FINAL REPORT

INDUSTRIAL HYGIENE STUDY OF THE GOUVERNEUR TALC COMPANY, NUMBER ONE MINE AND MILL

Balmat, New York

Volume I

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ABSTRACT

A industrial hygiene study was undertaken at the Gouverneur Talc Company, number one mine and mill, during November 3-7, 1975. Samples were collected to evaluate exposures to respirable dust, free silica and asbestos fibers. In addition impinger samples were collected for comparison with past exposure measurements. Bulk product talc samples were also collected for mineralogical analyses by both NIOSH and independent consultant laboratories.

Results of mineralogical analyses of talc product samples by all laboratories concluded that asbestiform minerals (tremolite and anthophyllite) were present. Time-weighted-average fiber exposures in mine and mill operations were found to range from 1.7 to 9.8 fibers > 5 µm/cc and time-weighted-average respirable dust exposures were found to range from 0.25 to 2.96 mg/m^3. No free silica exposures were found to exceed the NIOSH recommended standard of 50 µg/m^3. Electron microscopic analyses of the airborne dusts showed 38 to 45% of airborne fibers to be anthophyllite with lesser quantities (12 to 19%) of tremolite. More than 90% of the airborne fibers were shorter than 5 µm in length.

A review of historic exposure data of these operations and epidemiological data concerning health effects of exposures to tremolite and anthophyllite are included in addition to recommendations for workplace improvements to reduce exposures.

ACKNOWLEDGEMENTS

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Analyses of talc bulk samples were performed by W.C. McCrone Associates and the Mt. Sinai School of Medicine of the City University of New York.

INTRODUCTION

The term "talc" in the mineralogical sense denotes a specific rockforming mineral of the sheet silicate category [Mg_6 (Si_8O_{20}) $(OH)_4$]; however, "talc" in the industrial sense may represent a varied mixture of minerals with similar physical properties as talc.[1] Unfortunately, many past studies of the health effects of industrial talc exposures have not adequately indentified the various hazardous agents which may have been present in the talcs.

The National Institute for Occupational Safety and Health (NIOSH) has underway an industrywide study of the talc mining and milling industry. These studies include both epidemiological studies of exposed worker populations to determine health effects which may be attributed to the work environment and detailed industrial hygiene studies to characterize the various agents to which these workers have been exposed.

The "talc" mining area in the vicinity of St. Lawrence County, New York, represents a complex association of amphiboles (anthophyllite, tremolite, etc.) talc, quartz, and serpentines.[1] Proportional mortality studies by Kleinfeld et.al.[2,3] of talc miners and millers in this area have demonstrated significantly increased mortality due to both malignant and non-malignant respiratory diseases. Also, NIOSH analyses of talcs (Nytal 200) certified by the Vanderbilt Company not to contain asbestos have demonstrated significant contamination levels of both fibrous tremolite and fibrous anthophyllite.[4] However, it has been stated that these studies are not appropriate since the mineral make-up of talc deposits in this area differ substantially with each deposit; some containing asbestos while others do not. One study[16] has suggested differences in toxicity among these minerals.

Those questioning these studies base their arguments on the definition of a fiber (3 to 1 aspect ratio) as described in OSHA standards[8] rather than mineralogical fiber identification. In order to resolve the question concerning the toxicity of these talcs, it was decided that NIOSH would conduct epidemiological mortality, morbidity, and industrial hygiene studies of the Gouverneur Talc Co. which produces Nytal and other talcs which Vanderbilt contends do not contain asbestos. The Vanderbilt Company presently markets products from one mine and mill (#3) which the company admits to containing asbestos and are so labeled.

During November 3-7, 1975, an industrial hygiene study was conducted at the number one mine and mill of the Gouverneur Talc Company, Balmat, New York. Air samples were collected to evaluate worker exposures to asbestos fibers, respirable dust, free silica, and talc dust. A progress report of this study containing all personal exposure data was issued on May 25, 1976 which demonstrated exposures to asbestiform minerals to exceed current OSHA and MESA standards. This final report contains a description of facilities studied, sampling and analytical methods employed, sample results and conclusions and recommendations for workplace improvements to help protect employee health at this and other facilities using these or similar products.

DESCRIPTION OF THE FACILITIES

R.T. Vanderbilt began talc operations at the Gouverneur Talc Company in 1947 with one mine (#1) and one mill (#1). In 1974, the Vanderbilt Corporation acquired all talc operations of the International Talc Company. From this purchase, Vanderbilt was operating two mills (#3 and #6), one underground mine (#3 mine) and one open pit (Arnold Pit) at the time of this study. Only the #3 mine contains what the Vanderbilt Corporation considers to be fibrous anthophyllite and this ore is processed in the #3 mill.

The total employment at all R.T. Vanderbilt New York talc operations at the time of the present study was approximately 170 persons. These are broken down as follows:

Underground	- 41
Open Pit	- 13
Mills	- 67
Salaried	- 49
	170

Employees of these operations are represented by Local #4979 of United Steel Workers which organized in these talc operations in 1954. All operations were on a 5½ day per week schedule with the mine operating only during the day shift while the mill operates three shifts. A list of jobs and a description of related duties in the number one mine and mill are given in Appendix II.

Approximately 19 talc products from all of the Company's New York talc operations are marketed. Mineral Product Safety Data Sheets for these products (supplied by R.T. Vanderbilt), are shown in Appendix I. These talcs are used in numerour products. Some typical uses are as follows:

1. Ceramic wall tile
2. Pottery artware
3. Electrical insulators
4. Ceramic tile glaze and flux
5. Paint filler and carrier for extenders
6. Putties and spackling compounds
7. Die castings (fibrous grades)

DESCRIPTION OF OPERATIONS AND CONTROLS

GOUVERNEUR TALC CO. MINE AND MILL (#1 MINE, ARNOLD PIT AND #1 MILL)

Surface facilities include the main office, mine office, quality control laboratory, change room, crusher building and packer building.

Underground hard rock mining methods are employed using jackleg drills to make holes for blasting the ore in open stopes. The number one mine consists of one main shaft 1250 feet in depth with three main working levels branching off. During the present survey, ore was being mined from approximately 6 of 26 active stopes. According to Company personnel, mining follows a typical cycle: blasting is done with gelatin dynamite and ANFO; time is allowed for dust and gases to dissipate; stoping operations are begun including drilling for the next shifts, blasting, and removal of ore. However, some secondary blasting is done during the work shift.

Ore (muck) from the stoping areas is loaded into 2 ton rail cars using either gravity drawpoint loading or scraper (slusher) loading. Ore from these cars is discharged into a central jaw crusher located at the 700 ft. level although some crushing is also done on the 1110 ft. level. The crushed ore is loaded into a skip and carried to the mine headframe where a gyratory crusher reduces the ore to approximately 3/4 inch screen size. The ore is then transported by conveyor belt to one of four wet ore storage bins in the mill.

Approximately 40,000 cfm of mining ventilation is provided to this mine. In addition, the ore may be quite moist, thereby further reducing dust exposures. Drilling is usually done using wet methods. At the 700 ft. level crusher, water sprays are also used for dust suppression.

In addition to ores from the number one mine, the number one mill also receives ores for first stage crushing from the Arnold Pit located approximately one mile from the mill. Ores are mined from the Arnold Pit using traditional hard rock open pit mining methods by drilling blastholes then blasting to break the ore. A front loader is used to load ore into trucks by which the ore is transported to the primary crushers which are located at the open pit. There are no dust collectors on the open pit crusher.

In the number one mill, various grade talc products are produced by dry grinding operations. A simplified flow sheet for the milling operations is given in Figure 1.

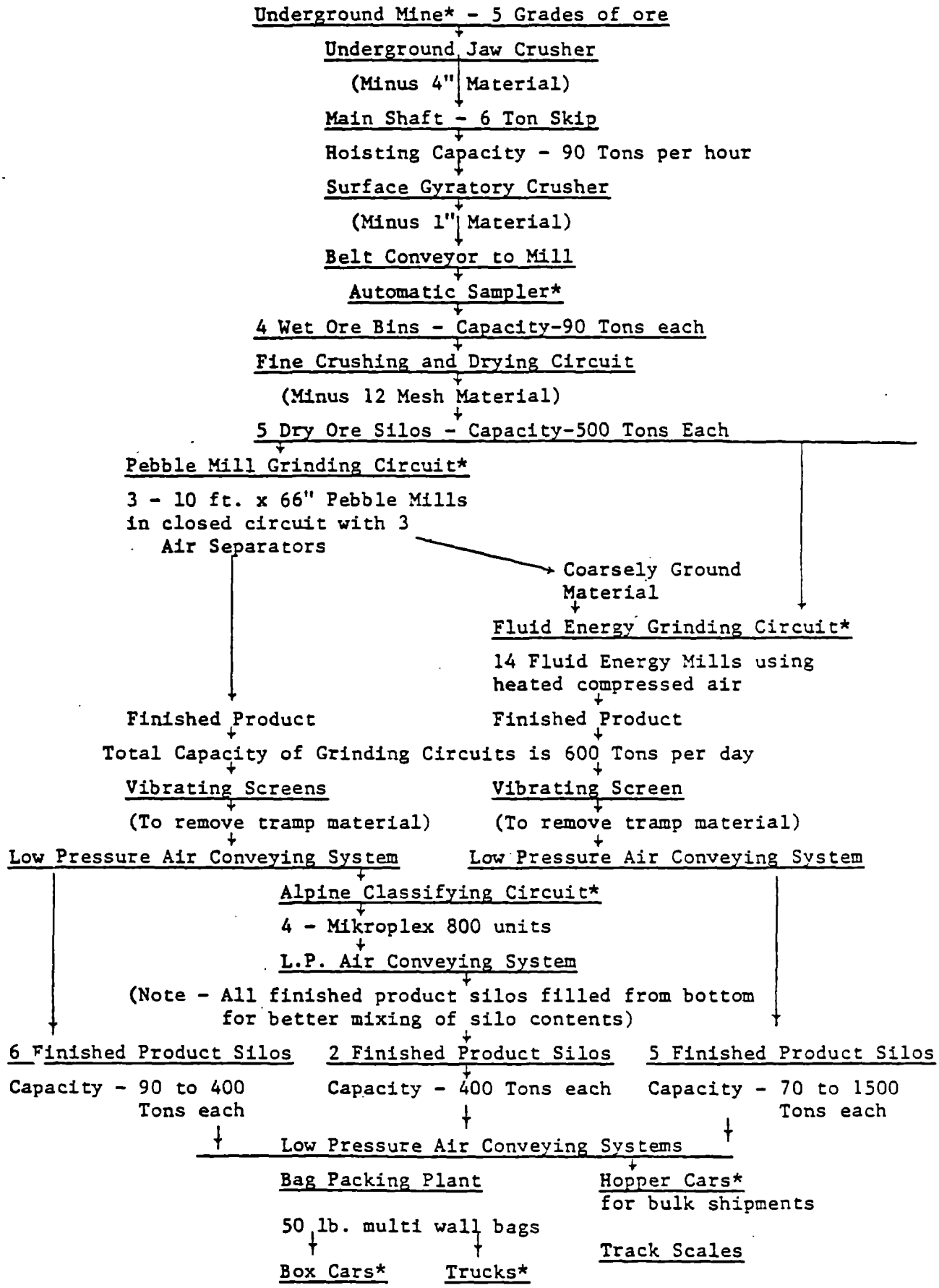
Ores from the wet ore storage bins are periodically sampled by the quality control lab to determine appropriate product grade. The ores are first ground in a cone crusher followed by drying in a rotary dryer. The dry ore is next further reduced using a gyratory disc crusher to produce a minus 12 to 14 mesh product. The product is next screened on vibratory screens and transported to one of six dry ore silos. Fine grind products are made from these ores using either Hardinge pebble mills in closed circuit with Raymond separators or impact crushers in closed circuit with fluid energy mills.

The fine ground powder is stored in one of several concrete silos. These silos are filled using a bottom filling technique patented by R.T. Vanderbilt. Material from these silos is withdrawn by air slides and pumped to the packaging and shipping areas.

FIGURE 1

GOUVERNEUR TALC COMPANY, INC.

SIMPLIFIED FLOW SHEET



* = Sampling Point

Talc may be either sold in bulk or packaged in 50 lb. valve type Kraft paper bags. Bag packaging is done using pneumatic packing machines.

In general, ventilation systems within the mill are quite good. Most material transfer points are provided with local exhaust ventilation and bucket elevators and conveyors are maintained under negative pressure. At the bagging machines, local exhaust ventilation is provided at the filling spout in addition to downdraft ventilation at the bag hopper. For bulk car loading, the telescopic loading spout is provided with a local exhaust ventilation collar.

Air pollution controls consist largely of baghouse dust collectors, although a cyclone is used on the mine headframe gyratory crushers. Much of the collected material is recycled to the product streams. No products from the number one mine or Arnold Pit were being labeled with the OSHA asbestos warning at the time of this study.

OTHER MINES AND MILLS

The #3 mine was not observed during this study. The #3 and #6N mills were observed during a previous visit. The #3 mill produces products considered by the Company to contain anthophyllite asbestos. These products are labeled with the OSHA asbestos warning label. Milling operations at these mills are basically the same as those previously described for the #1 mill with minor variations. Dust control measures are not, however, as effective as those observed in the #1 mine and are being further improved.

MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

Only first-aid medical facilities are available at the Gouverneur Talc Co. New employees are given a pre-employment examination consisting of a work history, medical history, physical examination, and chest x-ray. Periodic examinations including a chest x-ray have been given at yearly intervals. All examinations are given by a local physician who consults with the Plant.

Plant safety is handled by a Plant Safety Director (Floyd Robinson). Monthly departmental safety inspections are conducted by Union and Plant personnel in addition to monthly safety meetings. Personnel protective equipment presently used in the mine includes hard hats, mine lights, personnel rescuers, safety glasses, and safety boots all of which are provided by the Company. In the mill, safety glasses are encouraged and workers at talc bagging operations are provided with dust masks which, according to observations made during this study, are only sporadically used. Hearing protection is provided for specific operations in the mill and mine. In 1974, there were 9 reported (lost time) accidents in the mine and 2 in the mill.

The Company presently does not maintain the services of a full time industrial hygienist. Some sampling is conducted by the Plant Safety Director in addition to yearly sampling by the insurance carrier. Air sampling in these operations has also been conducted by the New York Division of Industrial Hygiene and the Mining Enforcement and Safety Administration (MESA).

INSPECTION OF MINE AND MILL OPERATIONS

POTENTIAL HEALTH HAZARDS

The following are potential health hazards noted during this visit:

1. Respiratory exposures to mineral dusts (fibrous and non-fibrous tremolite and anthophyllite, talc, serpentine, quartz, etc.) in mining and milling operations.
2. Excessive noise exposures in selected plant operations.
3. Exposures to blasting gases in mining operations during secondary blasting.

HOUSEKEEPING

In general, housekeeping in these operations was judged to be acceptable. Some loose talc was, however, noted on the floors in the talc bagging operations. Numerous leaks at material transfer points were noted in the mill.

STUDY METHODS

BULK SAMPLE COLLECTION AND ANALYSIS

Bulk samples of products being produced and bagged during the industrial hygiene study were collected for laboratory mineralogical assay. In addition, seven talc samples produced at this mine and mill were collected from independent talc suppliers (Table 1) for mineralogical assay. Several ore samples were also collected during mine sampling.

Analyses of collected bulk samples were performed by both NIOSH and independent consultant laboratories. The seven talc bulk samples collected from talc suppliers were submitted to both Walter C. McCrone Associates Incorporated and to the Mount Sinai School of Medicine for independent analysis by x-ray diffraction, optical microscopy and electron microscopy. These same samples were also analyzed by NIOSH for the presence of asbestiform fibers by electron microscopy using electron diffraction and energy dispersive x-ray analysis for fiber identification.[7]

Bulk samples collected during the industrial hygiene study were submitted to Walter C. McCrone Associates Incorporated for mineralogical analyses by x-ray diffraction (using step scanning methods) and optical microscopic analyses. These same samples were analyzed by NIOSH for selected trace metals by atomic absorption spectroscopy (after acid digestion).

