diboride (TiB_2) showed that the total TiB_2 ranged from 0.78 to 6.60 mg/M^3 and the respirable from non-detected to 1.75 mg/M^3.

b) Fluorides
Exposures were evaluated for both the particulate and gaseous fluorides. The particulate fluoride concentrations (Table VI) ranged from 148 to 3519 micrograms per cubic meter (ug/M^3) of air sampled. Gaseous fluorides found in these samples ranged from five to 81 ug/M^3. The highest concentrations of total fluorides occurred during the pumping of hydrofluoric acid into the digestor and during the washing out of empty drums by the employees in Building 073; however, during a malfunction the concentrations would have greatly exceeded the permissible levels.

VIII. Discussion

A. Carbides/Diborides
Because the number of employees exposed to these materials is so small, firm conclusions cannot be expected from this medical data. Some observations can be made, however.

The mean FVC for the nine workers with the most exposure to carbides and diborides was slightly lower than for controls, even though smoking histories are similar for the two groups. If one compares these exposed workers to controls who themselves worked only under factory conditions (Table I, column 5), this difference persists. However, the differences are not significant statistically.

While there were a few abnormal chest x-rays, the x-rays overall do not suggest a pneumoconiosis problem at the plant. These findings and the absence of any dramatic effects on lung function suggest that carbides and diborides are probably not causing a major respiratory problem. However, since the exposed workers may have had, on the average, slightly poorer test results than did controls, a possibility remains that these materials may have some deleterious effect on lung function. This point should be kept in mind when engineering controls are designed for the processes involved.

As noted, pulmonary function test results were better for R&D workers exposed to carbide/diboride than for production workers so exposed. Two possible explanations for the difference would be:

1. That R&D workers had substantially different (presumably less) exposure to carbides/diborides than did factory workers in Building 005.

2. That the observed difference is unrelated to carbides or diborides, but rather an effect of some other difference between the groups.

Since many R&D employees who worked with carbides and diborides did so while the process was in the early developmental stage, and since their exposure was sporadic, the first explanation may be important. Table II evaluated the second possibility. The data in this table suggests that employees who have worked in production for sixteen or more years tend to have lower lung capacity than normal, a restrictive change. This trend still holds if one excludes workers having upper respiratory infections at the time of the survey. This effect was not observed for R&D workers. The simplest interpretation of this result is that conditions at the plant over 16 years ago (before 1964) were significantly worse than they are now. It is also possible that some material in use at the plant has a long latency, that is, it takes 16 years or more for the effects of exposure to it to become manifest.

While this study could not identify such a material, the restrictive changes in these senior workers were statistically significant when compared with R&D employees and should be a matter of concern. The advisability of medically following workers with pulmonary function tests should be apparent, for by so doing, the source of significant differences may be delineated, and the presence of the smaller differences noted above may be confirmed as genuine, or disproven.

B. Fluorides

Table III indicates that production workers are absorbing more fluoride from their work environment than are non-production workers, but not in amounts which research indicates are dangerous.

As seen in Table VII (OSHA results of August to October 1978), there are periods when exposures to fluorides can be excessive. In previous years this may have accounted for the employee complaints of nosebleeds, sore throats, wheezing, chest pain, nausea and skin rash. Even with the levels found during the NIOSH evaluations of February and March 1980 some of these complaints would be consistent with the high air concentrations found during certain operations.

On February 12, 1980, there was a major malfunction (acid leak) on the press. Although the samples (Table IV, Nos. 13 and 15) were collected for six hours, the major exposure was during the first three hours. The press was shut down and water washed prior to making mechanical repairs.

The questionnaire also suggests that some workers are noticing irritative effects from fluoride. Thus, despite protective equipment (body suits), workers in the drying room have problems with slowly healing cuts. Some workers (Building 032)

may still be having nasal problems. There have been no recent nasal perforations, something which was a problem in the past. No evidence of chronic health effects was found. These results suggest that conditions at the plant have improved but, given the very irritative nature of fluorides, indicate the potential for problems.

IX. Recommendations

A. Medical

1. Perform baseline chest x-rays and pulmonary function tests on new employees. X-rays should be interpreted according to the UICC/Cincinnati system.

