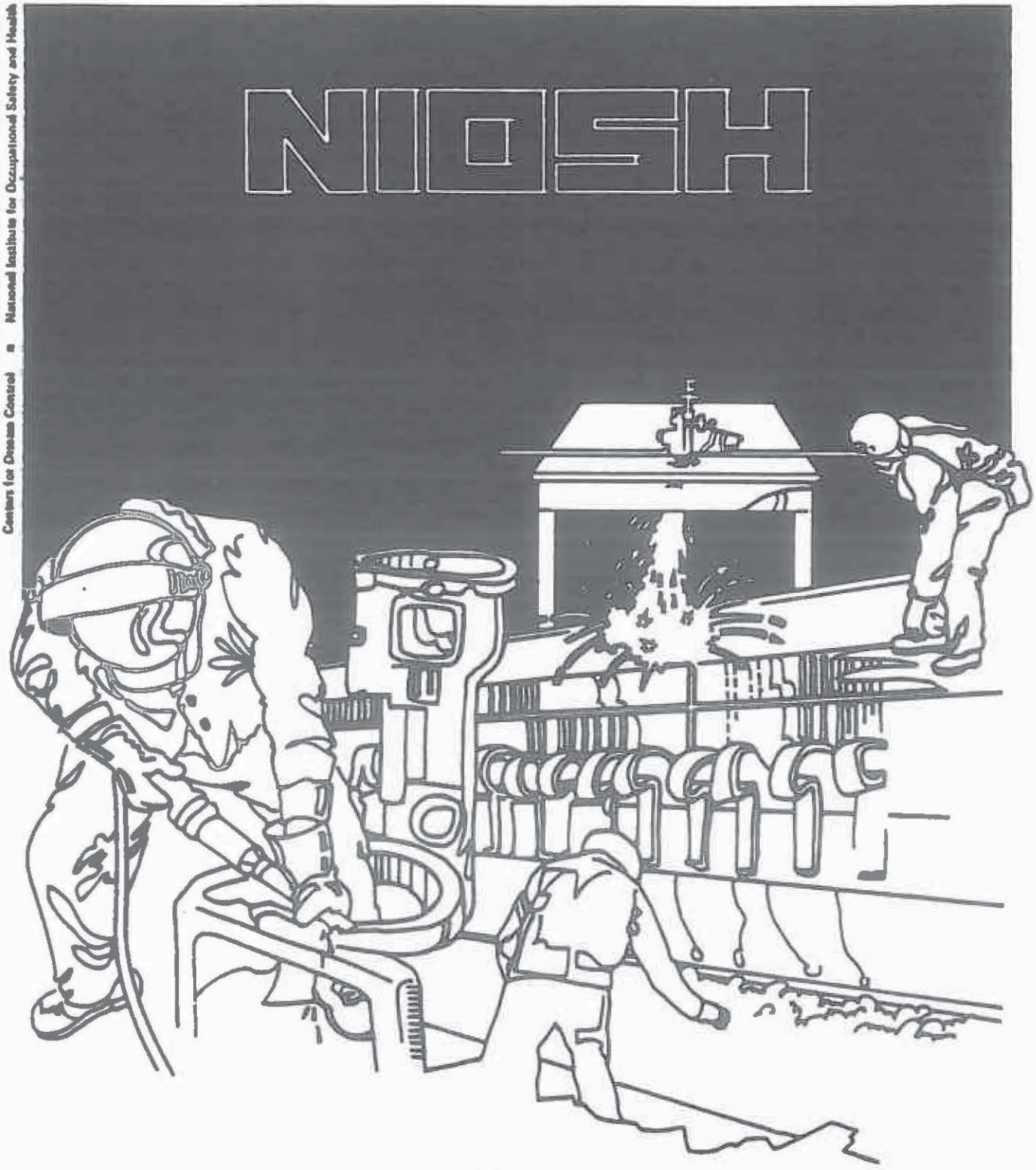
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 84-449-1778
AGRICO CHEMICAL COMPANY
PIERCE, FLORIDA

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. 669(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.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 84-449-1778
FEBRUARY 1987
AGRICO CHEMICAL COMPANY
PIERCE, FLORIDA

NIOSH INVESTIGATORS:
Diane E. Bennett, M.D.
Mitchell Singal, M.D.