In addition to the above analyses, several products produced at the number one mine and mill and submitted to NIOSH by Vanderbilt were analyzed for chemical composition by Dr. D.R. Bowes of the Department of Geology, the

Table 1

Sources of R.T. Vanderbilt Talcs Produced at the Gouverneur Talc Company, Number One Mine and Mill and Obtained from Suppliers

Product Name	Source	NIOSH #
Nytal 300	Crone Chemical P.O. Box 14042 Houston, Texas 77021	001
Nytal 400		002
5X	Paul Crazier Company 1115 Silver St. Houston, Texas 77007	003
325		004
X		005
FT		006
3X		007

University of Glasgow. For these analyses, Dr. Bowes used spectrophotometry for SiO_2, TiO_2, Al_2O_3, total Fe (Fe_2O_3 by difference from FeO) and P_2O_5 determinations. Atomic absorption analysis was used for Mno, MgO and CaO. Flame photometry was used for Na_2O and K_2O and wet chemical assay was used for FeO.[10]

AIR SAMPLING AND ANALYSIS

Personal air samples were collected from the breathing zone (miners and millers) to determine time-weighted-average exposures to respirable dust, free silica, and asbestos fibers. Personal samples for respirable dust and free silica were collected at a flow rate of 1.7 lpm using 37 mm diameter polyvinyl chloride filters (pre-weighed) preceeded by 10 mm nylon cycone separators. Samples for asbestos fiber analysis were collected on open faced 37 mm diameter Millipore Type AA filters (0.8 μm pore size) at a flow rate of 1.7 lpm. Respirable samplers were allowed to operate for the full work shift while asbestos samples were changed periodically during the work shift as needed to prevent overloading of filters.

Free silica concentrations were determined using x-ray diffraction as specified in the NIOSH Silica Criteria Document.[5] All asbestos samples were analyzed using the NIOSH phase contrast counting technique.[6] In addition, a representative portion of the asbestos samples were randomly chosen and analyzed by electron microscopy using selected area electron diffraction and energy dispersive x-ray analysis for fiber identification. Electron microscopy was also used to determine airborne fiber concentrations, and size (diameter and length) distributions.[7] Samples for electron microscopic analysis were prepared using a modification of methods described by Ortiz.[9]

In order to relate results of the present industrial hygiene study to past studies in these operations, midget impinger samples also were taken in a manner identical to past sampling techniques. Breathing zone impinger samples were collected in ethyl alcohol at a flow rate of 0.1 cfm with sampling periods ranging from 15 to 30 minutes. These samples were counted at the end of each work shift using Dunn counting cells and bright field optical microscopy (100X). Two preparations were made for each sample and allowed to settle for 30 minutes and counts made by two counters. When counts differed by more than 10%, new preparations were made and recounted.

In addition to personal sampling, stationary samples were taken to further attempt correlations between impinger counts, respirable mass concentrations, total mass concentrations, and asbestos fiber concentrations. Midget impingers were collected as described above using a sequential sampler (24 samplers) such that the entire work shift was sampled. Simultaneously, respirable and total mass samples were collected at flow rates of 10 lpm using 37 mm diameter polyvinyl chloride filters (pre-weighed). The respirable samples were collected using stainless steel cyclone and free silica analyses of the respirable dust performed using x-ray diffraction.[5] Asbestos count samples were collected and analyzed as described above for personal samples.

STUDY RESULTS

BULK SAMPLE ANALYSES

Results of analyses of the seven talc samples obtained from suppliers are shown in Tables 2 and 3. Copies of the reports submitted by McCrone and Mt. Sinai and analytical data obtained by NIOSH are given in Volume II of this report. These reports all concluded that asbestiform tremolite and anthophyllite were present in these samples. In addition, Mt. Sinai and NIOSH reported trace quantities of chrysotile in some samples. The only major discrepancy notable is a higher quartz content for each sample reported by Mt. Sinai. NIOSH analyses tend to support the lower McCrone results which is substantiated by the air sample results.

Results of NIOSH electron microscopic analyses of these talcs, given in Table 3, show that a majority of the fibrous particles in these samples are anthophyllite (67 to 88%) with smaller quantities of tremolite (4 to 12%). A large majority of the tremolite identified by x-ray diffraction is not fibrous. Anthophyllite fibers with very large aspect ratios (1000/1) were observed. A close association between talc and tremolite has been demonstrated by Stemple and Brindley.[15]

Results of further x-ray diffraction and petrographic microscopic analyses (McCrone) of product samples collected during the study are shown in Table 4. These results are in basic agreement with previous results given in Table 2. As can be seen in Table 5, all trace metals for which analyses were performed, with the exception of iron and manganese, were essentially absent. Only insignificant quantities of iron and manganese were detected.

Table 2

Summary of Independent Analyses of
Talcs Produced at the Gouverneur Talc
Company Number One Mine and Mill.
Samples Obtained From Talc Suppliers

Mineral Phase	Percent Composition By Weight						
	Nytal 400	Nytal 300	5X	X	3X	FT	325
Tremolite							
McCrone	50-60	40-50	40-50	>50-60	50-60	50-60	∿60
Mt. Sinai	24	18	27	50-60	32	17	24
Anthophyllite							
McCrone	Present	*	Present	Present	*	*	*
Mt. Sinai	2-3	4-5	7-9	---	*	*	5-7
Quartz							
McCrone	0.5-1.0	2	∿1.5	<0.5	0.5-1.0	**	∿1.5
Mt. Sinai	7-10	9-10	8-9	9-10	7-8	**	3-4
Serpentines							
McCrone	10-15	10-15	10-12	∿15	∿30	∿20	10-12
Mt. Sinai	14-18	14-18	14-18	26-30	31-35	26-30	19-23

* Below detection limits using x-ray diffraction (line scan by McCrone, step scanning by Mt. Sinai).

** Below detection limits by step scanning.

Table 3

Summary of NIOSH Electron Microscopic
Analyses of Talc Produced at the
Gouverneur Talc Company
Number One Mine and Mill
Samples Obtained From Talc Suppliers

Talc Sample	Range of Fiber Aspect Ratios	Fiber Identification (Percent)**				
		Positive Amphiboles		Positive Chrysotile	Non Asbestos	Not* Identified
		Tremolite	Anthophyllite			
Nytal 400	3/1 to 1000/1	8	88	N.D.	4	---
Nytal 300	3/1 to 100/1	12	72	N.D.	4	12
5X	5/1 to 100/1	11	80	Trace	4	5
X	8/1 to 80/1	6	80	N.D.	2	12
3X	5/1 to 100/1	12	67	N.D.	4	16
FT	3/1 to 50/1	16	72	N.D.	4	8
325	3/1 to 50/1	4	88	Trace	7	---

* Selected area diffraction patterns not sufficient for positive identification
** Percent = % of all fibers analyzed by count and not by mass. All fiber lengths analyzed
ND - None Detected

Table 4

Results of X-Ray Diffraction and Petrographic Microscopic Analyses of Bulk Talc Samples Collected During Study Gouverneur Talc Company, Number One Mine and Mill

Mineral Component	Sample Analyses, % By Weight					
	Talc FT	Nytal 100	Ceramatalc HDT	Nytal 200	Nytal 300	Nytal 200
Talc	31-36	43-48	30-35	33-38	35-40	∿14
Tremolite	∿40	∿37	∿49	∿43	∿38	∿59
Anthophyllite	∿10	∿4.5	∿5	∿8	10	15
Quartz	2.6	<0.25	<0.25	0.7	0.8	1.1
Calcite	1	<0.5	0	0	<0.5	<1
Dolomite	1	<0.5	<0.5	<0.5	<0.5	<0.5
Serpentines *	10-15	10-15	10-15	10-15	10-15	∿10

* Includes lizardite and antigorite.

Table 5

Results of Trace Metal Analyses of Bulk Talc
Samples Collected During Study
Gouverneur Talc Company, Number One Mine and Mill

Product Name	Date Collected	Trace Metal, PPM*						
		Cr	Co	Fe	Mn	Ni	Zn	Cd
Talc FT	11/4/75	3	1	1100	1700	7	20	<1
Nytal 100	11/4/75	3	<1	1000	840	5	19	<1
Ceramatalc HDT	11/4/75	2	2	880	1000	6	17	<1
Nytal 200	11/4/75	3	2	970	1300	7	20	<1
Nytal 300	11/3/75	2	3	1000	1700	5	23	<1
Nytal 200	11/3/75	3	2	900	1400	5	22	<1

* Trace metals determined by atomic absorption spectroscopy

Results of major element analyses by Dr. Bowes are shown in Table 6. The high CaO content of these talcs correlates reasonably well with the observed high tremolite content. Other carbonates except traces of calcite are absent or negligible in these talcs as demonstrated by low CO_2 values.[13] The Fe and Mn analyses are consistent with the results shown in Table 5. These major element analyses are in basic agreement with results obtained by Ross et.al.[14] for talcs in the Arnold Pit and by Dreessen[18] for talcs in this area. Ross et.al. also suggested that an additional manganese-rich amphibole, tirodite, may be found in trace quantities in these deposits. Also, the major element analyses shown in Table 6 do show 0.12 to 0.22% MnO; however, no manganese-rich amphiboles were detected by the electron microscope analyses using selected area electron diffraction and microchemical analysis.

Table 6

Results of Major Element Analyses of Gouverneur Talc Company, Number One Mill, Product Samples*

Major Element	Sample Analyses, % By Weight*							
	Nytal 100	Nytal 200	Nytal 400	Ceramitalc 1	Ceramitalc 10A	Ceramitalc 10AC	Ceramitalc HDT	Talc Stds**
SiO_2	54.85	54.52	56.11	56.14	52.81	52.47	55.47	61.49
TiO_2	0.04	0.15	0.07	0.03	0.08	0.04	0.07	0.01
Al_2O_3	0.38	0.32	0.13	0.13	0.16	0.11	0.13	1.20
Fe_2O_3	0.10	0.13	0.08	0.11	0.08	0.06	0.11	0.38
FeO	0.04	0.03	0.05	0.03	0.03	0.01	0.03	1.07
MnO	0.21	0.20	0.22	0.15	0.12	0.10	0.12	0.00
MgO	28.40	28.78	29.40	29.56	30.20	30.56	29.10	30.54
CaO	9.02	8.53	7.50	7.40	8.15	8.30	8.25	0.46
Na_2O	0.28	0.44	0.18	0.25	0.38	0.16	0.18	--
K_2O	0.10	0.17	0.10	0.10	0.10	0.10	0.13	--
P_2O_5	0.03	0.03	0.03	0.03	0.03	0.03	0.03	--
H_2O	5.37	5.07	5.00	5.56	6.07	6.67	5.24	5.00
CO_2	1.35	1.15	1.03	0.96	1.30	0.98	0.84	5.00
Total	100.17	99.52	99.90	100.45	99.51	99.59	99.59	

* Samples submitted to NIOSH by R.T. Vanderbilt, Analyses performed by Dr. D.R. Bowes, University of Glasgow.

** From talc standard analyses in reference 10.

AIR SAMPLES

A brief description of each job, sampling and analytical methods used, results of all individual samples and appropriate summary statistics are shown in Appendix II. Jobs are identified by 4 digit job codes. Tabular summaries of time-weighted-average exposures by job category for the mine and mill are given in Tables 7 and 8, respectively.

Tables 7 and 8 show free silica exposures to be very low. The highest time-weighted-average free silica exposure observed was 0.040 mg/m^3 which is below the 8 hour time-weighted-average exposure value of 0.05 mg/m^3 recommended by NIOSH for this material.[5] Respirable dust exposures ranged from 0.25 to 2.96 mg/m^3. No respirable dust standard has been determined for the mineral talc or talc containing fibrous tremolite or anthophyllite.

Breathing zone impinger concentrations ranged from 0.5 to 15.8 million particles per cubic foot of air (mppcf) with highest concentrations being observed in the mine. The present OSHA and MESA standard for "talc" containing < 1% free silica and no asbestos fibers is 20 mppcf.[8]

Due to its fiber content, the occupational asbestos exposure standard must be applied to exposures to materials from these mining and milling operations. Time-weighted-average asbestos fiber exposures in excess of five fibers > 5 µm/cc were observed for the following job categories:

(1) Mine Crusher Operator

(2) Trammer

(3) Mine Cageman

Table 7

Summary of Time-Weighted-Average Exposures
By Job, Gouverneur Talc Co. Number One Mine

Job Code	Job Title	Asbestos fibers > 5 µm/cc (Optical Microscopy)	Resp. Mass mg/m^3	Impinger mppcf	Free SiO_2 mg/m^3
0102	Crusher Operator	9.8 (4)	--	--	--
0103	Trammer	5.6 (25)	0.64 (3)	10.1 (3)	0.020 (3)
0104	Scrapper Man	--	1.29 (3)	11.8 (5)	0.012 (3)
0105	Underground Laborer	--	0.58 (1)	--	0.006 (2)
0106	Driller	3.0 (5)	0.98 (3)	00.7 (1)	0.014 (2)
0114	Mucker	--	--	15.8 (1)	--
0115	Cageman	9.5 (5)	0.23 (1)	2.0 (1)	--
0301	Repairman	--	1.14 (1)	--	--
0302	Repairman's Helper	--	0.86 (1)	3.6 (1)	0.000 (1)
0303	Blacksmith	2.6 (3)	--	--	--
0304	Maintenance Mechanic	1.7 (12)	0.42 (1)	1.5 (1)	0.000 (1)

( ) = Number of samples used for calculation of time-weighted-average values for each job catagory. Samples for respirable mass and free SiO_2 were full shift samples.

Table 8

Summary of Time-Weighted-Average Exposures
By Job, Gouverneur Talc Co. Number One Mill

Job Code	Job Title	Asbestos fibers > 5 μm/cc (Optical Microscopy)	Resp. Mass mg/m^3	Impinger mppcf	Free SiO_2 mg/m^3
0201	Mill Foreman	5.3 (9)	0.58 (2)	2.9 (2)	0.013 (2)
0203	General Laborer	5.6 (5)	1.14 (1)	0.5 (1)	0.014 (1)
0204	Crusher Operator	5.1 (16)	0.85 (2)	2.6 (4)	0.020 (2)
0206	Hardinge Operator	7.9 (14)	1.09 (2)	3.4 (2)	0.012 (1)
0208	Wheeler Operator	8.4 (14)	1.56 (2)	3.1 (2)	0.012 (1)
0209	Packer	5.1 (48)	0.59 (9)	3.6 (6)	0.010 (7)
0211	Packer Serviceman	3.6 (11)	0.42 (2)	2.1 (1)	0.007 (2)
0212	Packhouse Foreman	1.5 (5)	0.25 (2)	--	0.014 (2)
0213	Fork Lift Operator	4.0 (15)	0.35 (3)	1.6 (2)	0.000 (1)
0214	Car Liner	3.4 (4)	0.31 (1)	--	0.000 (1)
0220	Bulk Car Loader	2.0 (3)	0.25 (1)	--	0.016 (1)
0401	Millwright	1.9 (3)	2.37 (2)	--	0.040 (2)
0402	Instrument Repairman	2.8 (6)	0.59 (2)	--	0.000 (1)
0403	Machinist	1.8 (3)	0.40 (1)	--	0.016 (1)
0405	Millwright Helper	4.0 (2)	2.96 (1)	--	0.000 (1)
0406	Sheet Metal Worker	1.7 (3)	0.50 (1)	--	0.013 (1)
0410	Oiler	4.0 (4)	0.72 (1)	--	0.016 (1)
0411	Welder	1.9 (3)	0.75 (1)	--	

( ) = Number of samples used for calculation of time-weighted-average values for each job catagory. Samples for respirable mass and free SiO_2 were full shift samples.

