# A COMPREHENSIVE PROGRAM FOR IMPROVED MANAGEMENT OF RESPIRATORY HEALTH

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## INTRODUCTION

Morgan has described a medical condition of the lung, of nonsmokers in the industry trade, characterized by chronic cough productive of sputum and accompanied by mild obstruction of the large airways. Since X-rays of the chests of these workers exhibit few change, and therefore little parenchymal involvement of the lung, he termed this entity industrial bronchitis.[1] Other investigators have reported similar findings in studies of workers having long-term exposure to nuisance dusts.[2,3]

In a study of workers exposed to high total dust levels of bauxite and alumina for 20 or more years, Townsend *et al* in a cross-sectional study of pulmonary function test results demonstrated a statistically significant increase in numbers of workers with a forced expiratory volume in one second ($FEV_1$ of less than 80% of predicted.[4] A separately reported study of changes on chest X-ray of these high-dust-exposed workers compared to others with little exposure revealed only minimal nonsignificant X-ray changes.[5]

Because of this evidence of a decrement in $FEV_1$ of workers exposed to high levels of dust for twenty or more years, Alcoa's medical staff decided to plan and implement a standardized program for pulmonary surveillance at domestic locations.[6]

## GENERAL DESCRIPTION OF ALCOA'S PULMONARY SURVEILLANCE PROGRAM

The goal of Alcoa's program for management of respiratory health is prevention of work-related lung impairment. We have identified two objectives which must be met in order to attain this goal. First, we must improve management of the multiple activities which are necessary for providing adequate respiratory protection, and secondly we must establish a mechanism to reevaluate continually the overall effectiveness of our efforts.

The major activities which must be managed for an effective program of respiratory protection are:

- Identification of hazardous exposures by air sampling;
- Education of employees about the respiratory hazards at work and the measures necessary for adequate protection;
- Provision of respiratory protection where indicated;
- Training of technicians to perform standardized testing of pulmonary function;

Pulmonary function testing of employees exposed to hazardous
materials;

- Identification of employees with lung function loss meeting some set of criteria;
- Medical referral of employees with confirmed functional loss for further diagnostic evaluation; and
- Modification of environmental controls to reduce health risks.

The resources we have developed for evaluating the overall effectiveness of our program for respiratory surveillance are:

- Creation of computer software to provide automatic storage of and access to data generated by spirometric testing;
- Development of criteria incorporated in the software for screening of spirometric test results; and
- Periodic analysis of data to determine the adequacy of the
surveillance program.

## PULMONARY SURVEILLANCE SYSTEM

We have created a computer-based system to support functions in the plant medical departments as well as at the corporate medical level. The system is supported by a personal computer (Compaq 386) with a printer in each plant medical department and a mainframe computer in Pittsburgh. The plant-based computer interfaces with a spirometer and is programmed with algorithms to analyze and screen the results of each test as it is performed. If the medical staff wishes, at the end of a test, a report may be provided to the employee. The file of the Compaq 386 is sufficiently large to accommodate these functions as well as previous test results for each employee at a plant with about 1500 employees.

The plant-based computer is also programmed to permit periodic uploading of all interim test results to a Pittsburgh-based mainframe file.

The mainframe computer file contains test results for all employees at domestic locations, and the corporate medical

staff has access to this file for periodic assessment of the timeliness of testing at each plant as well as for determining the incidence of functional decrements experienced by employees exposed to irritating dusts.

The mainframe computer software also has a scheduling function to identify a future date for the next scheduled test for each employee. This new schedule for testing is downloaded to the plant personal computer. In this process the mainframe computer also downloads all job or demographic changes derived from another system maintained in Pittsburgh.

## Criteria for Screening and Analysis of Spirometric Test Results

In Alcoa, pulmonary function testing is performed as a part of preplacement evaluations, non-occupational periodical medical evaluations, and periodic medical screening for hazardous work exposures.

Medical and industrial hygiene personnel have identified all plant materials which may be hazardous to the lungs. Arbitrarily we have identified an action level for triggering a medical exam. An action level is an exposure exceeding one-half the threshold limit value established by the American Conference of Governmental Industrial Hygienists.[7] Employees having such exposures have pulmonary function tests yearly. If test results are less than expected, the employee is retested in three months.