I. SUMMARY

In August 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Chemical Workers Union to evaluate respiratory problems among workers who had been employed at the Agrico Chemical Company's elemental phosphorus (EP) plant. The union expressed concern about potential exposures to silica, coke, and asbestos at the EP plant, which was sold by Agrico in 1974 and closed in 1979.

On April 4-12, 1985, NIOSH investigators conducted a medical survey of former EP plant workers, who were identified by using Agrico personnel records (for current Agrico employees) and by contacting retirees of Agrico and the other known operator of the plant. The survey included a medical and occupational history questionnaire, examination of the chest, pulmonary function tests, and a chest X ray.

Of the 108 survey participants, 91 formerly worked at the EP plant, representing 37% of the identified workforce and a smaller percentage of the actual plant population. Two participants had small, irregular interstitial pulmonary opacities, and two others had pleural plaque. Among the 88 participants with ten or more years in the phosphate industry, the 36 workers with ten or more years in the EP plant were no more likely than those with less than ten years to have chronic cough, shortness of breath, abnormal lung sounds on physical examination, pulmonary function impairment, or X ray signs of fibrogenic dust exposure. They had numerically higher prevalences of chronic bronchitis (17% vs 8%) and chronic wheeze (39% vs 27%), but the differences were not statistically significant (p=0.17 and 0.14, respectively, Fisher's exact test). Regression analyses revealed no associations between health outcomes and time in the phosphate industry or time at the EP plant.

This survey did not document any association between chronic respiratory disease and work at the EP plant. Considerably fewer than 40% of the former EP plant workers participated, however, and it is possible that the study participants were not representative of all former EP plant workers.

KEYWORDS: SIC 2819 (industrial inorganic chemicals, not elsewhere classified), phosphorus production, respiratory disease, asbestos.

II. INTRODUCTION

In August 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Chemical Workers Union to evaluate respiratory problems among workers who had been employed at the Agrico Chemical Company's elemental phosphorus (EP) plant. The requester stated that many former workers had severe respiratory problems and that the chest X ray of one such worker, who had never worked in a coal mine, had been diagnosed as showing "black lung." The union expressed concern about potential exposures to free silica, coke, and asbestos.

During September 26-28, 1984, two NIOSH physicians and an industrial hygienist met with management and the local union at the Agrico processing facility in Pierce, Florida, to decide how best to address this request. Walk-through surveys of the current Agrico facilities were conducted, but it was not possible at that time to view the facility that was the subject of the hazard evaluation request, because it was no longer active and did not belong to Agrico.

During April 4-12, 1985, we conducted a medical survey of former EP plant workers. At this time, the current owner of the property arranged for us to view the EP facility and to speak to workers and supervisors who had been employed there. Study participants were notified of their medical test results in February 1986.

III. BACKGROUND

The elemental phosphorus plant, also called the electrophos plant, was owned by Agrico until 1974. The most recent operator (and current owner), Mobil Oil Company, closed the plant in 1979. There had been two other owners, but we could not locate them. When the plant was sold by Agrico, many employees chose to stay with Agrico and moved to one of Agrico's other phosphate related plants in the area. These include mines and chemical phosphate fertilizer plants. Other employees stayed with the EP plant through its changes in ownership and are currently Mobil employees or Mobil retirees.

Agrico has no listing of workers that categorizes them by specific plants in which they have worked. Some of the company's retirees were likely to have worked in the EP plant, though they could not be differentiated from the other retirees. Workers who stayed on at the facility when it left Agrico's hands would not be on the retiree list, nor would other workers who left Agrico before retirement for sickness or other reasons. No official description of the process which took place at the EP plant was available, nor was there information on the number of workers involved. No process in the current Agrico facilities resembles any of the processes used in the EP plant.