(4) Mill Foreman

(5) Mill Laborer

(6) Crusher Operator

(7) Hardinge Operator

(8) Wheeler Operator

(9) Packer

In addition, 17 of the 24 job catagories samples had time-weighted-average exposures exceeding the current OSHA standard of 2.0 fibers > 5 µm/cc[8] and all operations exceeded the OSHA proposed standard of 0.5 fibers > 5 µm/cc.[12]

The following job catagories had exposures in excess of the OSHA and MESA allowable ceiling value of 10 fibers > 5 µm/cc:

(1) Mine Crushers Operator

(2) Trammer

(3) Mine Cageman

(4) Mill Foreman

(5) Mill Laborer

(6) Crushers Operator

(7) Hardinge Operator

(8) Wheeler Operator

(9) Packer

Individual sample results, as determined by electron microscopy, are shown in Table 9 and time-weighted-average fiber concentrations by job are shown in Table 14 of Appendix II. In these tables, "positive asbestos" means only those identified by electron diffraction; therefore these concentrations

represent minimum estimates of true total airborne asbestos concentrations. As shown in Appendix II, time-weighted-average positive asbestos fiber exposures as determined by electron microscopy ranged from 9.5 to 70.6 fibers/cc (all lengths) with concentrations in the mill tending to be slightly higher. As shown in Table 9, total fiber concentrations (all types and lengths) for individual samples ranged from 11.6 to 189.5 fibers/cc.

A summary of airborne fiber types as determined by electron microscopy is shown in Table 10. In the mine, 38% of the airborne fibers were identified as anthophyllite while 19% were tremolite and 39% were unidentified. In the mill, 45% of the fibers were anthophyllite, 12% tremolite and 38% unidentified. Three percent of the fibers in the mine and 2% in the mill gave chrysotile electron diffraction patterns. The presence of chrysotile in the air samples is consistent with the results of bulk sample analyses by Mt. Sinai and NIOSH where trace quantities of chrysotile were noted in some samples. All chrysotile fibers observed in the air samples were less than 1 µm in length. Nearly all of the serpentine minerals identified in the bulk samples is lizardite.

Results of airborne fiber size determinations (diameter and length) for tremolite and anthophyllite fibers are shown in Tables 11 and 12 with appropriate summary statistics. As was expected, tremolite fibers tended to be larger in diameter and shorter in length than anthophyllite fibers with size distributions for these minerals being similar for the mine and mill. Median fiber diameters of 0.19 and 0.13 µm were observed for tremolite and anthophyllite, respectively. In the mine, median fiber lengths of 1.6 µm for tremolite and 1.5 µm for anthophyllite were observed. Similar lengths

Table 9

Comparison of Optical and Electron Microscopic Fiber Concentrations, Gouverneur Talc Company, Number One Mine and Mill

Sample #	Job Code	Job Title	Fibers/cc			
			Electron Microscopy			Optical
			Post. Asbestos*	Total Fibers	All >5μm	>5μm
G194	0103	Trammer	20.2	42.1	1.2	3.5
G156	0103	Trammer	22.6	29.8	5.9	2.7
G149	0103	Trammer	13.2	27.8	2.4	4.2
G237	0103	Trammer	8.9	19.1	2.0	4.7
G240	0.06	Driller	9.5	14.4	1.3	No count
G223	0115	Cageman	17.5	30.3	2.2	6.0
G04	0201	Mill Foreman	18.4	28.8	5.8	5.8
G42	0201	Mill Foreman	33.7	70.0	7.0	5.3
G98	0203	General Laborer	36.6	64.9	9.3	5.9
G146	0203	General Laborer	9.0	14.9	1.3	2.9
G77	0204	Crusher Operator	9.0	45.5	2.8	3.8
G38	0204	Crusher Operator	15.6	27.2	4.4	2.2
G101	0206	Hardinge Operator	102.7	189.5	6.2	8.9
G22	0206	Hardinge Operator	33.6	51.5	4.2	5.5
G144	0208	Wheeler Operator	18.2	31.8	4.1	6.8
G02	0208	Wheeler Operator	25.5	37.4	4.0	6.0
G96	0209	Packer	31.9	57.5	4.8	1.2
G47	0209	Packer	41.8	73.5	8.5	3.2
G85	0211	Packer Serviceman	7.3	11.6	0.5	1.6
G10	0211	Packer Serviceman	26.7	34.7	4.4	4.2
G113	0212	Packhouse Foreman	13.6	18.4	1.4	1.6
G05	0212	Packhouse Foreman	16.2	28.4	5.7	1.1
G31	0213	Fork Lift Operator	36.0	71.9	8.7	8.3
G197	0304	Maintenance Mechanic	16.7	26.6	1.7	2.3
G180	0403	Machinist	24.9	42.5	3.6	3.6
G197	0411	Welder	9.9	14.6	2.1	3.1

* Includes only those giving identifiable electron diffraction patterns; therefore, represents a conservatively low estimate.

Table 10

Summary of Airborne Fiber Types Determined By
Analytical Electron Microscopy
Gouverneur Talc Company, Number One Mine and Mill

Operation	Percent of Airborne Fibers (All Lengths)				
	Positive Amphiboles*		Positive Chrysotile	Non Asbestos	Not Identified***
	Tremolite**	Anthophyllite**			
Mine	19	38	3	1	39
Mill	12	45	2	2	38

* Airborne fibers were identified as positive amphiboles by selected area electron diffraction.

** Amphiboles differentiated by energy dispersive microchemical analysis.

*** Electron diffraction patterns not sufficient for identification; however, many had x-ray spectra identical to tremolite.

Table 11

Summary of Airborne Fiber Diameters for Positive Amphiboles
Gouverneur Talc Company, Number One Mine and Mill

Operation and Fiber Type	Median Diameter µm	Geo. Std. Deviation	95% Conf. Interval for Median Diameter µm	% ≤ 0.5 µm in Diameter
Mine*				
Tremolite (N=83)	0.19	2.3	0.16-0.23	88
Anthophyllite (N=164)	0.13	2.4	0.12-0.15	93
Mill*				
Tremolite (N=160)	0.19	2.4	0.17-0.22	87
Anthophyllite (N=687)	0.13	2.9	0.12-0.14	90

* Results of all samples combined for distribution analysis.

N = Number of individual fibers analyzed.

Table 12

Summary of Airborne Fiber Lengths for Positive Amphiboles
Gouverneur Talc Company, Number One Mine and Mill

Operation and Fiber Type	Median Length µm	Geo. Std. Deviation	95% Conf. Interval for Median Length µm	% ≤ 5 µm in Length
Mine*				
Tremolite (N=83)	1.6	1.8	1.4-1.8	97
Anthophyllite (N=164)	1.5	2.6	1.3-1.7	90-92
Mill*				
Tremolite (N=160)	1.5	1.9	1.4-1.7	97
Anthophyllite (N=687)	1.4	2.9	1.3-1.5	90

* Results of all samples combined for distribution analysis.

N = Number of individual fibers analyzed.

were seen in the mill. In the mine and mill, only 3% of the tremolite fibers were longer than 5 μm whereas 8-10% of the anthophyllite fibers were longer than this length.

The trend for airborne anthophyllite fibers to have larger aspect ratios can be observed by inspection of Figures 2 and 3 and Table 13. Median aspect ratios of 9.5 and 7.5 were observed for anthophyllite and tremolite, respectively. Only 30% of the tremolite fibers had aspect ratios greater than 10 to 1 whereas 48% of the anthophyllite fibers had aspect ratios greater than this value.

Typical electron photomicrographs of airborne particulates from the mine and mill are shown in Figures 4,5 and 6. In addition to large amounts of analytical data already presented, the asbestiform nature of these fibers may be further appreciated by observation of their "fibril" structures.

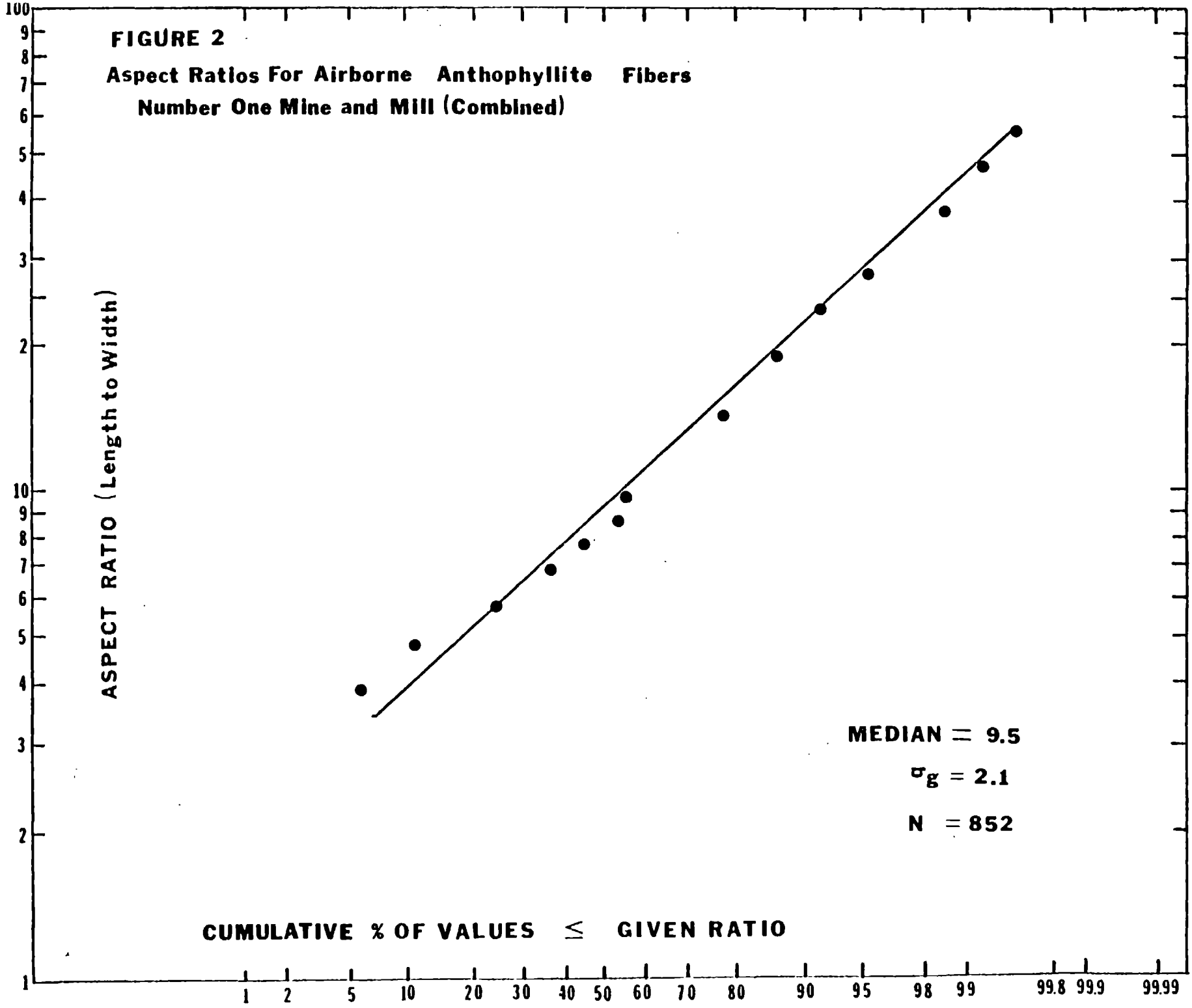


FIGURE 2
Aspect Ratios For Airborne Anthophyllite Fibers
Number One Mine and Mill (Combined)
ASPECT RATIO (Length to Width)
100
9
8
7
6
5
4
3
2
10
9
8
7
6
5
4
3
2
1
MEDIAN = 9.5
σ_g = 2.1
N = 852
CUMULATIVE % OF VALUES ≤ GIVEN RATIO
1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99

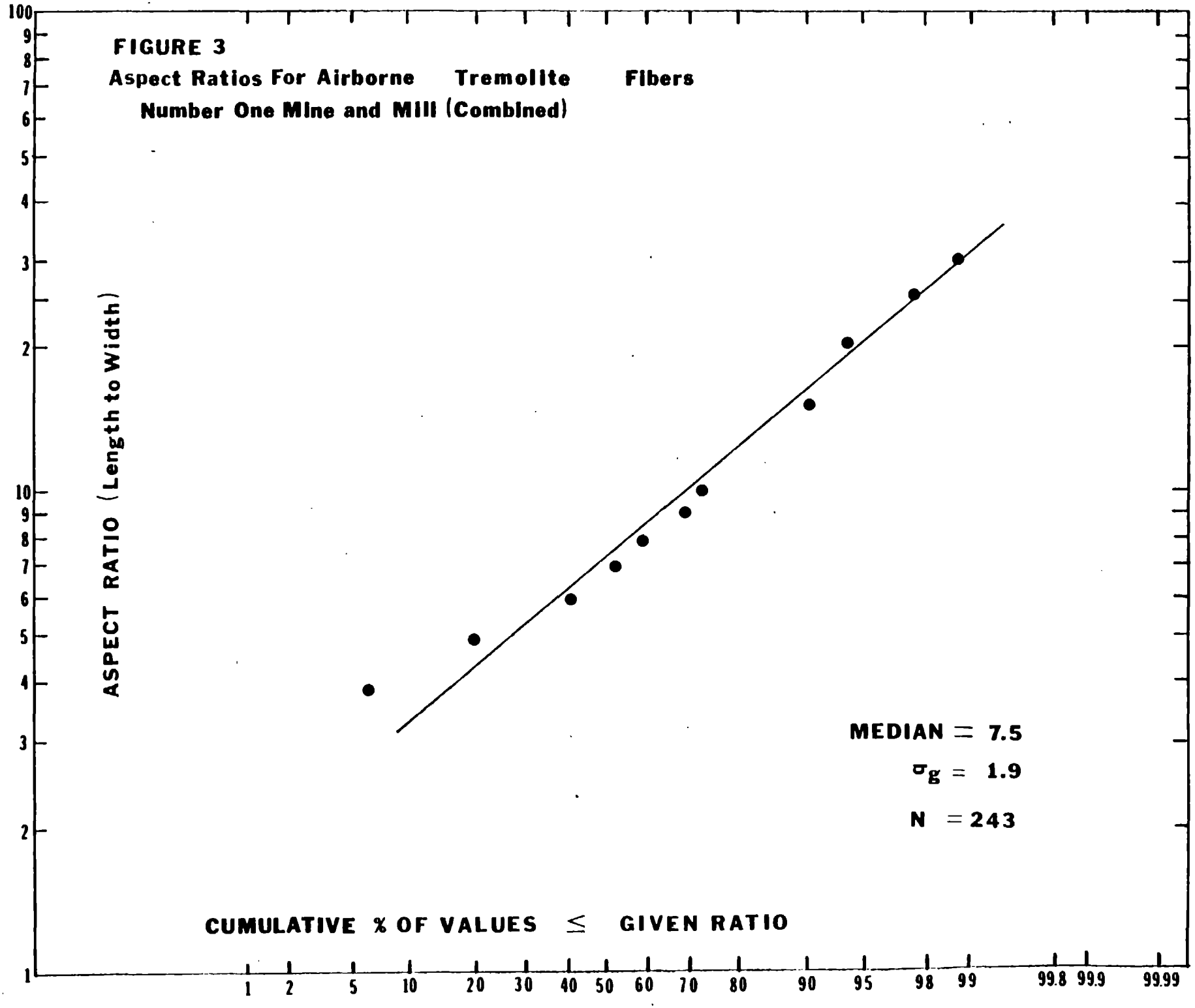


FIGURE 3
Aspect Ratios For Airborne Tremolite Fibers
Number One Mine and Mill (Combined)
ASPECT RATIO (Length to Width)
100
9
8
7
6
5
4
3
2
10
9
8
7
6
5
4
3
2
1
MEDIAN = 7.5
σ_g = 1.9
N = 243
CUMULATIVE % OF VALUES ≤ GIVEN RATIO
1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99