From Knudson's prediction equations[8] the plant personal computer has been programmed to calculate the predicted $FEV_1$ and the predicted forced vital capacity (FVC) based on the individual's age, sex, and height. Predicted values are adjusted for race. After corrections for BTPS the computer selects: the maximal $FEV_1$ and calculates a percent of predicted $FEV_1$ ; the maximal FVC and calculates a percent of predicted FVC; the maximal $FEV_1$ and calculates a percent of maximal FVC.

The criteria selected for the classification of respiratory impairment is consistent with the American Medical Association's guidelines for determination of respiratory impairment.[9] These criteria are: for normal function, a percent of predicted $FEV_1$ or FVC of 80 or better; for mild impairment, percent of predicted $FEV_1$ or FVC of less than 80 but 60 percent or better; and for moderate to severe impairment, a percent of predicted $FEV_1$ or FVC less than 60.

From the reports available, there appears to be considerable interest in developing sophisticated methods in the future for analyzing longitudinal pulmonary function data.[10,11,12] However, from a review of the recent literature there is insufficient information to support establishment with confidence of criteria for expected annual decrements in pulmonary function test results for an aging population.

In the absence of supporting information we have established arbitrary criteria to define significant loss of lung function over time (Table I). Because of the widely recognized variability in pulmonary function test results over time a worker, for his loss to be significant, must demonstrate a decrement in $FEV_1$ or FVC greater than 250 ml plus a yearly decrement 50 ml. (See Table I.)

Table I

Criteria for Defining Significant Lung Function Loss

| Interim Between Tests | Decrement in $FEV_1$ or FVC |
|---|---|
| 0 - 1 Years | > 300 ML |
| 0 - 2 Years | > 350 ML |
| 0 - 3 Years | > 400 ML |
| 0 - 4 Years | > 450 ML |
| 0 - 5 Years | > 500 ML |
| 0 - 6 Years | > 550 ML |
| 0 - 7 Years | > 600 ML |
| 0 - 8 Years | > 650 ML |
| 0 - 9 Years | > 700 ML |
| 0 - 10 Years | > 750 ML |

Medical referral for diagnostic testing is dependent on identification of employees exhibiting a significant loss in pulmonary function on successive tests. An employee with normal lung function ($FEV_1$ or FVC $\geq 80\%$ of predicted) will be referred for medical evaluation after he exhibits a significant loss on three successive tests or his test results indicate a change in status from normal to mild impairment ($FEV_1$ or FVC $< 80\%$ but $\geq 60\%$ of predicted).

A worker with mild impairment will be medically referred if he exhibits a significant loss on two successive tests or if his most recent test indicates a change in status from mild to moderate impairment ($FEV_1$ or FVC $< 60\%$ of predicted) his lung function becomes moderately impaired. A worker with existing moderate impairment will have a medical referral after exhibiting a significant loss on one test.

All plant medical technicians have received training in the conduct of standardized pulmonary function testing. At the end of August, 1988, computer-based testing is being done at two locations, and the corporate medical staff is preparing a schedule to complete implementation of the program at Alcoa's domestic locations over the next eight months. We think having a system to provide timely information about changes in lung function will permit us to achieve a high level of respiratory protection for Alcoans exposed to respiratory hazards.

Hazardous materials at all plants have been identified. Industrial hygienists have completed work on an employee educational package which will be distributed to all plants in the Fourth Quarter, 1988. We anticipate that the full program will be implemented at all domestic plants by mid-1989.

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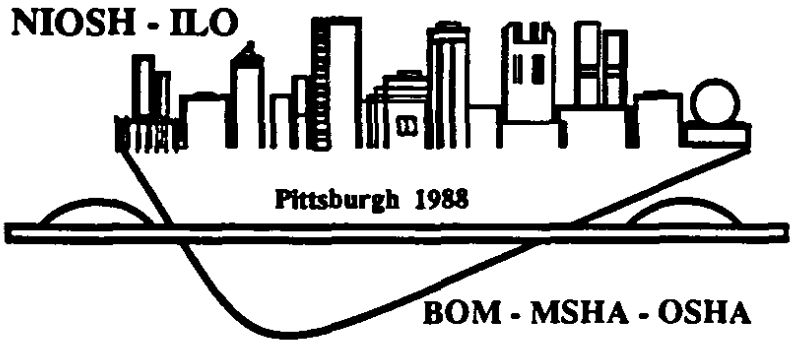
# I

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