2. Perform pulmonary function tests and respiratory histories on production workers on a periodic basis. Pulmonary function tests should be performed by certified technicians using equipment that meets American Thoracic Society specifications.

3. The continued complaints of irritative effects of fluorides demonstrate not only that the present program of supplying personal protective equipment (respirators and body suits) is inadequate, but that additional engineering controls should be installed to further control air contaminants. The present personal protective equipment program should be considered a temporary or emergency measure until adequate engineering controls are installed.

4. Periodic fluoride sampling (air and urine) in those buildings where use is heavy or where workers complain of irritative effects.

B. Environmental

Although some of the recommendations from interim reports may have been installed, they are reiterated in this report.

1. An education program for employees handling all chemcials should be established. The program should include information on toxicity, proper handling techniques, and use of protective equipment.

2. A labeling program should be established. Employees were observed using materials in unmarked containers.

3. Establish a program of periodic maintenance on all wall exhaust fans and local exhaust systems. In certain areas the fans were inoperable while in others they were not operating at maximum efficiency.

4. Approved ventilation design principles should be utilized in many areas. These areas were pointed out and discussed with union and management personnel.

5. Install local ventilation at the weighing station "K" cell Building 032.

6. Discontinue the practice of pumping hydrofluoric acid in buildings. A more acceptable method would be to pump the acid into the holding tank outdoors.

7. Discontinue washing of 55 gallon drums manually and indoors. Drums should be placed over high pressure nozzles in a ventilated area.

At present time the empty drums are brought into Building 073 and the remaining acid washed from the drum by inserting a hose and filling the drum 1/3 to 1/2 with water. The drums are then overturned and acid/water is drained.

X. Authorship and Acknowledgements

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Acknowledgements

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XI. Distribution and Availability

Copies of this report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, OH 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, VA. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

Plant Manager, Kawecki Berylco Industries, Boyertown, PA
Corporate Industrial Hygienist, Reading, PA
International Chemcial Workers Union

President, Local 619, ICWU
President, Local 959, ICWU
NIOSH, Region III
OSHA, Region III

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TABLE I

KAWECKI BERYLCO INDUSTRIES
BOYERTOWN, PENNSYLVANIA

HHE 79-87

RESULTS OF PULMONARY FUNCTION TESTS

CARBIDE/DIBORIDE WORKERS

GROUP (See Text)	I	II	III	Controls	Factory Workers Not Exposed
Number of Workers	9	7	13	26	21
Mean FEV_1 (% of predicted)	82.0 (5.83)*	80.4 (7.33)	95.3 (3.72)	89.6 (3.41)	90.5
Mean FVC (% of predicted)	84.4 (4.99)	84.9 (6.16)	93.3 (3.11)	89.1 (3.29)	90.5
Mean FEV/FVC	74.7 (4.06)	72.0 (4.74)	78.8 (2.01)	78.4 (11.54)	78.0
Mean age (years)	39.6	43.1	35.2	35.7	
[illegible]n exposure	12.0	10.7	----	----	
Smokers	7	6	7	17	
Non-Smokers	2	1	6	9	
Yes to Q1 +	3	0	3	6	
Yes to Q2 ++	2	0	1	7	

\+ "Do you usually cough on most days for 3 consecutive months or more during the year?"

++ "Do you bring up phlegm on most days for 3 consecutive months or more during the year?"

*( ) Standard error of the mean

TABLE II

KAWECKI BERYLCO INDUSTRIES
BOYERTOWN, PENNSYLVANIA

HHE 79-87

PULMONARY FUNCTION TESTS FOR EMPLOYEES

YEARS WORKING at KBI	FACTORY - 0-5 years	FACTORY - 6-10 years	FACTORY - 11-15 years	FACTORY - 15 or more yrs.	R & D
Number of workers	7	11	8	8	17
Mean FEV (% of predicted)	92.5 (2.93)*	90.3 (5.03)	94.4 (5.54)	76.8 (6.38)[1]	92.6 (3.97)
Mean FVC (% of predicted)	88.3 (4.27)	95.9 (4.64)	94.5 (5.47)	77.3 (6.78)[1]	90.6 (2.86)
Mean FEV/FVC	84.0 (1.92)	73.7 (2.26)	76.8 (1.92)	75.1 (4.35)	79.2 (2.26)
Mean Age	28.9	30.0	40.4	48.0	34.5
Smokers	5	9	7	6	7
Non-Smokers	2	2	1	2	10

