PRELIMINARY INDUSTRIAL HYGIENE SURVEY

U.S. Mineral Products
Stanhope, N.J.

SURVEY DATE

December 11, 1974

REPORT BY

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PLACE VISITED:	U.S. Mineral Products Company Stanhope, New Jersey 07874
DATE OF VISIT:	December 11, 1974
PERSONS MAKING VISIT:	John M. Dement, NIOSH C.J. Schneider, Calspan Corp. A.J. Pifer, Calspan Corp.
PERSONS CONTACTED:	P.J. Verhalen, President F. Slumf, Plant Engineer L. Koonts, Manager of Manufacturing
PURPOSE OF VISIT:	To conduct a preliminary industrial hygiene survey of this facility including air sampling for mineral wool fibers.

INTRODUCTION

As part of the NIOSH industrywide study of the mineral wool industry, a preliminary industrial hygiene survey was conducted at the U. S. Mineral Products rockwool fiber facility in Stanhope, New Jersey. This survey was coordinated with a visit by the Calspan Corporation who visited the plant for purposes of observing work practices and engineering controls (NIOSH Contract No. CDC-99-74-65).

The present survey included observation of the manufacturing processes and control measures in addition to preliminary air sampling for mineral wool fiber concentrations and size distributions (length and diameter). Also, plant personnel records were evaluated for possible inclusion into future NIOSH mortality studies. The following paragraphs describe processes in this facility, sampling procedures and air sample results.

DESCRIPTION OF THE FACILITIES

The major products produced at this plant are various mineral wool insulation products. These are as follows:

1) Cerama Fiber (mineral wool loose fiber insulation)
2) CAFCO (self adhering, blowing insulation)
3) Blaze Shield, Sound Shield, Power Shields and Deck Shields (speciality purpose heat and sound insulations).

Fiber production started at this plant in approxiamtely 1875 and, according to company personnel, this plant is the World's oldest producer of mineral wool. Fibers were produced by the stream attenuation process until approximately 1955 when the spinning process was instigated. Mr. Verhalen, President of U.S. Mineral Products, indicated that fibers presently produced are probably larger in diameter and longer in average length than those produced prior to 1955. Twenty samples of fibers are collected weekly for diameter determinations by optical microscopy. Average diameters are typically 7 μm although some averages as small as 4 μm are observed.

Prior to 1970, an insulating product containing asbestos (chrysotile) was produced at this plant; however, it was discontinued due to a declining market. Also, a fiber batt containing a phenolic resin binder was product until 1972 when it was discontinued due to air pollution emissions from the binder curing ovens.

There are approximately 60 production and maintenance workers employed at this plant on a 3 shift, 5 day per week basis. These workers are represented by Local 427 of the International Union of Electrical Workers.

MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

There are presently no in-plant medical facilities at this location. A local physician is retained on a 24 hour call basis and use is made of the Dover Hospital (10 miles away) and the local rescue squad. No pre-employment or routine medical examinations are given. According to plant management, the only problem encountered has been transient dermatitis (wool itch) among selected employees.

There is presently no industrial hygiene program in this facility. Prior to the removal of asbestos from the products, some air sampling was done.

The safety program at this plant consist primarily of the use of personal protective devices. These include safety glasses, hard hats for some operations and disposable dust masks (not approved). Only one employee (fiber bagger) was noted wearing a respirator during this visit.

DESCRIPTION OF THE PROCESSES

Mineral wool fibers produced in this facility are properly classified a "rockwool" as the raw materials are trap rock plus limestone and dolomite obtained from the area. These materials are layer charged with coke into a cupola where a molten stream is formed at temperatures of approximately 2700^{o}F.

Fibers are formed by the so call "rotary process". In this process, a molten slag is directed onto a spinning disc where centrifugal force causes the molten slag to be thrown from the rim of the disc forming primary fibers. These primary fibers are then met by either a high velocity steam jet or by high velocity air streams where the primary fibers are attenuated to the final fiber diameters. These fibers are blown onto a wire mesh conveyor to remove shot (unfiberized slag). Conveyors move the fiber to a surge area which feeds into the product blending (cement and binders) and bagging area. Fibers used as blowing wool insulation are sprayed with an anealing oil (0.001% by weight) which acts as a dust suppresent. Fibers are bagged into craft paper bags using a pneumatic bagging machine, sewn closed and conveyed to storage areas.