Figure 4: Electron Photomicrograph of Airborne Particulates from number one Mill and Mine

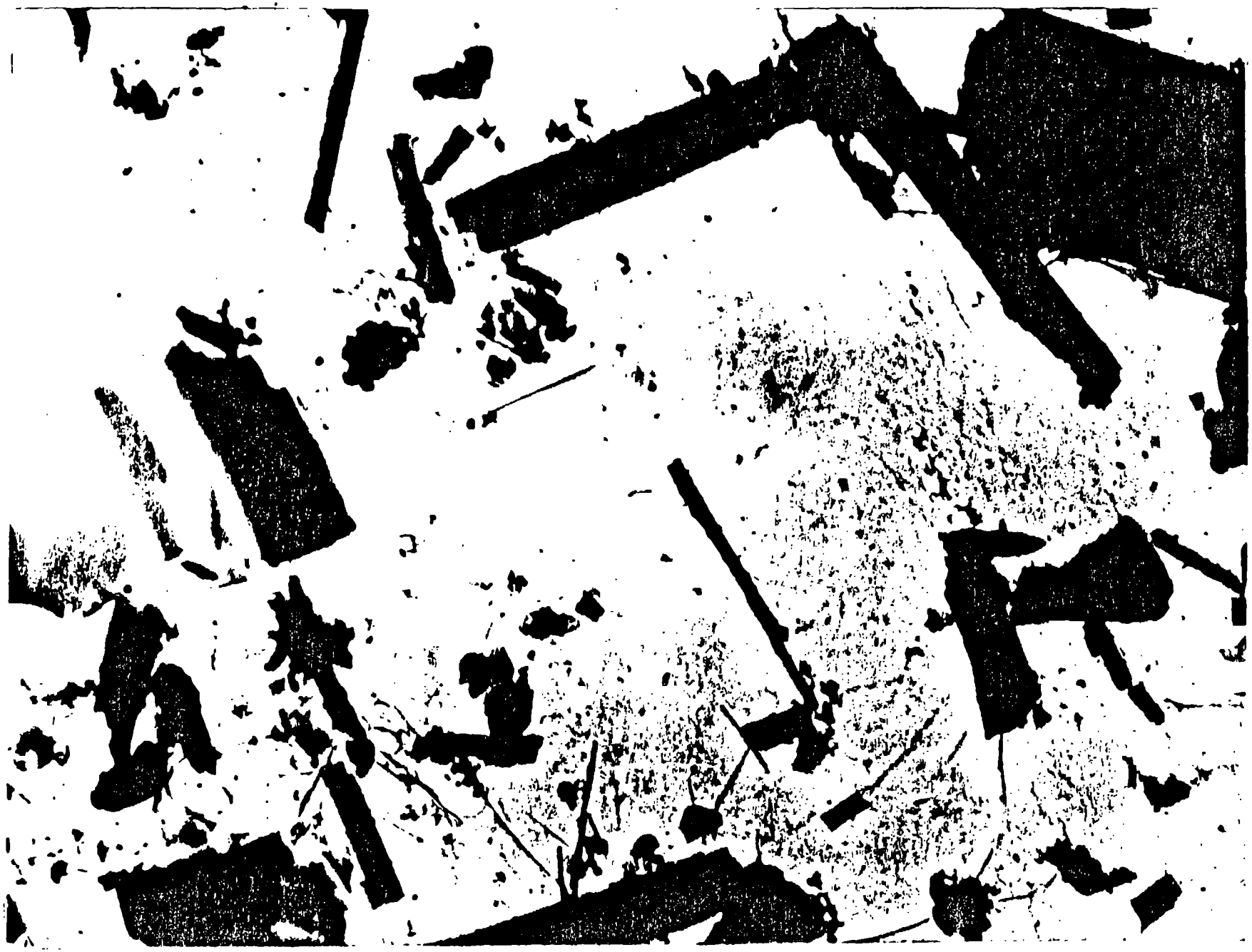


Figure 5: Electron Photomicrograph of Airborne Particulates from Number one Mine and Mill

Figure 6: Electron Photomicrograph of Airborne Particulates from number one Mine and Mill

Table 13

Aspect Ratios for Positive Amphiboles Determined by Electron Microscopy
Gouverneur Talc Company, Number One Mine and Mill

Aspect Ratio Measurement	Tremolite*		Anthophyllite*	
	Mine	Mill	Mine	Mill
Median Aspect Ratio	7.5	7.5	9.5	9.5
Aspect Ratio				
$\leq$ 5/1	23%	24%	17%	15%
$\leq$ 10/1	70%	70%	52%	52%
$\leq$ 20/1	96%	96%	85%	88%
$\leq$ 50/1	>99%	>99%	99%	>99%

* Data shown are for all fiber lengths

COMPARISON OF SAMPLING AND ANALYTICAL METHODS

In order to compare results of the present study with historic dust measurements, several comparisons were made. Results of the stationary samples for correlation of sampling and analysis methods are shown in Table 14. Based on these limited data, the following average relationships were calculated:

Ratio	Average	Range
resp. dust, mg/m^3/mppcf	0.22	0.12-0.29
fibers > 5 μm/cc/resp. dust mg/m^3	6.7	3.1-11.9
fibers > 5 μm/cc/mppcf	1.2	0.9-1.4

These data also show that an average of 28 percent of the airborne dust in the mill is respirable.

A further comparison of fiber concentrations determined by optical microscopy and respirable dust concentrations is afforded by the paired personnal dust measurements made in the mill. A linear regression analysis of these time-weighted-average values is shown in Figure 7. The regression line was forced through the null points after this null hypothesis was tested[11] and could not be rejected. A good correlation (r=0.73) was found between these two sampling methods. The results of this analysis demonstrated the following relationship:

$$\text{fibers} > 5\ \mu m/cc/\text{resp. dust}, mg/m^3 = 6.3$$

FIGURE 7

Comparison of Time Weighted Average Fiber and Respirable Dust Exposures, Mill Samples

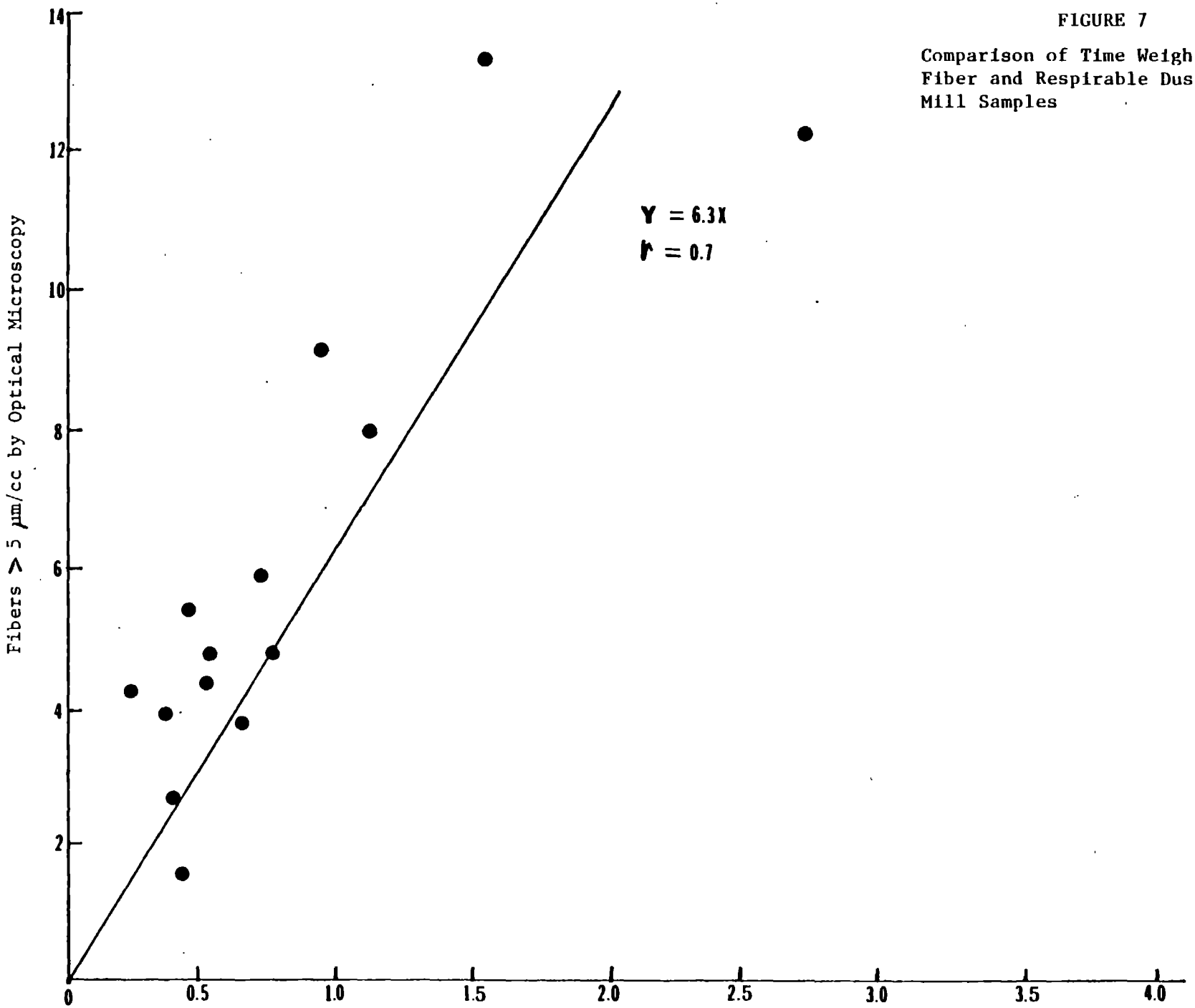


Table 14

Summary of Stationary Samples for Correlation of Sampling Methods
Gouverneur Talc Company, Number One Mill

Sample Station	Time-Weighted-Average Concentrations			
	Total Dust mg/m^3	Resp. Dust mg/m^3	Impinger mppcf	Asbestos Fibers > 5μm/cc
1	2.44 (N=1)	0.88 (N=1)	3.5 (N=12)	4.4 (N=3)
2	1.47 (N=1)	0.36 (N=1)	3.0 (N=5)	4.3 (N=3)
3	8.81 (N=1)	2.14 (N=1)	7.2 (N=6)	6.7 (N=2)

N = Number of individual samples collected.

The 95% confidence interval for this ratio was calculated to be 4.1 to 8.5. These results are consistent with those shown in Table 14 for the stationary mill samples.

A comparison was also made between time-weighted-average fiber exposures (fibers > 5 μm/cc) and impinger dust exposures (mppcf) for individuals in the mine and mill. These results are shown in Table 15. As can be seen, no consistent conversion between these sampling methods was obtained although some differences in conversion values in the mine and mill are evident. A median conversion ratio (fibers > 5 μm/cc/mppcf) of 0.5 was obtained for mine samples whereas a median ratio of 1.7 was obtained for the mill. These differences are statistically significant ($p<0.001$). Several possible explainations exist for this difference; however, the most plausible is that fine grinding, which takes place in the mill, liberates greater numbers of "free" fibers from the host rock. In addition, finer dust particles in the mill are less efficiently collected and counted by the impinger method.

A graphical comparison between total fiber concentrations by electron microscopy and fibers > 5 μm by optical microscopy is shown in Figure 8. These data were found to be highly scattered with no consistent correlation. These data are summarized in Table 16 and show a significantly different ratio of total fibers by electron microscopy to fibers > 5 μm by optical microscopy between mine and mill samples although no single predictive values can be estimated.

Table 15

Comparison of Impinger and Optical Fiber Count Results
Gouverneur Talc Company, Number One Mine and Mill

Summary Statistic	Ratio (fibers > 5 um/cc/mppcf)	
	Mine	Mill
Median Ratio	0.5	1.7
Range of Ratios	0.2-1.2	0.6-3.4
Number of Comparisons	6	15
95% Conf. Interval for Median Ratio*	0.3-0.8	1.3-2.2

* Based on log - normal distribution model.

FIGURE 8

Comparison of Fiber Concentrations
by Optical and Electron Microscopy

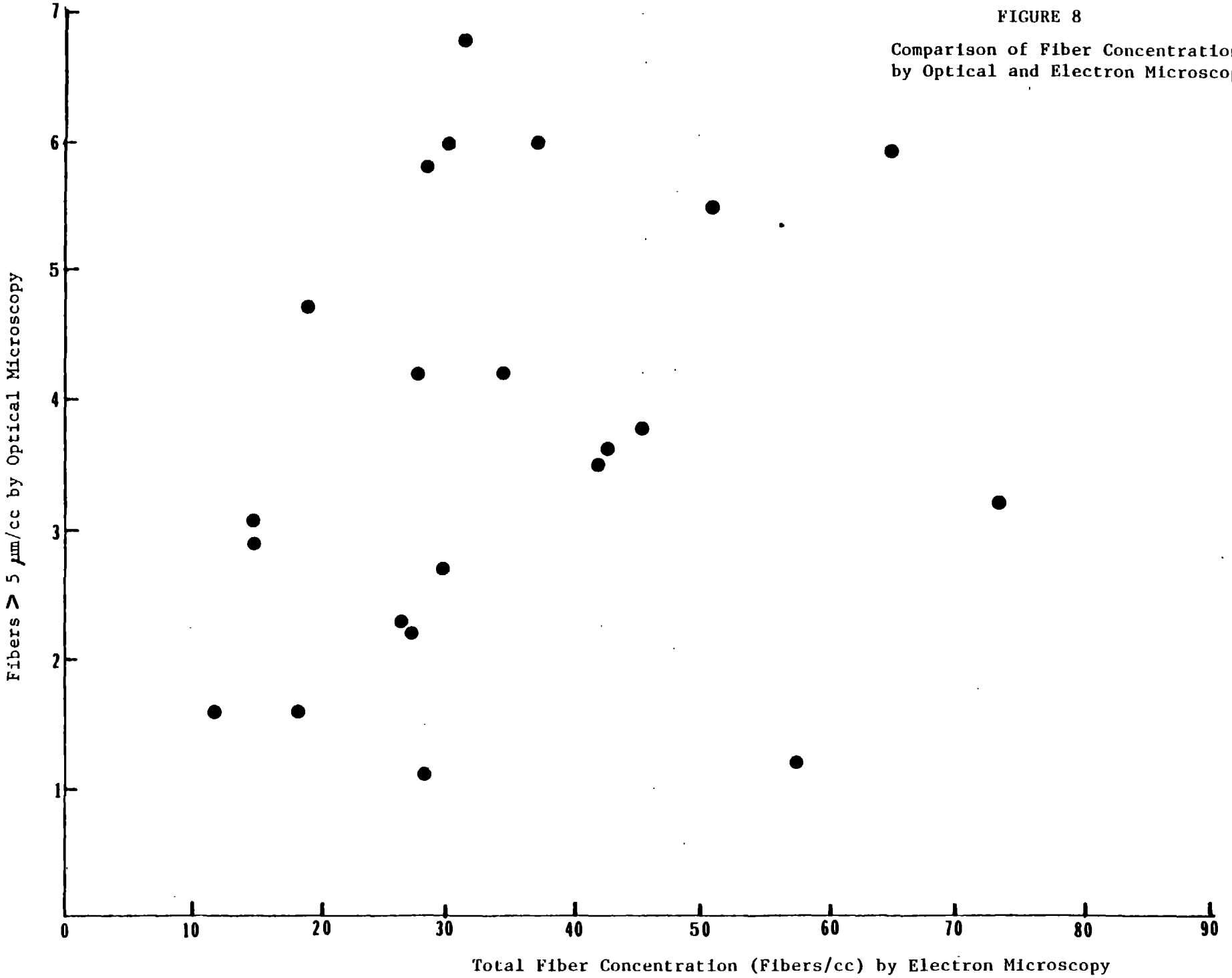


Table 16

Comparison of Optical and Electron Microscopic Fiber Concentrations
Gouverneur Talc Company, Number One Mine and Mill

Summary Statistic	Ratio (EM total fiber/cc/Opt. fiber > 5 μm/cc	
	Mine	Mill
Median Ratio	7.1	11.0
Range of Ratios	4.1-12.0	4.7-47.9
Number of Comparisons	5	17
95% Conf. Interval* for Median Ratio	6.7-7.5	10.7-11.3

* Based on log - normal distribution model.