*( ) Standard error of the mean

1 $p < .05$, compared to R & D employees, student t test

TABLE III

KAWECKI BERYLCO INDUSTRIES
BOYERTOWN, PENNSYLVANIA

HHE 79-87

MEANS FOR URINE FLUORIDE OF EMPLOYEES

BUILDING	001	017	010	019	032	ALL BUILDINGS	CONTROLS
Number of Employees	4	3	16	6	13	42	40
Mean Fluoride (Standard error of mean)	0.360 (0.136)	0.492 (0.138)	0.651 (0.104)	0.452 (0.099)	0.379 (0.076)	0.499 (0.053)	0.134 (0.0214)
Student t test for significance (compared to controls)	$p<0.01$	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$	

TABLE IV

KAWECKI BERYLCO INDUSTRIES
BOYERTOWN, PENNSYLVANIA

HHE 79-87

POSITIVE ANSWERS TO SELECTED QUESTIONS ON THE FLUORIDE QUESTIONNAIRE

LOCATION	CONTROLS	BUILDING 001	BUILDING 017	BUILDING 018	BUILDING 019	BUILDING 032
Number of employees	28	4	3	16	6	13
Slowly healing cut in past 2 days	0	0	2[1]	1	0	2
Eye irritation in past 2 days	0	0	0	2	1	4[2]
Nosebleeds in past 2 days	1	0	0	4	0	1
Ever had a nose-bleed on your present job	5	0	0	6	2	3
Onset of stuffy nose on the job	5	1	1	10	3	8[3]

1 p = 0.00667 Fisher's Exact Test

2 p = 0.0093 Fisher's Exact Test

3 p = 0.0097 Fisher's Exact Test

TABLE IV

KAWECKI BERYLCO INDUSTRIES
BOYERTOWN, PENNSYLVANIA

HHE 79-87

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HHE 79-87

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Student t test for significance (compared to controls)	$p<0.01$	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$	

TABLE V

Kawecki Berylco Industries
Boyertown, Pennsylvania

HHE 79-87

Airborne Concentrations of Dust Building 005

Date	Sample No.	Type	Sample Period	Sample Volume M^3	Gravimetric*		TiB_2**	
					Total	Respirable	Total	Respirable
12/17/79	4817	Total	12:30-15:08	277	7.76		0.78	
	4806	Respirable	12:30-15:08	261		0.50		<LLD**
	4812	Total	15:57-03:10	700	7.11		4.31	
	4810	Respirable	15:57-03:10	743		0.54		.61
12/18/79	4818	Total	03:10-08:10		5.95		6.60	
	4808	Respirable	03:10-08:10			1.10		1.75
	4883	Total	08:10-15:30		5.07		1.90	
	4822	Respirable	08:10-15:30			0.37		0.24
OSHA 08/24/78		Total			7.41			

* Denotes milligrams (mg) of substance per cubic meter of air samples.

** Lower limit of detection 20 microgram (ug) per sample.
These values are approximate. The upper limit of the analytical calibration curve was 2000 ug. Assuming that the calibration curve is linear above 2000 ug the listed values would be the concentrations found.

TABLE VI

Kawecki Berylco Industries
Boyertown, Pennsylvania

HHE 79-87

February-March, 1980

Airborne Concentrations of Particulate and Gaseous Fluorides (ug/M^3)