According to former EP plant workers, phosphorus rock was unloaded from railroad cars and mixed with coke, river rock, and silica in the feed preparation area. The coke house was in this area. Payloader operators, coke operators, and dryer operators worked in this area. The workers recalled the area as very dusty. In later years they were issued dust masks, but were not required to wear them. (They stated that they were not informed that wearing the masks was important to prevent disease; they thought that the masks were for comfort.)

In the furnace area the mixture was put together and melted into phosphorus vapor. A tapper and a tapper's helper took charge of this operation. Respirators were available in later years, but their use was optional. A utility operator did clean-up, helped the tapper when extra assistance was needed, or filled in for the tapper's helper. This person also had a respirator available in later years, but its use was optional. A panel board operator and an operator's assistant monitored furnace instruments in an enclosed area; they also took readings on other instruments throughout the plant. Six people per shift usually worked one furnace; during some time periods the EP plant had two furnaces. Slag workers or laborers had to tap the slag from the bottom of the furnaces and move it.

In the condenser area the phosphorus vapor was cooled in pans to become a liquid. No personnel were involved in this part of the process, except once each day when filter operators would "puddle" the pans by mixing solids in the bottom.

The phosphorous was transferred from the pans to the filter press area. After they had prepared filters, the filter press operators worked machines to filter the solids/phosphorus mixture. Filters were reportedly prepared daily by shaking loose asbestos from large bags over round filters twelve feet or greater in diameter. The "mud" (or "sludge") from the filtering operations was taken to ponds to settle; the transferring was done by payload bucket. The pure phosphorus went to storage tanks. Filter press utility men helped with the pan puddling and also used front end loaders to move the sludge to the ponds. Respirators were optional in this area. Workers state they were never told that asbestos was dangerous. The area was reportedly very dusty. Eight people per shift worked in this area.

At the storage tanks, the phosphorus was loaded into railroad cars. This operation was part of the filter press utility operator's job.

After the mud settled in the ponds, additional phosphorus was reclaimed from them. If there was too much coke mixed in with the phosphorus, additional filtering had to be done.

In 1975, a new operation was begun. When phosphorus rock was brought in, it was dried and made into briquettes before going to feed

preparation. There were four briquette operators per shift and four shifts per day. They operated the machinery which metered and measured the rock, compacted it into briquettes, and dried and cured the briquettes.

IV. METHODS

From January through March 1985, we attempted to notify former employees of the EP plant of the planned medical study. We sent a letter to each of the approximately 140 Agrico retirees asking if he or she ever worked in the EP plant and, if so, whether he or she would be willing to participate in the study. We also sent a letter soliciting participation to the approximately 120 Mobil employees who were working at the EP plant when it closed in 1979. We attempted to contact by telephone those who didn't respond to the letters, those who had responded but had not indicated interest in participating, and those whose letters were returned as undeliverable. Finally, we attempted to contact by telephone the approximately 30 current Agrico employees who, according to company records, had worked at the EP plant.

The medical survey included a medical and occupational history questionnaire, a physical examination of the chest, pulmonary function tests, and chest X rays (posterior-anterior and lateral views).

The questionnaire, which was administered by NIOSH interviewers, inquired about basic demographic characteristics, respiratory symptoms and illnesses, cigarette smoking behavior, job history at Agrico and Mobil, other jobs in the phosphate industry, and other work involving potential exposure to respiratory hazards. For the epidemiologic purposes of this study we defined chronic bronchitis as cough and phlegm on most days, at least 3 months a year, for at least 2 years.[1] By analogy, we defined chronic cough as cough on most days, at least 3 months a year, for at least 2 years. We defined chronic wheeze as wheeze occurring most days and nights for at least 2 years. We asked whether shortness of breath occurred "when hurrying on level ground or walking up a slight hill" and, to define severe shortness of breath, whether the participant had "to stop for breath when walking at your own pace on level ground."