COMPARISON OF PRESENT AND PAST EXPOSURES

The present studies demonstrate elevated exposures to asbestiform minerals in nearly all mine and mill process operations. Comparisons between present dust (mppcf) and fiber (fibers > 5 μm/cc) exposures and historic exposure measurements are shown in Tables 17 and 18, respectively. These data were gathered from a number of sources.

Trends in dust concentrations as a function of calendar time are difficult to intrepret for several reasons. First and most important is the relative pausity of data on some operations prior to approximately 1970. Secondly, very few samples were taken in any given year and the representativeness of these samples is unknown.

For visual inspection of trends in dust concentrations, average values for mine and mill operations by year were calculated and are shown in Figures 9 and 10, respectively. Inspection of Figure 9 shows no consistent trends in dust concentrations when all mine operations are considered. On the other hand, the mine exposures for such operations as drilling, dragline loading, tramming and mucking show relatively consistent exposure levels over the years with only slight deviations. This might be expected as wet drilling has been a routine practice. In addition, ores being mined are relatively wet. Primary crushing and hoist loading operations show somewhat of a decreasing trend. Such controls as water sprays for dust suppression at the primary crusher are the most probable explaination for this trend.

Table 17

Summary of Historic Impinger Dust Measurements at the Gouverneur Talc Company, Number One Mine and Mill

Job or Operation	Mean Dust Concentration (mppcf)										Median Yearly Average
	1954	1958	1963	1964	1969	(1) 1970	(2) 1972	(2) 1973	(2) 1975	NIOSH 1975	
Mine											
Drilling	5		5		13	7	4	5	3	12	5
Dragline Loading			7			10	8	3	5	12	8
Tramming & Mucking					29	11	10	3	5	10-15	10
Primary Crushing	2	26	23	18	13	48	11	5	18		18
Hoist Loading				70	140	14	18	10	15	2	14
Mill											
Secondary Crushing	12	23	8	10	12	13	3	8	3	3	9
Wheeler Grinding	15	13	5	3	11	19		4	10	3	10
Hardinge Grinding	18	14	4	7		8			10	3	8
Bagging	25	15	5	9	4	8		8	9	4	8
Palletizing	40			25	10	6		8	15	2	10
Bulk Loading						10					35
Loading Bags		109	39	31		62					50
Other											
Millwright								4		4	
Maintenance								12		2	

(1) Values for 1954 - 1970 taken from reference 16.
(2) Calculated from MESA reports references 33-42

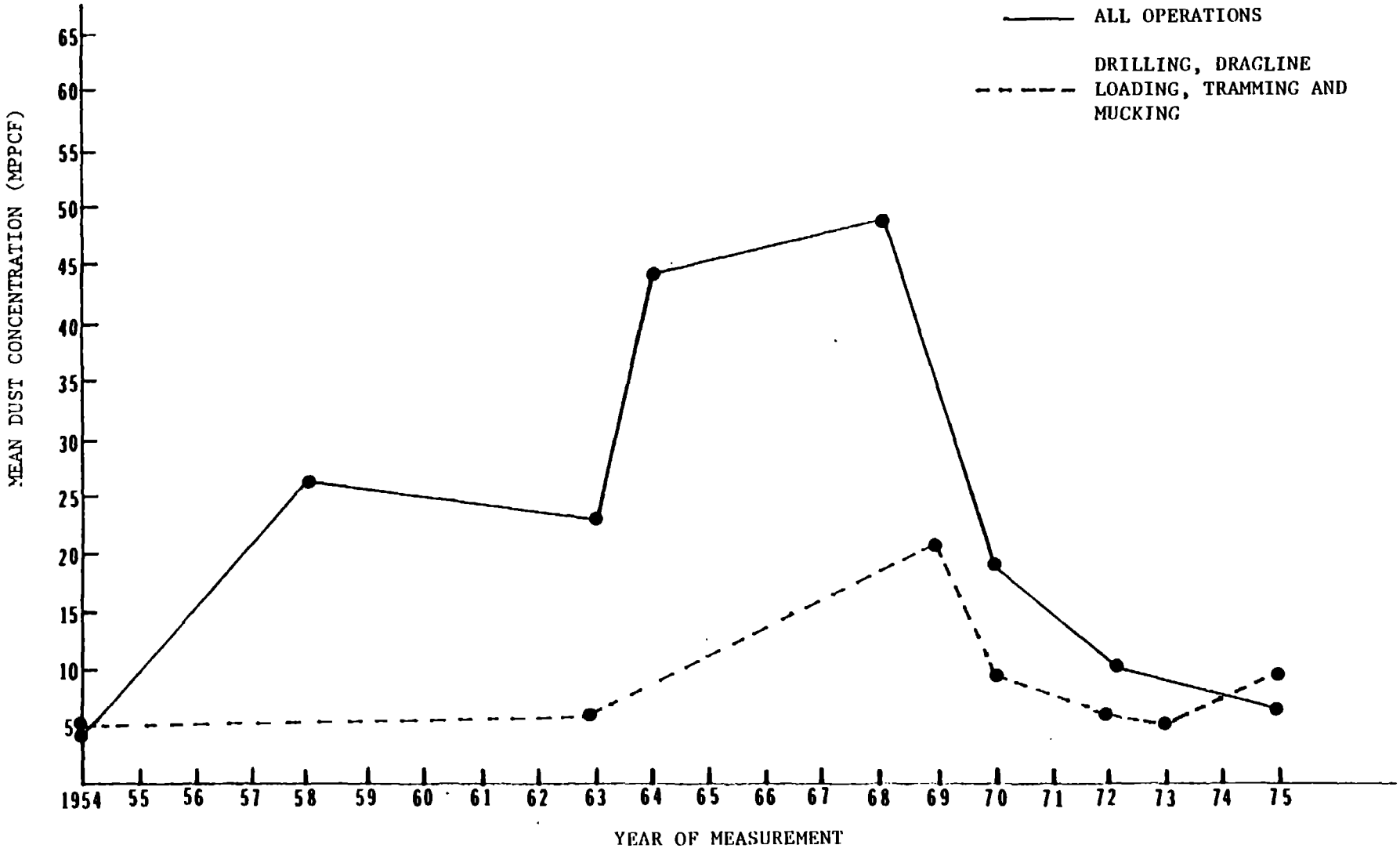
Table 18

Summary of Historic Fiber Exposure Measurements at the Gouverneur Talc Company, Number One Mine and Mill

Job or Operation	Mean Fiber Concentration (fiber > 5 μm/cc)						
	(1) 1970	(2) 1972	(2) 1973	(2) 1974	(2) 1975	NIOSH 1975	(2) 1976
Mine							
Drilling	8	4	1	1	1	3	24
Dragline Loading	16	6	1	2		6	
Tramming & Mucking	22	6	1		3	6	8
Primary Crushing	260	22	5	9	20	10	25
Hoist Loading	29	5	10	13	3	10	12
Mill							
Secondary Crushing	13	5	14	6	9	5	18
Wheeler Grinding	30		14	13	17	8	14
Hardinge Grinding	33			13	10	8	14
Bagging	30		11	15	6	5	14
Palletizing	27		8	15		4	
Bulk Loading	8					2	
Loading Bags						3	
Other							
Millwright			9			2	
Maintenance			14			2-4	38

(1) Taken from reference 16
(2) Calculated from MESA reports, references 33-43

FIGURE 9: MEAN YEARLY IMPINGER DUST CONCENTRATIONS FOR MINE OPERATIONS, GOUVERNEUR TALC COMPANY, NUMBER ONE MINE



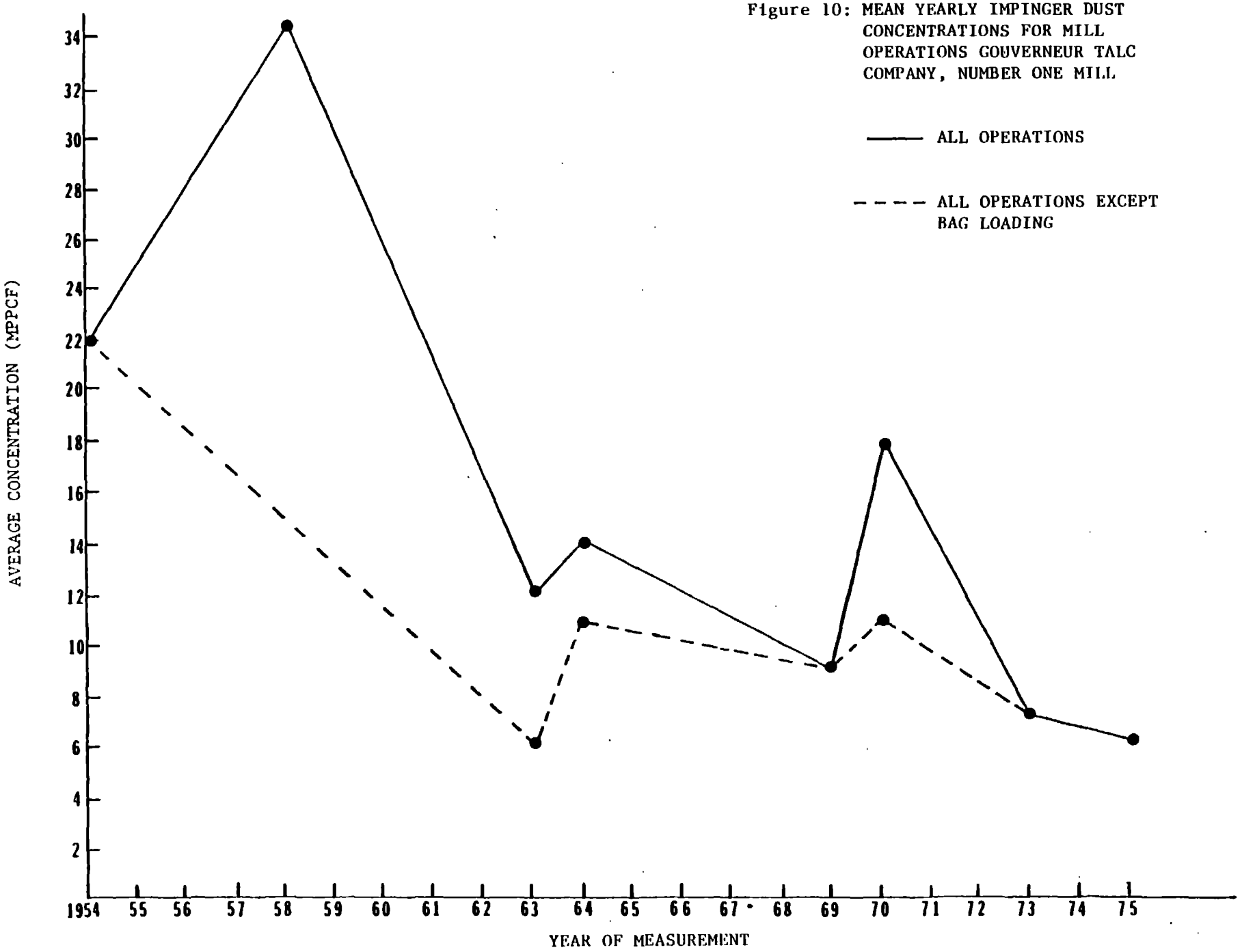


Figure 10: MEAN YEARLY IMPINGER DUST CONCENTRATIONS FOR MILL OPERATIONS GOUVERNEUR TALC COMPANY, NUMBER ONE MILL

A greater trend for decreasing dust concentrations in mill operations is demonstrated in Figure 10 for all mill operations combined. Figure 10 also shows a greater decreasing trend in exposure when the uncontrolled operation of loading bagged talc into box cars is excluded from the calculated yearly averages. Engineering controls for talc milling operations have improved with time.

As shown in Table 18, fiber exposure measurements have only been made since 1970. Results of the NIOSH 1975 survey tend to show a reduction in fiber exposure when contrasted with earlier data for most operations.

Radon daughter measurements have been made in the number one mine by the Mining Enforcement and Safety Administration (MESA). Measurements taken in 1973 and 1976 showed only nil to trace levels.[44,45]

DISCUSSION

Results of the present industrial hygiene study and past surveys demonstrate significant exposures to airborne fibers in both mine and mill operations at this facility. Electron microscopic analyses of both bulk talcs and airborne dust samples have shown that these airborne fibers are largely asbestiform tremolite and anthophyllite with airborne fibers sizes (length and diameter) consistent with those found for industrial processes using asbestos.[17] By any reasonable mineralogical or physiological definition of "fiber", one must consider tremolite and anthophyllite fibers in these talcs to be asbestiform.

More than four decades have elapsed since the first epidemiological data were published demonstrating adverse health effects of tremolite talc exposure. In 1933, Dreessen[18] published the results of a chest x-ray study of 57 workers engaged in the mining and milling of talcs containing up to 45% tremolite and little free silica. This study showed that all workers with greater than 10 years exposure had increased lung markings ranging from increased fibrosis to what was termed "second stage" pneumoconiosis. Among these 17 workers, no cases of active tuberculosis were observed. Dreessen stated that the observed pneumoconiosis had not led to disability.

The respiratory effects of exposures to talc containing 10% "bladed" tremolite in two Georgia talc mines and mills were reported by Dreessen and Dalla Valle in 1935.[19] A total of 66 workers were given physical examinations and chest x-rays of which 19 were exposed for more than 10 years with only 2 having 20 or more years of exposure. Twenty two of these workers demonstrated pneumoconiosis with varying severity. Approximately half of the mill workers exposed to an average dust concentration of 300 mppcf

were diagnosed as having pneumoconiosis with 8 having frank symptoms such as dyspnea, cough, chest pain, rales, and finger clubbing. Examination of 9 former talc workers who had been separated from exposure more than 3 years demonstrated pneumoconiosis in all cases with 4 cases in advanced stages causing these authors to conclude that the lung changes were permanent.

Additional case studies of New York tremolite talc workers were reported by Porro et.al.[20] Fifteen pneumoconiosis deaths in talc workers were studied in addition to 5 autopsy studies. Thirteen of these deaths were considered to be directly attributable to the pneumoconiosis confirming the disabling character of this exposure. These authors concluded that the disabling tissue changes were due to tremolite talc exposure. Some calcifications were noted.

Siegal et.al.[21,22] reported a study of roentgenological findings among New York talc workers in addition to an assessment of their exposures. These talcs were described as containing fibrous tremolite and anthophyllite and less than 1% free SiO_2. A total of 221 talc workers in three mines and five mills were given chest x-ray examinations. Of the 221 men examined, 32 showed marked fibrosis. Those workers with 10 or more years employment demonstrated an incidence of fibrosis of 29.9% whereas those employed for more than 30 years had a fibrosis incidence of 74%. This fibrosis was described as disabling and often accompanied by dyspnea, cough and fatigue. "Talc plaques" were identified in 6.3% of the workers examined. These authors described the fibrosis observed as resembling that seen among asbestos workers.