INSPECTION OF THE PLANT POTENTIAL SAFETY AND HEALTH HAZARDS

The following are potential health and safety hazards noted during this survey:

1) Skin and respiratory exposures to mineral wool fibers.
2) Carbon monoxide and metal fume exposures in cupola charge areas.
3) High noise exposures in fiber forming areas.

On the day of the present visit, housekeeping was observed to be minimal. Waste fiber had been used to dry up a floor area and in addition, fiber from the bagging surge area had overflowed.

FIG: 1 FIBER DIAMETER DISTRIBUTION

U.S. MINERAL PRODUCTS STANHOPE, NEW JERSEY

BLOWING WOOL FIBER

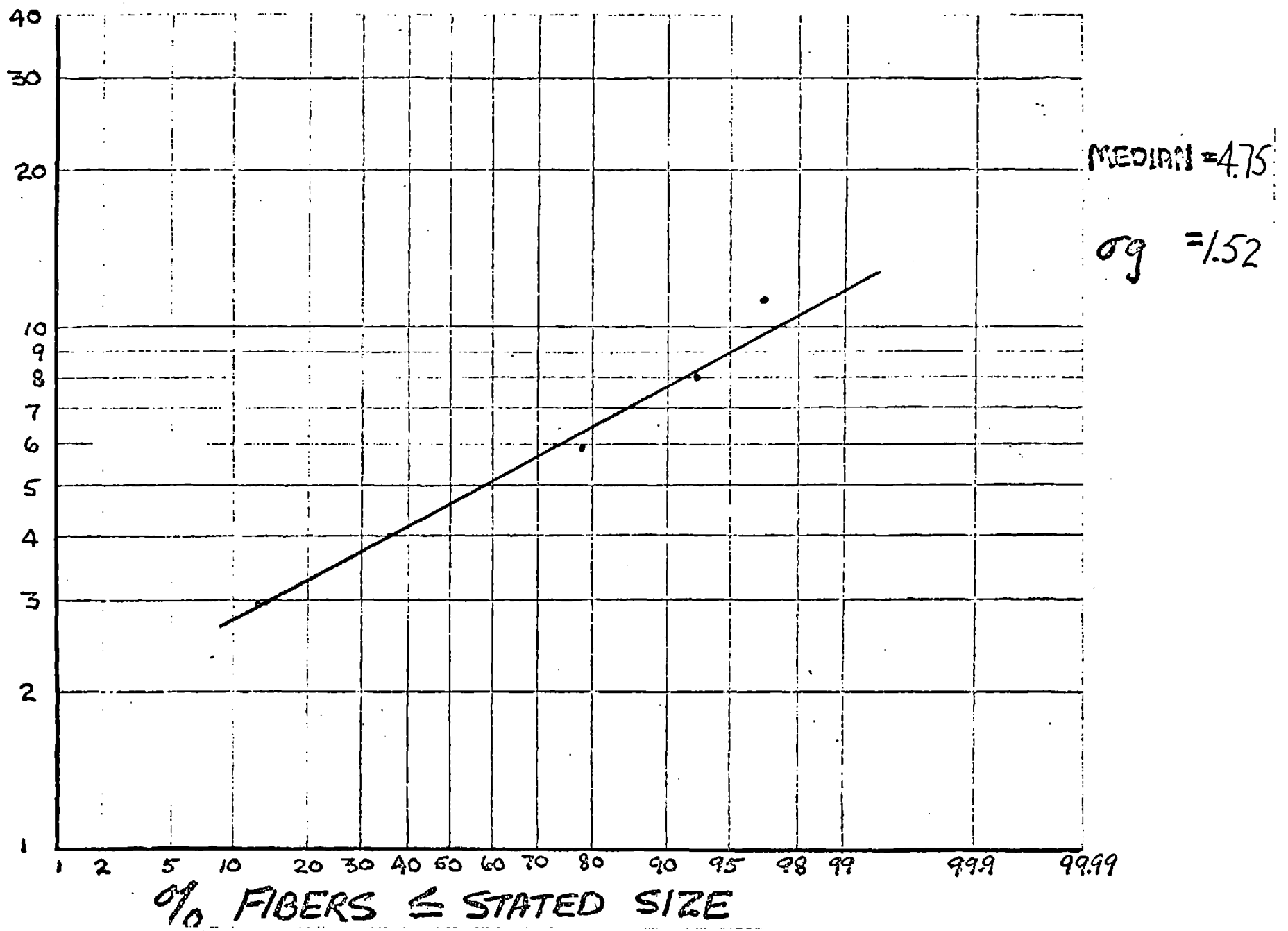
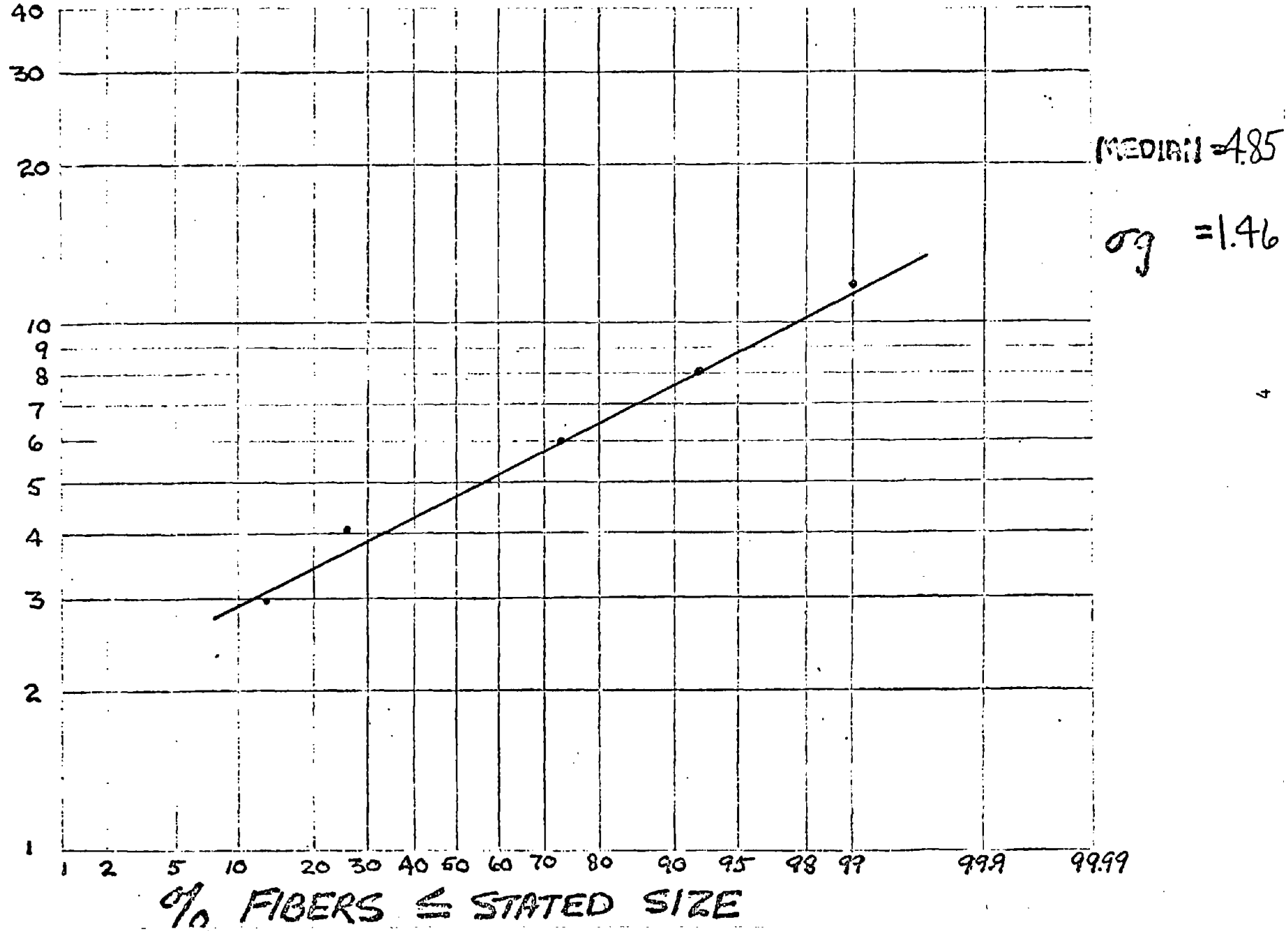


FIG: 2 FIBER DIAMETER DISTRIBUTION

U.S. MINERAL PRODUCTS STANHOPE, NEW JERSEY

CATCO TYPE D



MEDIAN = 4.85

σ_g = 1.46

TABLE 1

SUMMARY OF PRODUCT FIBER DIAMETER DISTRIBUTIONS,
U.S. MINERAL PRODUCTS, STANHOPE, NEW JERSEY

Size Parameter	Product	
	Blowing Wool	CAFCO Typed
Count Median Diameter	4.75μm	4.85μm
Geometric Standard Deviation	1.5	1.5

Results of the trace metal analysis of the blowing wool fiber and CAFCO insulation bulk samples are shown in Table 2. Major contaminants are seen to be Co, Cr, Mn, Ni and Pb; however, it would be anticipated that large deviations in these values would occur from day-to-day due to variations in slag and coke composition.