One-second forced expiratory volume (FEV_1) and forced vital capacity (FVC) were measured with an Ohio Medical Model 822 dry rolling seal spirometer attached to a Spirotech 200B dedicated computer. Equipment and test procedures conformed to the American Thoracic Society's criteria for screening spirometry.[2] Predicted values for FEV_1 and FVC were calculated using the equations of Knudson;[3] these values were multiplied by 0.85 to obtain the predicted values for Blacks.[4]

Chest X rays were interpreted according to the ILO 1980 International Classification of Radiographs of Pneumoconioses.[5] Each X ray was read independently by two radiologists certified in the use of the ILO

system ("B readers"). In case of a disagreement, the X ray was read independently by a third reader, and the majority opinion (or median value) of the disputed finding was used for analysis.

V. EVALUATION CRITERIA[6]

Asbestos, crystalline silica, and coal dust can cause pneumoconiosis, a lung condition called asbestosis, silicosis, or coal workers' pneumoconiosis (CWP), depending the cause. Silicosis and CWP have similar early X ray findings--small, rounded opacities--which occur before there are symptoms of disease. Shortness of breath is the main symptom of more advanced disease. Pulmonary function tests reveal a restrictive pattern (decreased lung capacity), and additional X ray findings are present. Asbestosis is also manifested by shortness of breath and a restrictive pulmonary function pattern, but the typical early X ray finding is that of small, linear and irregular, rather than rounded, opacities. Asbestos can also cause thickening and calcification of the pleura (the membrane lining the chest wall and diaphragm). These X ray findings, often called plaque, are not necessarily associated with pulmonary function abnormalities or symptoms, and they can have causes other than asbestos. Finally, asbestos can cause certain cancers, most notably lung cancer and mesothelioma [cancer of the pleura or peritoneuma (the membrane lining the abdomen and various abdominal organs)]. Although there are no studies that specifically associate pneumoconiosis with exposure to coke dust, studies of carbon electrode workers have shown that exposure to carbon dust (in the absence of silica) can cause pneumoconiosis indistinguishable from CWP.

VI. RESULTS

Of the approximately 290 people on the company list of former EP plant workers, 50 could not be contacted. Of the remaining 240, 33 (14%) claimed not to have worked at the EP plant. Eleven respondents were reported by a family member as deceased. Although all but 6 eligible respondents were willing to participate in the survey, for various reasons--including distance from the survey site--many did not do so. Including some persons not on the original list, 109 persons participated in the survey. Eighteen of these said that they had not worked at the EP plant. Even if the denominator is assumed to be 249 (290 minus 14% eroneously on the list), the 91 EP plant participants (109 minus 18) represent only 37% of the EP plant workers. The actual sample size would be less, since the denominator should include an unknown number of EP plant workers not on the list.

Although not originally part of the study design the participants who had never worked at the EP plant were included in the analyses comparing workers categorized according to both time in the EP plant and time in the phosphate industry (Table 1). Although the workers

with less than 10 years in the industry tended to be younger than those with 10 or more years, the latter workers who worked in the EP plant less than 10 years were of comparable age to those who worked there 10 or more years. Furthermore, these two groups had worked a comparable period of time in the phosphate industry. The group who worked at the EP plant 10 or more years, however, had a greater proportion of Whites, and the three groups differed with respect to cigarette smoking history. Among those in the phosphate industry 10 or more years, the mean pack-years of cigarette smoking and proportion of workers who were current or former smokers were numerically greater among those who worked at least 10 years in the EP plant, although the difference in pack-years was not statistically significant.

The two groups with at least 10 years in the phosphate industry had comparable proportions of workers with chronic cough, severe shortness of breath, and X ray signs of exposure to fibrogenic dust. Those with 1 or more years in the EP plant had numerically greater prevalences of chronic bronchitis and chronic wheeze, and a numerically smaller proportion of ronchi or wheezes on physical examination, but none of the differences was statistically significant.