The 32 cases of pneumoconiosis identified by Siegal et.al.[21,22] were followed prospectively by Kleinfeld et.al.[23] In the 14 year period after the Siegal study, 19 of the 32 workers died with the ages at death ranging from 48 to 84 years. Four of these 19 deaths were believed to be directly attributable to talc pneumoconiosis. One death due to pleural mesothelioma was reported. Medical examinations of the 13 living workers were performed including a physical examination, chest x-ray, EKG and peripheral blood studies (Hgb, RBC, WBC, Diff Count). Dyspnea was found in all workers of such severity as to limit ordinary physical activity. Moderate to severe progression of lung x-ray findings were seen in 10 of these workers and "talc plaques" were seen in all but one worker. Six out of 11 demonstrated an abnormal electrocardiogram. Peripheral blood findings were not considered of significance. These authors also reported the presence of "asbestos bodies" histologically. Similar findings were reported in a latter study of six pneumoconiosis with autopsy studies.[25]

A comparative clinical and environmental study of workers exposed to fibrous and non-fibrous talcs in New York State was reported by Messite et.al.[24] Three talc operations in St. Lawrence County (fibrous) and one operation in Lewis County (non-fibrous) were selected for study and a total of 299 workers were given physical examinations and chest x-rays. Among miners, the incidence of pulmonary fibrosis was low for both the St. Lawrence and Lewis County cohorts; however, the mean duration of exposure was only 12.7 and 10.3 years, respectively. Among millers, the incidence of fibrosis was 12.2% and 4.3% respectively for the St. Lawrence and Lewis cohorts. Exposure levels in the plants were described as being similar with all talcs

having a low free silica content. These authors concluded that both types of talc were capable of producing pulmonary fibrous although the tremolite (fibrous) variety was more pathogenic. In addition, these investigators stated that no cases of fibrosis was found in millers of either talc variety whose average exposure was less than 20 mppcf or whose duration of exposure was less than 10 years.

In a follow-up study, Kleinfeld et.al.[28] made additional comparisons, including lung function, between the St. Lawrence and Lewis County New York cohorts described above. Thirty workers exposed to fibrous and 13 exposed to non-fibrous talcs were given chest x-rays and pulmonary function tests. Dyspnea was present in 16 of 30 workers in the fibrous talc exposed group and 6 of 13 in the non-fibrous talc exposed group. Abnormal auscultatory findings (rales, rhonchi, wheezing) were found in 8 of the 30 workers and 6 of 13 workers exposed to fibrous and non-fibrous talc, respectively. The incidence of pulmonary infiltration as seen in chest films was 13 of 30 for the fibrous group and 3 of 13 for the non-fibrous group. Both groups showed pulmonary function changes with 4 of 13 workers in the group exposed to non-fibrous talc and 14 of 30 workers in the group exposed to fibrous talc showing significantly reduced vital capacity. Exposures to both groups were considerably in excess of 20 mppcf.

Several additional studies of lung function have been conducted among talc workers in New York State.[26,27,29] Kleinfeld et.al.[26] studied the lung function of sixteen tremolite talc workers who ranged from 39 to 69 years of age (mean age 54.8 years). All had been exposed to talc dust in milling operations for 10 or more years and had no previous occupational dust

exposures. The clinical examinations showed 14 of the 16 workers studied to have dyspnea on exertion, 10 had rales or wheezing and clubbing of the fingers was found in 6 workers. Increased lung pulmonary infiltration was noted in the chest x-rays of all workers studied and cardiac enlargement was noted in 5 of these 16 workers. The lung function studies showed 7 of 16 to have reduced vital capacities and one worker was found to have a lung function consistent with restrictive lung disease. The mean duration of exposure for these 16 workers was 20.4 years and the mean weighted average exposure was 68.9 mppcf. Thirteen of the 16 workers studied gave a positive smoking history (30 cigarettes per day for a minimum of 5 years).

In a subsequent study Kleinfeld[27] performed similar studies as those described above among a group of 43 tremolite talc workers and 41 controls of similar age and smoking history. In the talc cohort, 29 had dyspnea versus only 2 in the control population. Eleven talc workers gave a history of chronic cough and none in the controls and 8 talc workers showed finger clubbing whereas no clubbing was noted among controls. Sixteen of 43 talc workers had positive x-ray findings of pulmonary infiltration and none in controls and, in addition, reduced vital capacity was found in 13 talc workers and one control. These talc workers had a mean exposure duration of 19 years and a weighted average exposure of 62.3 mppcf.

A study of chest x-ray findings and clinical symptoms among miners and millers at the Gouverneur Talc Company, number one mine and mill has been reported by Kleinfeld et.al.[16] Thirty nine workers with a mean exposure of 16.2 years (range 11-22 years) were studied in addition to 41 controls who lived

in the same geographic area and who were of the same sex and mean age but having no occupational dust exposure. Dyspnea was present in 23.1% of the talc workers versus 7.3% for controls, a finding similar to that seen in anthophyllite asbestos workers.[33] One worker studied was said to have radiologic findings compatible with pneumoconiosis whereas no cases were found among controls. These authors suggested that talc containing tremolite and anthophyllite may be less fibrogenic than chrysotile or amosite asbestos at similar exposure levels and exposure duration; however, these authors did not preclude the possible existance of pneumoconiosis among these workers as no lung function studies were conducted.

Although the above studies have demonstrated the presence of pneumoconiosis among tremolite talc miners in New York, these study designs were insensitive for detection of carcinogenic risks. However, two retrospective proportional mortality studies have demonstrated an increased risk of cancer of the lung and pleura among these workers.[2,3] The initial study by Kleinfeld et.al.[3] included 220 talc miners and millers employed in 1940 who had 15 or more years of exposure to talc dust in addition to those who achieved a minimum of 15 years of exposure between 1940 and 1965. Among this cohort there were 91 deaths of which 10 (11%) were due to malignacies of the lung or pleura whereas only 2.9 (3.2%) were expected. In addition, 28 deaths were due to pneumoconiosis or its complications. One of the respiratory cancers was a fibrosarcoma of the pleura.

In a subsequent follow-up study, Kleinfeld et.al.[2] extended the observation of the previous cohort from 1960 to 1969. This cohort consisted of 260 workers

among which there were 108 deaths. Thirteen of these deaths (12%) were due to respiratory cancer whereas only 4 (3.7%) were expected. Twenty nine deaths were due to pneumoconiosis or its complications. These authors analyzed mortality patterns by 5 year intervals between 1940 and 1969 and concluded that the respiratory cancer risk approached expected values after the period 1960-64. The validity of this conclusion must be questioned as an analysis of mortality in relation to cancer latency was not undertaken. In addition, the limitations of proportional mortality studies in the presence of an elevated pneumoconiosis risk are now well known.

An excess cancer risk has been demonstrated among workers exposed to anthophyllite asbestos.[30,31,32] Kiviluoto and Meurman[30] studied 1,092 anthophyllite asbestos workers who had worked for more than 3 months between 1936 and 1967 and compared cause specific mortality with rates for Finland. In addition, chest x-rays where read for 252 living workers. Twenty one lung cancers were observed whereas only 12 were expected which was statistically significant. Thirteen of these lung cancer victims had been exposed less than 10 years and only one of these cases was known to have asbestosis. No pleural or peritoneal mesotheliomas were observed.

Nurminen[31] has also reported on the mortality experience of anthophyllite asbestos workers in Finland. This study included 1030 workers who had been employed for three months or more from 1936 to 1966 and followed until 1968. Expected cause specific deaths were calculated using Finland national rates for 1951-1964. There were 224 deaths in this cohort whereas 204 were expected with a mean age at death of 53.4 years. Twenty five deaths (12%)

had asbestosis as an underlying cause and, in addition, there was a highly significant excess risk of respiratory cancer (13 obs. versus 6 exp., $p<0.01$). No mesotheliomas were detected. The mean latency between first exposure and death due to asbestosis was 19 years.

One of the most comprehensive studies of mortality and morbidity among anthophyllite asbestos workers was reported by Meurman et.al.[32] A cohort of 1092 workers who had worked at least 3 months between January 1936 and June 1967 was obtained from two mining operations; one of which produced anthophyllite asbestos and the other produced mainly tremolite talc. For calculation of expected age, cause specific deaths, proportional rates for Finland were used for 1958 which was the median year of death for these workers. In addition, a control group matched for date of birth and sex was chosen from a local population registry.

Of the 1092 employees, 248 deaths were observed. Thirteen deaths due to asbestosis were observed for the cohort and none in the controls. Twenty one lung cancers were observed in the worker cohort versus 13 in the control group. The most significant cancer risk was observed in those with ten or more years of exposure. These authors adjusted lung cancer rates for smoking habits and concluded that a non-smoking asbestos worker had a relative risk of 1.4 whereas the smoking asbestos worker had a relative risk of 17.0. No cases of mesothelioma were reported.

All of the above epidemiological studies of workers exposed to fibrous tremolite or anthophyllite have demonstrated an excess risk of both pneumoconiosis and lung and pleural cancer. No evidence of an excessive risk of mesothelioma

among such exposed workers has yet been demonstrated; however, an excessive incidence of pleural changes including pleural calcifications have been observed in chest films.

CONCLUSIONS AND RECOMMENDATIONS

Results of the present industrial hygiene study show numerous operations in both the number one mine and mill to have excessive exposures to airborne fibers. Analyses of both bulk talcs samples and airborne dust samples by analytical electron microscopy have shown that a majority of these fibers are asbestiform tremolite and anthophyllite. Based on these studies and on exhaustive review of the epidemiological literature concerning health effects of such exposures, it is concluded that immediate corrective actions to reduce exposures must be taken as recommended in the Progress Report issued on May 25, 1976. Specific actions include the following:

1. Mine ventilation should be evaluated with considerations for increasing air volume and distribution. Water sprays should be installed at the ore pockets.
2. During the present study, numerous leaks were observed at material transfer points within the mill. More emphasis should be placed on maintaining equipment in proper working order.
3. At the packing stations, ventilation improvements are needed. Local exhaust hoods at these machines are located too far from the filling spout to be effective. Hood designs at these machines should be further evaluated. In addition, bursting bags at these stations are a significant source of exposure; therefore, use of bags with a greater bursting strength should be considered.
4. Until ventilation and work practice improvements are made and asbestos fiber exposures reduced to acceptable levels, employees should be provided with respiratory protection as specified in the OSHA asbestos standard.[8]

5. All provisions for medical examinations specified in the OSHA asbestos standard[8] should be followed.

The asbestiform mineral content of products from the number one mine and mill make it imperative that these talcs be labeled with the OSHA warning label.[8]

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APPENDIX I

Mineral Product Safety Data Sheets
For R.T. Vanderbilt Products
(Supplied by R.T. Vanderbilt)

R.T. Vanderbilt Company, Inc.

MINERAL PRODUCT SAFETY DATA SHEET

NOTE: Exposure to all airborne mineral dusts is subject to OSHA regulations in accordance with Section 1910.93 of the Occupational Health and Safety Administration Standard as published in the Federal Register of October 18, 1972, starting on page 22139

SECTION I		
TRADE NAME AND SYNONYMS	IT X, IT 3X, IT 5X, IT FT, IT 325, IT 625	Industrial Talc
MINERAL FAMILY	Hydrous Silicates	
CHEMICAL COMPOSITION	Complex hydrous calcium magnesium silicates	

SECTION II INGREDIENTS	
MATERIAL	% RANGE
Talc	20 - 40
Non-asbestiform tremolite and/or anthophyllite	40 - 60
Serpentine	20 - 30
Quartz	1 - 5

SECTION III PHYSICAL DATA			
COLOR	White	SPECIFIC GRAVITY ($H_2O=1$)	±2.8
APPEARANCE	Powder		
OTHER PROPERTIES			

SECTION IV HEALTH HAZARD DATA	
MATERIAL	*TLV
Talc	20 Mopcf
Non-asbestiform tremolite and anthophyllite	20 Mppcf
Serpentine	50 Mppcf
Quartz 30 mg./cu.m. ÷ % Quartz + 2	

SECTION V SPECIAL PRECAUTIONS
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Avoid breathing dust. Use respirator if TLV's exceeded.

DATE: May 1, 1975

OVER FOR FURTHER INFORMATION

APPENDIX I

Mineral Product Safety Data Sheets
For R.T. Vanderbilt Products
(Supplied by R.T. Vanderbilt)

R.T. Vanderbilt Company, Inc.

MINERAL PRODUCT SAFETY DATA SHEET

NOTE Exposure to all airborne mineral dusts is subject to OSHA regulations in accordance with Section 1910.93 of the Occupational Health and Safety Administration Standard as published in the Federal Register of October 18, 1972, starting on page 22139

SECTION I		
TRADE NAME AND SYNONYMS	IT X, IT 3X, IT 5X, IT FT, IT 325, IT 625	Industrial Talc
MINERAL FAMILY	Hydrous Silicates	
CHEMICAL COMPOSITION	Complex hydrous calcium magnesium silicates	

SECTION II INGREDIENTS	
MATERIAL	% RANGE
Talc	20 - 40
Non-asbestiform tremolite and/or anthophyllite	40 - 60
Serpentine	20 - 30
Quartz	1 - 5

SECTION III PHYSICAL DATA			
COLOR	White	SPECIFIC GRAVITY ($H_2O=1$)	±2.8
APPEARANCE	Powder		
OTHER PROPERTIES			

SECTION IV HEALTH HAZARD DATA	
MATERIAL	*TLV
Talc	20 Mppcf
Non-asbestiform tremolite and anthophyllite	20 Mppcf
Serpentine	50 Mppcf
Quartz 30 mg./cu.m. ÷ % Quartz + 2	

SECTION V SPECIAL PRECAUTIONS
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Avoid breathing dust. Use respirator if TLV's exceeded.

DATE: May 1, 1975

OVER FOR FURTHER INFORMATION

This information is furnished solely for the purpose of disclosure regarding health hazard and shall not be used or relied upon by any person for any other purpose

R.T. Vanderbilt Company, Inc.

MINERAL PRODUCT SAFETY DATA SHEET

NOTE: Exposure to all airborne mineral dusts is subject to OSHA regulations in accordance with Section 1910.93 of the Occupational Health and Safety Administration Standard as published in the Federal Register of October 18, 1972, starting on page 22139.

SECTION I

TRADE NAME AND SYNONYMS	IT FIBER No. 1, IT Fiber 6N	Industrial Fibrous Talc
MINERAL FAMILY	Hydrous silicates	
CHEMICAL COMPOSITION	Complex hydrous calcium magnesium silicates	

SECTION II INGREDIENTS

MATERIAL	% RANGE
Asbestiform talc and/or asbestiform anthophyllite	20 - 40
Talc - non-asbestiform	5 - 15
Non-asbestiform tremolite and/or anthophyllite	40 - 60
Quartz	1 - 5
Serpentine	10 - 20

SECTION III PHYSICAL DATA

COLOR	White	SPECIFIC GRAVITY ($H_2O=1$)	±2.7
APPEARANCE	Fibrous		
OTHER PROPERTIES			

SECTION IV HEALTH HAZARD DATA

MATERIAL	* TLV
Asbestiform talc and asbestiform anthophyllite	5 fibers/cc>5μm. in length
Talc - non-asbestiform	20 Mppcf
Non-asbestiform tremolite and anthophyllite	20 Mppcf
Serpentine	50 Mppcf
Quartz 30 mg./cu.m. ÷ % Quartz + 2	

SECTION V SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Avoid breathing dust. Use respirator if TLV's exceeded.

DATE: May 1, 1975

OVER FOR FURTHER INFORMATION

R.T. Vanderbilt Company, Inc.

MINERAL PRODUCT SAFETY DATA SHEET

NOTE: Exposure to all airborne mineral dusts is subject to OSHA regulations in accordance with Section 1910.93 of the Occupational Health and Safety Administration Standard as published in the Federal Register of October 18, 1972, starting on page 22139.

SECTION I		
TRADE NAME AND SYNONYMS	MOULDENE, IT FIBER No. 2	Industrial Fibrous Talc
MINERAL FAMILY	Hydrous silicates	
CHEMICAL COMPOSITION	Complex hydrous calcium magnesium silicates	

SECTION II INGREDIENTS	
MATERIAL	% RANGE
Asbestiform talc and/or asbestiform anthophyllite	40 - 60
Talc - non-asbestiform	5 - 15
Non-asbestiform tremolite and/or anthophyllite	30 - 60
Quartz	1 - 5
Serpentine	5 - 10

SECTION III PHYSICAL DATA			
COLOR	White	SPECIFIC GRAVITY ($H_2O=1$)	±2.7
APPEARANCE	Fibrous		
OTHER PROPERTIES			

SECTION IV HEALTH HAZARD DATA	
MATERIAL	*TLV
Asbestiform talc and asbestiform anthophyllite	5 fibers/cc>5μm. in length
Talc - non-asbestiform	20 Mppcf
Non-asbestiform	20 Mppcf
Serpentine	50 Mppcf
Quartz	30 ma./cu.m. ÷ % Quartz + 2

SECTION V SPECIAL PRECAUTIONS
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Avoid breathing dust. Use respirator if TLV's exceeded.