Date	Sample No.	Bldg/Operation	Sample Period	Sample Volume M^3	Particulate	Gaseous	Comments
2/11/80	1	073 helper	16:10-23:15	.74	497	59	
	2	073 operator	16:12-23:15	.72	598	14	
	4	032 B helper	16:02-23:30	.74	325	26	
	5	032 helper	16:06-23:32	.76	937	32	
	6	017 operator	16:10-23:37	.62	244	6	
	7	032 A operator	17:00-23:32	.59	730	56	
2/12/80	8	032 B operator	08:27-15:27	.71	420	13	
	9	032 helper	09:23-15:23	.74	503	26	
	10	017 Rotary Kiln Oper	8:30-15:30	.71	378	25	
	11	032 helper	08:20-15:20	.71	850	24	
	12	032 A operator	08:25:15:25	.71	406	13	
	13	073 helper	08:37-15:25	.62	1932	16	Malfunction, Acid Leak
	14	073 operator	08:35:15:30	.66	701	8	
	15	073 helper	08:26:15:25	.67	2099	12	Malfunction, Acid Leak
	16	018 helper	16:06-23:10	.78	166	5	
	17	018 operator	16:07-23:10	.71	268	6	
	18	001 operator	16:15-23:10	.68	791	29	
	19	019 operator	16:10-23:15	.74	188	7	
2/13/80	20	018 helper	08:07-15:38	.75	148	5	
	21	018 operator	08:10-15:38	.70	172	67	
	22	001 operator	08:05-15:35	.86	678	14	
	23	001 helper	08:06-15:35	.76	354	10	
	24	019 operator	08:10-15:40	.68	343	33	

TABLE VIA

Kawecki Berylco Industries
Boyertown, Pennsylvania

HHE 79-87

February-March, 1980

Airborne Concentrations of Particulate and Gaseous Fluorides (ug/M^3)

Date	Sample No.	Bldg/Operation	Sample Period	Sample Volume M^3	Particulate	Gaseous	Comments
3/4/80	25	073 operator	08:14-15:50	.68	3519	81	Drum Washing
	26	073 helper	08:18-15:50	.71	622	18	
3/27/80	27	073 helper	08:13-15:32	.81	843	42	
	28	073 helper	08:15-15:37	.77	3100	61	Acid pumping
	29	073 operator	08:16-15:39	.78	426	14	
	30	073 helper	08:20-15:32	.73	395	12	

		Particulate	Gaseous
Criteria	OSHA	2500	200
	ACGIH	2500	2000
	NIOSH	2500	

Table VII
Kawecki Berylco Industries
Boyertown, Pennsylvania
OSHA Results of Airborne Concentrations of Particulate and Gaseous Fluorides ($\mu g/M^3$)

Date	Bldg./Operation	Sample Period (Min.)	TWA Conc. - Actual (TWA Conc. - 480 Min.) Particulate	Gaseous	Comments
9/19/78	001/Operator	411		540 (460)	Top Side
	001/Area	404		230	
9/21/78	001/Operator	12	76,000 (1900)		Pan Dryer
9/27/78	001c/ 002b/Operator	59	34,800 (4280)		Pan Dryer
9/26/78	017/Operator	428	10,600 (9400)		Jaw Crusher
	017/Area	381	160		
9/18/78	017/Operator	414	1,920 (1660)		Palverizer
	017/Area	432	670		
10/24/78	017/Operator	422	470 (410)		Blender
8/24/78	017/Operator	616	580	270	Kiln
	017/Area	481	90	N.D.	
9/14/78	017/Operator	446	1,700 (1580)	210 (190)	Kiln
	017/Area	318	30	120	
8/29/78	073/Operator	358	N.D.		Digestor
	073/Area	432	80		
8/29/78	019/Operator	435	270 (240)		Ta Salt
8/31/78	032/Operator	89	7,310 (1360)		K Cell

Table VIIA
Kawecki Berylco Industries
Boyertown, Pennsylvania
OSHA Results of Airborne Concentrations of Particulate and Gaseous Fluorides ($\mu g/M^3$)

Date	Bldg./Operation	Sample Period (Min.)	TWA Conc. - Actual (TWA Conc. - 480 Min.) Particulate	Gaseous	Comments
8/31/78	042/Operator	327	290 (200)		K Cell, Pavilion
9/27/78	023/Operator	401	70 (60)		Columbium Oxide
10/18/78	14c90/Operator	544	30		Rotary Kiln
10/23/78	058/Operator	7	N.D.		Wire Draw
	058/Operator	267	N.D.		Wire Draw
8/29/78	035/Operator	460	N.D.		Welding Shop
8/30/78	018/Operator	450	70 (70)		Master Alloy

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