Two EP plant workers had X ray signs of exposure to fibrogenic dust. One had irregular opacities, size t, profusion 2/2, involving the left upper and both middle and lower lung fields. The other had unilateral chest wall pleural plaque. Two participants who had not worked at the EP plant, but had worked in the phosphate industry at least 10 years, had X ray signs of exposure to fibrogenic dust. One had irregular opacities, size t, profusion 1/1, involving both middle and lower lung fields. The other had bilateral chest wall pleural plaque. Because the opacities in both cases were irregular rather than rounded, and tended to occur in the lower rather than upper lung fields, they were more likely due to asbestos than silica.[6] The worker with unilateral plaque had worked 15 years in a shipyard; the other three reported no jobs outside the phosphate industry that involved asbestos exposure.

For the 91 participants who worked at the EP plant, logistic (for dichotomous variables) or multiple regression (for continuous variables) analyses were performed. Independent variables were age, years of work in the phosphate industry, years of work at the EP plant, and pack-years of cigarette smoking. Dependent (outcome) variables were chronic cough, chronic bronchitis, chronic wheeze, shortness of breath, severe shortness of breath, percent predicted FVC, and FEV_1/FVC. Although there were associations between smoking and chronic cough, chronic bronchitis, and FEV_1/FVC, and between age and shortness of breath, percent predicted FVC, and FEV_1/FVC, there were no associations between any outcome variable and time in the phosphate industry or at the EP plant (Table 2).

VII. CONCLUSIONS

This survey did not document any association between chronic respiratory disease and work at the EP plant, but considerably fewer than 40% of the former EP plant workers participated. The participants obviously did not include workers who had died or those too ill to come to the study site. It is also possible that persons with already diagnosed respiratory disorders (whether or not recognized as work-related) would perceive little personal benefit from participating, and thus not bother. On the other hand, one could argue that is it persons who feel well, especially those who have had a recent medical examination, that would have the least interest in participating. It is thus not possible to determine from the available information whether the study participants were epidemiologically adequately representative of all former EP workers.

VIII. REFERENCES

1. American Thoracic Society. Chronic bronchitis, asthma, and pulmonary emphysema. Am Rev Respir Dis 1962;85:762-8.

2. American Thoracic Society. ATS statement--Snowbird workshop on standardization of spirometry. Am Rev Respir Dis 1979;119:831-8.

3. Knudson RJ, Slatin RC, Lebowitz MD, Burrows B. The maximal expiratory flow-volume curve. Normal standards, variability and effects of age. Am Rev Respir Dis 1976;113:587-600.

4. Lanese RR, Keller MD, Foley, MF, Underwood EH. Differences in pulmonary function tests among Whites, Blacks, and American Indians in a textile company. J Occup Med 1978;20:39-44.

5. International Labour Organization. Guidelines for the use of the ILO international classification of radiographs of pneumoconioses, revised ed. Geneva: International Labour Organization, 1980. [Occupational safety and health series, no. 22 (rev.)].

6. Morgan WKC, Seaton A. Occupational lung diseases. 2nd ed. Philadephia: WB Saunders, 1984.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report prepared by:	Mitchell Singal, M.D., M.P.H. Assistant Chief Medical Section
Medical investigator:	Diane E. Bennett, M.D., M.P.H. Medical Officer Medical Section
Industrial hygiene assistance:	Raymond L. Ruhe Industrial Hygienist Industrial Hygiene Section Hazard Evaluations and Technical Assistance Branch
Statistical assistance:	William T. Stringer Statistician Statistical Services Section Support Services Branch
Originating office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies
Report typed By:	Joyce D. Godfrey Clerk-Typist Medical Section

X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. 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:

1. Agrico Chemical Company
2. International Chemical Workers Union
3. NIOSH, Region IV
4. OSHA, Region IV

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1

Characteristics of Study Participants by
History of Work in Elemental Phosphorus (EP)
Plant and Phosphate Industry
Agrico Chemical Company
Pierce, Florida