DATE. May 1, 1975

OVER FOR FURTHER INFORMATION

This information is furnished solely for the purpose of disclosure regarding health hazard and shall not be used or relied upon by any person for any other purpose

R.T. Vanderbilt Company, Inc.

MINERAL PRODUCT SAFETY DATA SHEET

NOTE: Exposure to all airborne mineral dusts is subject to OSHA regulations in accordance with Section 1910.93 of the Occupational Health and Safety Administration Standard as published in the Federal Register of October 18, 1972, starting on page 22139.

SECTION I

TRADE NAME AND SYNONYMS	NYTAL 99, NYTAL 100, NYTAL 100HR Industrial Talc
MINERAL FAMILY	Hydrous silicates
CHEMICAL COMPOSITION	Complex hydrous calcium magnesium silicates

SECTION II INGREDIENTS

MATERIAL	% RANGE
Talc	20 - 30
Non-asbestiform tremolite and/or anthophyllite	50 - 70
Serpentine	20 - 30
Quartz	1 - 5

SECTION III PHYSICAL DATA

COLOR	White	SPECIFIC GRAVITY ($H_2O=1$)	±2.8
APPEARANCE	Powder		
OTHER PROPERTIES			

SECTION IV HEALTH HAZARD DATA

MATERIAL	*TLV
Talc	20 Mppcf
Non-asbestiform tremolite and anthophyllite	20 Mppcf
Serpentine	50 Mppcf
Quartz 30 mg./cu.m. ÷ % Quartz + 2	

SECTION V SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Avoid breathing dust. Use respirator if TLV's exceeded.

DATE: May 1, 1975

OVER FOR FURTHER INFORMATION

R.T. Vanderbilt Company, Inc.

MINERAL PRODUCT SAFETY DATA SHEET

NOTE: Exposure to all airborne mineral dusts is subject to OSHA regulations in accordance with Section 1910.93 of the Occupational Health and Safety Administration Standard as published in the Federal Register of October 18, 1972, starting on page 22139

SECTION I		
TRADE NAME AND SYNONYMS	NYTAL 200, NYTAL 300, NYTAL 400	Industrial Talc
MINERAL FAMILY	Hydrous silicates	
CHEMICAL COMPOSITION	Complex hydrous calcium magnesium silicates	

SECTION II INGREDIENTS	
MATERIAL	% RANGE
Talc	20 - 40
Non-asbestiform tremolite and/or anthophyllite	40 - 60
Serpentine	20 - 30
Quartz	1 - 5

SECTION III PHYSICAL DATA			
COLOR	White	SPECIFIC GRAVITY ($H_2O=1$)	±2.8
APPEARANCE	Powder		
OTHER PROPERTIES			

SECTION IV HEALTH HAZARD DATA	
MATERIAL	*TLV
Talc	20 Mppcf
Non-asbestiform tremolite and anthophyllite	20 Mppcf
Serpentine	50 Mppcf
Quartz — 30 mg./cu.m. ÷ % Quartz + 2	

SECTION V SPECIAL PRECAUTIONS
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Avoid breathing dust. Use respirator if TLV's exceeded.

DATE: May 1, 1975

OVER FOR FURTHER INFORMATION

R.T. Vanderbilt Company, Inc.

MINERAL PRODUCT SAFETY DATA SHEET

NOTE. Exposure to all airborne mineral dusts is subject to OSHA regulations in accordance with Section 1910.93 of the Occupational Health and Safety Administration Standard as published in the Federal Register of October 18, 1972, starting on page 22139

SECTION I		
TRADE NAME AND SYNONYMS	CERAMITALC 10AC, CERAMITALC HDT	Industrial Talc
MINERAL FAMILY	Hydrous silicates	
CHEMICAL COMPOSITION	Complex hydrous calcium magnesium silicates	

SECTION II INGREDIENTS	
MATERIAL	% RANGE
Talc	20 - 30
Non-asbestiform tremolite and/or anthophyllite	50 - 70
Serpentine	20 - 30
Quartz	1 - 5

SECTION III PHYSICAL DATA			
COLOR	White	SPECIFIC GRAVITY ($H_2O=1$)	±2.8
APPEARANCE	Powder		
OTHER PROPERTIES			

SECTION IV HEALTH HAZARD DATA	
MATERIAL	*TLV
Talc	20 Mppcf
Non-asbestiform tremolite and anthophyllite	20 Mppcf
Serpentine	50 Mppcf
Quartz — 30 mg./cu.m. ÷ % Quartz + 2	

SECTION V SPECIAL PRECAUTIONS
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Avoid breathing dust. Use respirator if TLV's exceeded.

DATE: May 1, 1975

OVER FOR FURTHER INFORMATION

R.T. Vanderbilt Company, Inc.

MINERAL PRODUCT SAFETY DATA SHEET

NOTE. Exposure to all airborne mineral dusts is subject to OSHA regulations in accordance with Section 1910.93 of the Occupational Health and Safety Administration Standard as published in the Federal Register of October 18, 1972, starting on page 22139.

SECTION I	
TRADE NAME AND SYNONYMS	CERAMITALC No. 1, CERAMITALC 10-A, IT 3X Industrial Talc
MINERAL FAMILY	Hydrous Silicates
CHEMICAL COMPOSITION	Complex hydrous calcium magnesium silicates

SECTION II INGREDIENTS	
MATERIAL	% RANGE
Talc	20 - 40
Non-asbestiform tremolite and/or anthophyllite	40 - 60
Serpentine	20 - 30
Quartz	1 - 5

SECTION III PHYSICAL DATA			
COLOR	White	SPECIFIC GRAVITY ($H_2O=1$)	±2.8
APPEARANCE	Powder		
OTHER PROPERTIES			

SECTION IV HEALTH HAZARD DATA	
MATERIAL	*TLV
Talc	20 Mppcf
Non-asbestiform tremolite and anthophyllite	20 Mppcf
Serpentine	50 Mppcf
Quartz 30 mg./cu.m. ÷ % Quartz + 2	

SECTION V SPECIAL PRECAUTIONS
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Avoid breathing dust. Use respirator if TLV's exceeded.

DATE May 1, 1975

OVER FOR FURTHER INFORMATION

APPENDIX II

Results of Individual Air Samples
And Summary Statistics for
NIOSH Industrial Hygiene Study

GOUVERNEUR TALC CO.

GOUVERNEUR, N.Y.

DATE OF STUDY: 11/03/75 - 11/07/75

AGENT STUDIED: TALC

SIC CODE: 1499 COUNTY: ST. LAWRENCE

CODE	JOB TITLE	DUTIES
0101	MINE FOREMAN	UNDERGROUND SUPERVISOR
0102	CRUSHER OPERATOR	TO REGULATE AND CONTROL FLOW OF MATERIAL FROM CRUDE ORE PACKET THROUGH THE CRUSHING CIRCUIT TO EITHER STOCK PILES OR LOADING FACILITIES.
0103	TRAMMER	FILLS ORE CARS WITH BROKEN ORE OR WASTE FROM DRIFTS, RAISES OR STOPES AND TRANSPORTS TO ORE POCKETS, ORE PASSES OR OTHER PLACES AS DIRECTED.
0104	SCRAPPER MAN	LOAD ORE INTO TRAM CARS
0105	UNDERGROUND LABORER	PERFORMS GENERAL LABOR WORK SUCH AS DIGGING, SHOVELING, CLEANING DRIFTS, HANDLING TIMBER, MINE SUPPLIES, ETC.
0106	DRILLER	OPERATES ALL REQUIRED DRILL EQUIPMENT AND MOVES EQUIPMENT IN AND OUT OF BLASTING AREA
0107	DIAMOND DRILLER	TO OPERATE DIAMOND CORE DRILL FOR DRILLING TEST AND BLAST HOLES.
010A	RAISE BORING MACHINE OPERATOR	MOVE, SET UP AND OPERATE RAISE BORING MACHINE TO DRILL HOLES.
0109	RAISE BORING MACHINE HELPER	TO ASSIST RAISE BORING MACHINE OPERATOR TO MOVE, SET UP AND OPERATE MACHINE.
0110	UNDERGROUND HOISTMAN	TO OPERATE HOIST AND RELATED EQUIPMENT DURING WINZE AND SHAFT DEVELOPMENT WORK
0111	HOISTMAN	TO OPERATE HOIST LOWER OR RAISE CAGE AND SKIP AS SIGNALED AND OPERATE MINE AIR COMPRESSOR
0112	UNDERGROUND STOCK CLERK	RESPONSIBLE FOR RECEIVING, RECLAIMING, REPAIR, STORAGE AND CONSIGNMENT OF MINE UNDERGROUND STOCK EQUIPMENT, PARTS ETC., AND PREPARES AND CONSIGNS DAILY EXPLOSIVE SUPPLIES
0113	SUPPLY MAN	PROCURES AND DISTRIBUTES THE SUPPLIES NECESSARY FOR THE OPERATION OF THE MINE SURFACE AND UNDERGROUND WORKINGS
0114	EIMCO MAN(MUCKER)	LOADS BROKEN ORE FR. ORE POCKETS INTO TRAM CARS USING 1 MAN LOADING MACHINE

CODE	JOB TITLE	DUTIES (FIMCO MACHINE)
0115	CAGEMAN	OPERATES THE COMBINED CAGE AND SKIP TO TRANSPORT MEN, MATERIAL AND EQUIPMENT TO AND FROM SURFACE TO UNDERGROUND STATION LEVELS AND THE HAULAGE OF ORE OR WASTE FROM ONE POCKETS TO SURFACE
0201	MILL FOREMAN	SUPERVISES MILL GRINDING, DRYING AND PRODUCT BLENDING
0202	MILLER	GENERAL MILL WORKER
0203	GENERAL LABORER	TO PERFORM ALL TYPES OF LABOR WORK AS ASSIGNED IN AND ABOUT THE MILL YARDS, AND BUILDING
0204	CRUSHER OPERATOR	OPERATES THE DRYER, SECONDARY CRUSHERS AND ALL AUXILIARY EQUIPMENT IN THE SECONDARY CRUSHER AREA TO DRY AND REDUCE THE ORE IN SIZE FOR THEIR PROCESSING
0205	FULLER-KINYON OPERATOR	TO SERVICE PACKAGING OPERATION BY OPERATING F-K EQUIPMENT AND TO LOAD BULK PRODUCT INTO DESIGNATED CARRIER
0206	HARDINGE OPERATOR	TO OPERATE THE HARDINGE GRINDING MILLS, SEPARATORS, ALPINE CLASSIFIERS AND ALL ASSOCIATED EQUIPMENT TO PRODUCE FINISHED PRODUCT AND AN INTERMEDIATE PRODUCT FOR USE AS FEED TO OTHER SECTIONS
0207	PROCESS AIR OPERATOR	OPERATES THE MILL AIR COMPRESSOR, ALCORN HEATER, AND ALL AUXILIARY EQUIPMENT IN THE PROCESS AIR AREA
0208	WHEELER OPERATOR	OPERATES THE WHEELER MILL GRINDING EQUIPMENT, THE DUSTEX CYCLONE AND ALL ASSOCIATED EQUIPMENT
0209	PACKER	OPERATES THE SEMI-AUTOMATIC PACKER AND LOADS BAGGED, FINISHED PRODUCT IN RAILROAD CARS AND TRUCKS
0210	PACKHOUSE UTILITY MAN	TO SERVICE PACKING OPERATION BY MAINTAINING BAG SUPPLY, OPERATING LIFT TRUCK, AND ASSITING IN OTHER SERVICE DUTIES IN THE PACKHOUSE AS DIRECTED
0211	PACKER SERVICEMAN	TO SERVICE PACKING AND CHECKING WEIGHT OF BAGGED, FINISHED PRODUCT OPERATION BY MAINTAINING AND STENCILLING BAG SUPPLY

CODE	JOB TITLE	DUTIES
0212	WAREHOUSE FOREMAN	SUPERVISES TALC BAGGING
0213	FORK LIFT OPERATOR/TOW MOTOR OPER.	OPERATES THE TOW MOTOR AND MAINTAINS WAREHOUSE INVENTORY RECORDS
0214	CAR LINER	PREPARES EMPTY RAILROAD CARS AND TRUCKS FOR LOADING AND PREPARES COMPLETED CARS FOR SHIPMENT
0215	TRUCK DRIVER	OPERATES SERVICE VEHICLE TO TRANSPORT VARIOUS MATERIALS IN OR OUTSIDE PLANT AREA, LOADS AND UNLOADS VEHICLE
0216	STOCK CLERK	RESPONSIBLE FOR RECEIVING, STORING AND CONSIGNMENT OF EQUIPMENT, SUPPLIES AND SPARE PARTS, ETC., AND ASSITS IN MAINTAINING ADEQUATE STOCK LEVELS OF SUPPLIES AND SPARE PARTS
0217	STENCIL AND CHECKWEIGH MAN	LABELS TALC BAGS-SHIPMEN
0218	SUPERVISOR OF INVENTORY CONTROL	PROPERTY CONTROL
0219	CALIFORNIA PROCESS OPERATOR	
0220	BULK CAR LOADER	LOADS TALC INTO RAIL BULK CARS USING PNEUMATIC FILLING SYSTEM
0301	REPAIRMAN(MINE)	TO MAINTAIN AND REPAIR MINE EQUIPMENT SUCH AS TUGGER-HOISTS, AND INSTALL, CONSTRUCT AND REPAIR VARIOUS WOOD AND CONCRETE STRUCURES
0302	REPAIRMANS HELPER	TO ASSIST THE REPAIRMAN AND MAINTENANCE MECHANIC IN THE CONSTRUCTION, INSTALLATION, MAINTENANCE AND REPAIR OF MINE MACHINERY AND EQUIPMENT
0303	BLACKSMITH	TO FORGE, HAMMER-WELD, HEAT TREAT AND FUSE BY WELDING METAL MATERIALS REQUIRED IN THE CONSTRUCTION, MAINTENANCE AND MINE SURFACE AND UNDERGROUND MACHINERY AND EQUIPMENT
0304	MAINTENANCE MECHANIC	PERFORM THE LAYOUT, ASSEMBLY, INSTALLATION, REPAIR AND MAINTENANCE OF MINE SURFACE AND UNDERGROUND MACHINERY, EQUIPMENT AND WOOD WORK CONSTRUCTION
0305	MOBILE EQUIPMENT MECHANIC	INSPECT, TEST, ADJUST, DISMANTLE AND REPLACE UNIT ASSEMBLIES OR PARTS, AND MAKE COMPLETE REPAIRS TO GASOLINE, ELECTRIC AND DIESEL POWERED EQUIPMENT