Although many of the metals listed in Table 2 are considered carcinogens, their availability in the pulmonary environment is unknown; however, the solubility would be expected to be quite low. Similar concentrations of metals are typically seen with bulk asbestos fiber samples; however, the proven carcinogenicity of these fibers is presently thought to be due to its fibrous nature rather than to carcinogenic metal contamination.

Air Samples

Before discussing the specific results of air samples collected during this survey, a brief discussion of fiber respirability is appropriate. Although the respirability of airborne fibers is not clearly understood, this characteristic is thought to be chiefly diameter dependent and fibers greater than 10 μm in diameter certainly have little chance of deep pulmonary penetration. Timbrell's[2] work suggests that the two major mechanisms of fiber deposition in the upper airways (settlement under gravity and inertial deposition) are chiefly dependent upon particle free falling speed (i.e. equivalent Stoke's diameter) and fibers with densities less than 3.5 g/cm^3 and less than 3.5 μm in diameter may escape deposition by these two mechanisms and penetrate deeply into the lungs. Timbrell's work further suggests that the limitation on the length of fibers which reach the deep pulmonary air spaces is imposed by the nasal hairs and small diameters of the respiratory bronchioles. Timbrell and Skidmore[3] in a more recent inhalation experiment with rats, using fibrous glass of 0.75 - 1.5 μm in diameter and lengths up to 100 μm, found a few fibers up to 50 μm in length in the lungs of rats sacrificed during exposure although the bulk of all fibers found were less than 20 μm in length.

Another study conducted by Gross, et al[4], concerned itself with fiber size distributions in the lungs of previous fibrous glass workers. Postmortem examinations were made of lung sections of 20 workers who had been exposed to fibrous glass dust for 16 and 32 years. In this study, approximately 95 percent of all fibers observed were less than approximately 40 μm in length. Occasionally, fibers 50 to 60 μm in length were observed; however, it must be pointed out that these size distributions were made following the lung clearing process therefore no statement can be made regarding initial deposition of fibers.

In contrast to the above quoted articles, Murphy[5] reported a case of acute pulmonary involvement following a short period of fibrous glass exposure. A lower lobectomy was performed and careful pathological examination demonstrated the presence of glass fibers up to 14 μm in diameter and 60 μm in length in the terminal bronchioles. In addition, Balber[6] reports finding fibers 100 μm to 200 μm in length in the

TABLE 2

RESULTS OF TRACE METAL ANALYSES OF PRODUCT FIBER BULK SAMPLES, U.S. MINERAL WOOL PRODUCTS, STANHOPE, NEW JERSEY

Trace Metal	Concentration PPM	
	Blowing Wool	CAFCO* Insulation
Be	<1	<1
Cd	4	5
Co	45	35
Cr	314	507
Mn	965	828
Ni	69	48
Pb	39	35
Zn	<1	<1

*Analysis includes associated binders.

TABLE 3

AIRBORNE FIBER CONCENTRATIONS (FIBERS/CC)
U.S. MINERAL PRODUCTS, STANHOPE, NEW JERSEY

Sample #	Job or Sample Location	Air Vol., Liters	Fiber Conc. Fibers/cc
USM-38	Fiber Bagger	44	2.6
USM-43	Bag Stitcher	33	2.1
USM-45	Bag Car Loader	82	0.8
USM-31	Stationary 15 ft. From Bagging	72	1.5
USM-47	Stationary 15 ft. From Bagging	66	1.3

TABLE 4

SUMMARY OF AIRBORNE FIBER DIAMETER
AND LENGTH DISTRIBUTIONS, U.S. MINERAL PRODUCTS,
STANHOPE, NEW JERSEY

Size Parameter	Measure
Diameter	
Count Median Dia., μm	2.4
Geometric Std. Dev.	1.6
Length	
Count Median Length, μm	17
Geometric Std. Dev.	2.5

VENTILATION AND CONTROLS

At U.S. Mineral Products, cupola gas discharge is vented through a cyclone/ wet scrubber combination. The scrubber has been recently installed. This ventilation system appeared efficient in minimizing worker exposure to cupola gases (carbon monoxide etc.).