HETA 84-449
April 1985

	EP plant <10 years, Industry <10 years	EP plant <10 years, Industry ≥10 years	EP plant ≥10 years, Industry ≥10 years
Number of workers	21	52	36
Number and (%) women	2 (10)	0 (0)	1 (3)
Age (years)			
Range	23-69	32-75	33-73
Mean	38	56	56
Median	34	58	57
Race, number and (%)			
White	16 (76)	34 (65)	34 (94)
Black	5 (24)	16 (31)	2 (6)
Asian	0 (0)	2 (4)	0 (0)
Years in phosphate industry, mean	5.3	24.3	23.1
Years at EP plant, mean	4.8	2.6	16.7
Cigarette smoking status, number and (%)			
Current smoker	12 (57)	20 (38)	14 (39)
Former smoker	6 (29)	15 (29)	17 (47)
Never smoked	3 (14)	17 (33)	5 (14)
Pack-years of cigarette smoking	13	27[A]	34[A]
Medical history, number and (%) (see text for definitions)			
Chronic cough	3 (14)	11 (21)	8 (22)
Chronic bronchitis	2 (10)	4 (8)[B]	6 (17)[B]
Chronic wheeze	5 (24)	14 (27)[C]	14 (39)[C]
Shortness of breath	4 (20)	26 (50)	14 (39)
Severe shortness of breath	1 (5)	8 (15)	6 (17)
Physical examination findings, number and (%)			
Rales	0 (0)	1 (2)	0 (0)
Ronchi or wheezes	1 (5)	6 (12)[D]	1 (3)[D]
Pulmonary function tests			
Percent predicted FVC, mean	93	92[E]	89[E]
FEV_1/FVC, mean	0.78	0.72	0.73
X ray findings, number and (%)			
Pneumoconiotic opacities	0 (0)	1 (2)	1 (3)
Pleural plaque	0 (0)	1 (2)	1 (3)

A - $z = 1.03$, $p > 0.2$ (2-tailed)
B - $p = 0.17$, Fisher's exact test (1-tailed)
C - $X^2 = 0.907$, $p = 0.34$
D - $p = 0.14$, Fisher's exact test (1-tailed)
E - $z = 0.89$, $p > 0.1$ (1-tailed)

Table 2
Regression Analyses for Selected Variables
Agrico Chemical Company
Pierce, Florida

HETA 84-449
April 1985

Independent variables	Dependent variables*						
	Chronic cough	Chronic bronchitis	Chronic wheeze	Shortness of breath	Severe Shortness of breath	% predicted FVC	FEV_1/FVC
Age (years)	OR= 1.02 r= 0.000 p= 0.47	OR= 1.01 r= 0.000 p= 0.26	OR= 1.01 r= 0.000 p= 0.64	OR= 1.06 r= 0.156 p= 0.027	OR= 1.03 r= 0.000 p= 0.52	β= -0.49 p= 0.016	β= -0.003 p= 0.042
Years in phosphate industry	OR= 1.01 r= 0.000 p= 0.74	OR= 0.95 r= 0.000 p= 0.38	OR= 1.02 r= 0.000 p= 0.45	OR= 1.03 r= 0.000 p= 0.39	OR= 1.03 r= 0.000 p= 0.58	β= 0.18 p= 0.48	β= 0.0004 p= 0.80
Years at EP plant	OR= 1.00 r= 0.000 p= 0.92	OR= 1.01 r= 0.000 p= 0.85	OR= 1.02 r= 0.000 p= 0.49	OR= 0.97 r= 0.000 p= 0.34	OR= 1.01 r= 0.000 p= 0.77	β= -0.05 p= 0.83	β= 0.001 p= 0.43
Pack-years of cigarette smoking	OR= 1.02 r= 0.209 p= 0.16	OR= 1.04 r= 0.395 p= 0.001	OR= 1.00 r= 0.000 p= 0.94	OR= 1.01 r= 0.000 p= 0.50	OR= 1.00 r= 0.000 p= 0.74	β= 0.004 p= 0.94	β= -0.001 p= 0.048

* - See text for definitions