Local exhaust ventilation is provided at the fiber bagging and blending areas which discharge to an outside bag collector. The efficiency of the bagging area ventilation was; however, minimal as considerable airborne dust was observed.

SURVEY PROCEDURES

The major portion of this survey was devoted to observation of manufacturing procedures and exposure control practices. Bulk samples of both blowing wool and Cafco insulation were collected. In addition, a limited number of air samples were collected for evaluation of worker exposures to airborne fibers. Personnel air samples were collected on 37 mm, Millipore type AA cellulose ester membrane filters (0.8 μm pore size) at a calibrated sampling rate of 2.0 lpm with an open filter face.

Laboratory evaluation of the collected air samples was done using the phase contrast optical microscopic fiber count method recommeded for asbestos[1]. A Zeitz phase contrast microscope was used for these counts at a magnification of 400X (objective Na = 0.65). All fibers were simultaneously counted and size by comparison with a calibrated porton eyepiece reticule.

In addition to sizing airborne fibers, fiber diameter distributions and trace matal levels were determined for collected bulk samples. Diameter distributions were determined using phase contrast microscopy as described above for air samples. At least 200 randomly selected fibers were sized for each sample. Trace metal levels for the bulk fiber products were determined using atomic absorption spectroscopy following an acid digestion.

RESULTS AND DISCUSSION

Bulk Samples

Fiber diameter distributions for the product fiber samples are shown in Figures 1 and 2 and summarized in Table 1. These distributions were found to be log normal distributed. Count median fiber diameters were found to be 4.75 μm for the blowing wool sample and 4.85 μm for the CAFCO Type "D" product (blown insulation with binders). Geometric standard deviations were found to be 1.5 for both products. These diameters are slightly smaller than those seen for typical fibrous glass insulation samples.

alveolar regions of asbestos workers at autopsy.

As can be seen, considerable difference of opinion exists as to the true nature of a respirable fiber. For purposes of this discussion, based on the above cited studies, "potentially" respirable slagwool fibers shall be defined as those less than 3.5 μm in diameter and less than 50 μm in length.

Results of the airborne fiber concentration determinations are shown in Table 3. Fiber concentrations are seen to range from 0.8 to 2.5 fibers/cc in the blowing wool fiber bagging area. Results of the airborne fiber diameter and length determinations are shown in Table 4. Median airborne fiber diameter and length were found to be 2.4 and 17 μm, respectively while 65% of the airborne fibers could be considered respirable by the above definition.

There are presently little data available relating human experience with respirable mineral fiber exposures such as found in these operations. All human experience to date has been with fibers at significantly lower concentrations 7, 8, 9, 10 than observed at this facility. Studies of the health effects on these workers have produced essentially negative results.

Recent animal studies conducted by Stanton[11] and Friedrichs[12] have demonstrated that small diameter fibrous glass is carcinogenic when injected into the pleural cavity of rats. The significance of these studies in relation to the types of fibers being made at Stanhope, New Jersey are yet unknown. NIOSH has underway a retrospective mortality study of a cohort engaged in slagwool production; however, results of this study are not presently available.

CONCLUSIONS AND RECOMMENDATIONS

From the observations made during this survey and the results of the measurements which were made, the following conclusions are drawn and recommendations for improvements made:

1. There appears to be significant exposure to respirable mineral wool fibers at this facility. While no data presently exists to indicate respiratory problems due to such exposures, it must be emphasized that human experience with respirable rockwool fibers is limited. It would appear prudent that exposures to respirable fibers be kept at an absolute minimum by the use of good work practices and engineering controls. The use of brooms and hand brushes for cleaning should be eliminated in favor of much cleaner vacuum methods. In addition, those persons handling bulk fiber such as baggers and fiber batt handlers should be required to wear respiratory protection unless they have existing health problems which prohibits this, in which case they probably should be removed from this work environment.

2. Local exhaust ventilation whould be installed at all fiber bagging stations.

3. Good medical practice dictates close medical surveillance of those involved in these operations. It is recommended that a medical surveillance program be initiated in these facilities similar to that outlined in the currect asbestos standard (Federal Register, Volume 37, October 18, 1972, Section 1910.93a). This program includes both pre-employment and annual examinations, consisting of chest roentgenogram (14" x 17" posterior-anterior), a history to elicit symptomatology of respiratory disease, and pulmonary function tests (FVC and FEV1).

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