CODE	JOB TITLE	DUTIES
0a01	MILLWRIGHT	TO INSPECT,REPAIR,REPLACE,INSTALL,ADJUST AND MAINTAIN ALL MECHANICAL EQUIPMENT IN THE MILL
0a02	INSTRUMENT REPAIRMAN	TO INSTALL,REPAIR,CALIBRATE,TEST AND ADJUST ANY TYPE OF INTEGRATING, INDICATING,OR GRAPHIC ELECTRICAL OR MECHANICAL INSTRUMENT
0a03	MACHINIST	TO LAY OUT WORK, SET UP AND OPERATE MACHINE TOOLS,AND PERFORM ANY DISMANTLING,FITTING OR ASSEMBLY WORK REQUIRED FOR PLANT MAINTENANCE OR CONSTRUCTION
0a04	REPAIRMAN(MILL)	INSPECT,REPAIR,REPLACE, INSTALL,ADJUST AND MAINTAIN ALL MECHANICAL EQUIPMENT IN THE MILL
0a05	MILLWRIGHT HELPER	ASSIST TO INSPECT,REPAIR REPLACE,INSTALL,ADJUST AND MAINTAIN ALL MECHANICAL EQUIPMENT IN THE MILL
0a06	SHEET METAL WORKER	TO PERFORM ANY TIN OR SHEET METAL WORK REQUIRED FOR PLANT MAINTENANCE AND CONSTRUCTION
0a07	QUALITY CONTROL TECH,	TAKES TALC SAMPLES FOR LAB ANALYSIS
0a08	LAB TECHNICIAN	ASSIST IN QC ANALYSIS
0a09	ASSITANT LAB TECHNICIAN	
0a10	OILER	RESPONSIBLE FOR THE PROPER LUBRICATION OF ALL MACHINERY AND EQUIPMENT
0a11	WELDER	GENERAL WELDING IN MILL
0501	ELECTRICIAN AND ELECTRIC APPRENTICE	TO INSPECT,REPAIR,AND WIRE ALL ELECTRICAL APPARATUS,DEVICES, AND CIRCUITS OF ANY VOLTAGE IN THE PLANT OR ASSIGNED AREA INCLUDING POWER TRANSMISSION LINES,TRANSFORMERS, AND RELATED EQUIPMENT
0502	JANITOR	TO SWEEP AND CLEAN FLOOR OF MINE,MILL,OFFICES,LAVATORIES,CHANGE AND DINING ROOMS AND LABORATORY
0503	WELDER	TO PERFORM ALL KINDS OF WELDING,BRAZING AND CUTTING ON ANY TYPE OF METAL USING GAS AND ELECTRIC WELDING EQUIPMENT

TABLE 1. JOB DICTIONARY -

CODE	JOB TITLE	DUTIES
0504	MOBILE UTILITY OPERATOR	TO OPERATE MOBILE EQUIPMENT IN VARIOUS CAPACITIES SUCH AS CLEANING UP WASTE, DIRT AND DEBRIS, SNOW REMOVAL, ETC.
0505	WATCHMAN	MINE AND MILL SECURITY
0506	MINE AND MILL ENGINEER	
0601	ASSISTANT RESIDENT MANAGER	OFFICE DUTIES
0602	MINE SUPERINTENDANT	OFFICE DUTIES
0603	MILL SUPERINTENDANT	OFFICE DUTIES
0604	GENERAL MANAGER	OFFICE DUTIES
0605	PERSONNEL AND SAFETY DIRECTOR	OFFICE DUTIES
0606	OFFICE MANAGER	OFFICE DUTIES
0607	ENGINEER	
0608	ENGINEERING TECHICIAN(DRAFTSMAN)	
0609	SHIPPING AND INVENTORY COORDINATOR	
0610	INVENTORY CONTROL CLERK	
0611	ACCOUNTS PAYABLE CLERK	
0612	SHIPPING CLERK	
0613	SECRETARY	
0614	RECEPTIONIST	
0615	OFFICE CLERK	
0616	DRAFTSMAN	

TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
TALC	GRAVIMETRIC	POST-PRE WEIGHT	RESPIRABLE MASS SAMPLES ARE COLLECTED ON MSA POLY-VINYL CHLORIDE FILTERS(5.0UM PORE SIZE) WITH FLOW 1.7 LITERS PER MINUTE. NYLON CYCLONES (10MM) ARE USED FOR SIZE SEPARATION. FILTERS ARE WEIGHTED TO THE NEAREST 0.1MG USING A CAHN GRAM ELECTROBALANCE AND DUST CONCENTRATIONS REPORTED AS MG/M3.
TALC	IMPINGER SAMPLE	OPTICAL MICRO.	MIDGET IMPINGER SAMPLES ARE COLLECTED USING ETHYL ALCOHOL AS THE COLLECTING MEDIUM WITH FLOW 2.A3 LITERS PER MINUTE. AFTER DILUTION, SAMPLES ARE PIPETTED INTO DUNN COUNTING CELLS ALLOWING A 30 MINUTE SETTLING TIME. PARTICLE COUNTS ARE MADE BY TWO COUNTERS USING BRIGHT FIELD OPTICAL MICROSCOPY AT 100X. CONCENTRATIONS ARE REPORTED AS MILLIONS OF PARTICLES PER CUBIC FOOT OF AIR(MPPCF).

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: TALC
SAMPLE METHOD/ANALYTICAL TECHNIQUE: GRAVIMETRIC /POST-PRE WEIGHT

JOB CODE	SHIFT (MAN HRS),	SAMPLE NO.,	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.,	UNITS	
0103	1B	1008	11/06/75	0655	1455	0.8159	0.846	MG/M3	
TIME WEIGHTED AVE.= 0.846									
0103	1A	1004	11/06/75	0654	1456	0.8193	0.952	MG/M3	MOVED TO 700 LEVEL AT 830
TIME WEIGHTED AVE.= 0.952									
0103	1E	1024	11/06/75	0703	1455	0.8023	0.125	MG/M3	
TIME WEIGHTED AVE.= 0.125									
0104	1A	1009	11/06/75	0653	1459	0.8261	0.581	MG/M3	DRAGGING TO 700 FOOT LEVEL LUNCH TAKEN 1136 TO 1240
TIME WEIGHTED AVE.= 0.581									
0104	1E	1054	11/06/75	0659	1455	0.8091	1.569	MG/M3	SCRAPPING TO 700 FOOT LEVEL
TIME WEIGHTED AVE.= 1.569									
0104	1F	1003	11/06/75	0700	1455	0.8006	1.723	MG/M3	
TIME WEIGHTED AVE.= 1.723									
0105	1I	1023	11/06/75	0700	1455	0.8074	0.582	MG/M3	UNDERGROUND LABORER
TIME WEIGHTED AVE.= 0.582									
0106	1C	1046	11/06/75	0656	1405	0.7292	1.001	MG/M3	LUNCH TAKEN FROM 1130 TO 1240
TIME WEIGHTED AVE.= 1.001									
0106	1B	1019	11/06/75	0658	1340	0.6833	1.419	MG/M3	
TIME WEIGHTED AVE.= 1.419									
0106	1A	1047	11/06/75	0706	1415	0.7292	0.535	MG/M3	
TIME WEIGHTED AVE.= 0.535									
0115	1E	1041	11/06/75	0659	1459	0.8159	0.233	MG/M3	
TIME WEIGHTED AVE.= 0.233									
0201	1A	1049	11/04/75	0719	1420	0.7156	0.643	MG/M3	
TIME WEIGHTED AVE.= 0.643									
0201	2A	1006	11/05/75	1513	2238	0.7564	0.516	MG/M3	
TIME WEIGHTED AVE.= 0.516									
0203	1S	1019	11/04/75	0731	1430	0.7122	1.137	MG/M3	GENERAL LABORER

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: TALC
SAMPLE MET-OD/ANALYTICAL TECHNIQUE: GRAVIMETRIC /POST-PRE WEIGHT

JOB CODE	SHIFT MAN HR.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS
TIME WEIGHTED AVE.= 1.137								
0208	13	1442	11/04/75	0719	1425	0.7241	1.132	MG/M3
TIME WEIGHTED AVE.= 1.132								
0208	21	1436	11/03/75	1438	2238	0.8159	0.600	MG/M3
TIME WEIGHTED AVE.= 0.600								
0208	12	1401	11/04/75	0708	1425	0.7428	1.561	MG/M3
TIME WEIGHTED AVE.= 1.561								
0208	23	1650	11/03/75	1446	2237	0.8006	0.649	MG/M3
TIME WEIGHTED AVE.= 0.649								
0208	11	1456	11/04/75	0707	1430	0.7530	2.735	MG/M3
TIME WEIGHTED AVE.= 2.735								
0208	22	1429	11/03/75	1444	2236	0.8023	0.449	MG/M3
TIME WEIGHTED AVE 0.449								
0209	1F	1435	11/04/75	0740	1417	0.6748	0.756	MG/M3
TIME WEIGHTED AVE.= 0.756								
0209	1F	1431	11/04/75	0703	1420	0.6748	0.415	MG/M3
TIME WEIGHTED AVE.= 0.415								
0209	1G	1439	11/04/75	0705	1421	0.6731	0.728	MG/M3
TIME WEIGHTED AVE.= 0.728								
0209	17	1464	11/04/75	0711	1427	0.7411	0.391	MG/M3
TIME WEIGHTED AVE.= 0.391								
0209	1A	1459	11/04/75	0711	1426	0.7394	0.460	MG/M3
TIME WEIGHTED AVE.= 0.460								
0209	19	1469	11/04/75	0714	1429	0.7394	0.433	MG/M3
TIME WEIGHTED AVE.= 0.433								
0209	27	1472	11/03/75	1520	2248	0.7615	0.499	MG/M3
TIME WEIGHTED AVE.= 0.499								
0209	28	1445	11/03/75	1526	2253	0.7598	0.947	MG/M3
TIME WEIGHTED AVE.= 0.947								
0209	29	1430	11/03/75	1520	2250	0.7649	0.719	MG/M3
TIME WEIGHTED AVE.= 0.719								
0211	1A	1427	11/04/75	0730	1428	0.7105	0.436	MG/M3

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TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: TALC
SAMPLE METHOD/ANALYTICAL TECHNIQUE: GRAVIMETRIC /POST-PRE WEIGHT

JOB CODE	SHIFT MAN HRS.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS	
TIME WEIGHTED AVE.= 0.436									
0211	2A	1057	11/03/75	1525	2252	0.7598	0.395	MG/M3	
TIME WEIGHTED AVE.= 0.395									
0212	11	1060	11/04/75	0810	1428	0.6425	0.218	MG/M3	
TIME WEIGHTED AVE.= 0.218									
0212	2S	1077	11/03/75	1521	2300	0.7802	0.282	MG/M3	
TIME WEIGHTED AVE.= 0.282									
0213	1D	1359	11/04/75	0737	1424	0.6918	0.231	MG/M3	
TIME WEIGHTED AVE.= 0.231									
0213	1B	1043	11/04/75	0715	1424	0.7292	0.439	MG/M3	
TIME WEIGHTED AVE.= 0.439									
0213	2B	1032	11/03/75	1524	2247	0.7530	0.372	MG/M3	
TIME WEIGHTED AVE.= 0.372									
0214	1C	1028	11/04/75	0737	1429	0.7003	0.314	MG/M3	
TIME WEIGHTED AVE.= 0.314									
0220	1M	1036	11/04/75	0755	1413	0.6425	0.249	MG/M3	
TIME WEIGHTED AVE.= 0.249									
0301	11	1053	11/06/75	0654	1455	0.8176	1.137	MG/M3	
TIME WEIGHTED AVE.= 1.137									
0302	12	1035	11/06/75	0655	1455	0.8159	0.858	MG/M3	
TIME WEIGHTED AVE.= 0.858									
0304	1S	1048	11/06/75	0701	1455	0.8057	0.422	MG/M3	WORKING AT SHAFT STATION
TIME WEIGHTED AVE.= 0.422									
0401	1S	1005	11/07/75	0715	1327	0.6323	0.158	MG/M3	
TIME WEIGHTED AVE.= 0.158									
0401	1D	1300	11/07/75	0723	1325	0.6153	0.647	MG/M3	
TIME WEIGHTED AVE.= 0.647									
0402	1S	1050	11/07/75	0729	1336	0.6238	0.593	MG/M3	
TIME WEIGHTED AVE.= 0.593									
0402	1M	1070	11/07/75	0746	1300	0.5337	0.581	MG/M3	
TIME WEIGHTED AVE.= 0.581									

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: TALC
SAMPLE METHOD/ANALYTICAL TECHNIQUE: GRAVIMETRIC /POST-PRE WEIGHT

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS
0003	1A	1004	11/07/75	0712	1324	0.0323	0.395	MG/M3
TIME WEIGHTED AVE.= 0.395								
0005	1E	1334	11/07/75	0725	1331	0.0221	2.457	MG/M3
TIME WEIGHTED AVE.= 2.457								
0006	1C	1344	11/07/75	0718	1325	0.0238	0.497	MG/M3
TIME WEIGHTED AVE.= 0.497								
0010	1G	1002	11/04/75	0707	1427	0.1479	0.722	MG/M3
TIME WEIGHTED AVE.= 0.722								
0011	1F	1473	11/07/75	0727	1327	0.0119	0.752	MG/M3
TIME WEIGHTED AVE.= 0.752								

TABLE 4. INDIVIDUAL SAMPLE RESULTS

AGENT: TALC
SAMPLE METHOD/ANALYTICAL TECHNIQUE: IMPINGER SAMPLE/OPTICAL MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LT	CONC.	UNITS	
0103	1B	0135	11/06/75			3.0000	12.708	MPPCF	USING A PICK AND A SLEDGE ON BIG PIECES OF ORE, NO RESPIRATOR
TIME WEIGHTED AVE.= 12.708									
0103	16	0026	11/06/75	0112	0129	1.6996	12.424	MPPCF	SAMPLER WAS HOOKED UNTO TRAMMER CAR FOR 17 MINUTES
0103	16	0554	11/06/75	1204	1312	2.7985	5.951	MPPCF	SAMPLER HOOKED UNTO TRAMMING CAR FOR 20 MINUTES
TIME WEIGHTED AVE.= 8.396									
0104	1A	0005	11/06/75	0845	0915	3.0000	4.308	MPPCF	SCRAPPERMAN PULLING ORE TO 700 LEVEL
TIME WEIGHTED AVE.= 4.308									
0104	1E	0495	11/06/75	0800	0830	3.0000	3.844	MPPCF	SCRAPING ORE DOWN TO 700 FOOT LEVEL, NO RESPIRATOR.
TIME WEIGHTED AVE.= 3.844									
0104	17	0145	11/06/75			2.0000	18.372	MPPCF	
0104	17	0215	11/06/75			3.0000	18.743	MPPCF	
0104	17	0373	11/06/75			1.0000	24.536	MPPCF	
TIME WEIGHTED AVE.= 19.585									
0106	1C	0535	11/06/75	0938	0953	1.5017	11.678	MPPCF	DRILLING HOLES INTO ROCK STARTING AT 800FEET AND WORK ING DOWN TO 900 FEET NO RESPIRATOR.
TIME WEIGHTED AVE.= 11.678									
0114	14	0233	11/06/75			3.0000	15.774	MPPCF	PICKING UP ORE WITH MUCKING MACHINE AND PUTTING IN CARS, RESPIRATOR WAS NOT WORN
TIME WEIGHTED AVE.= 15.774									
0115	1F	0001	11/06/75			3.0000	1.972	MPPCF	
TIME WEIGHTED AVE.= 1.972									
0201	14	0394	11/04/75	1145	1215	3.0000	3.940	MPPCF	CHECKING INSTRUMENTS, CONVETER AND COLLECTORS ON HOOF FOR 20 MINUTES, 10 MINUTE IN CONTROL ROOM, DOES THIS 2 TIMES PER SHIFT
TIME WEIGHTED AVE.= 3.940									

TABLE 4. INDIVIDUAL SAMPLE RESULTS

AGENT: TALC
SAMPLE METHOD/ANALYTICAL TECHNIQUE: IMPINGER SAMPLE/OPTICAL MICRO.

JOB CODE	SHIFT MAN-HR.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LP	CONC.	UNITS	
0201	24	0415	11/03/75			5.0000	1.813	MPPCF	CHECKING INSTRUMENTS FOR 12 MINUTES, IN CONTROL ROOM FOR REMAINING 18 MINUTES, WORE RESPIRATOR
TIME WEIGHTED AVE.= 1.813									
0203	15	0251	11/04/75	1325	1355	5.0000	0.546	MPPCF	MOVING SCRAP IRON OUTSIDE
TIME WEIGHTED AVE.= 0.546									
0204	1H	0694	11/06/75	1230	1300	5.0000	2.911	MPPCF	PROCESSING WET ORE FROM 1100 LEVEL
0204	1H	0784	11/06/75	0908	0938	5.0000	2.656	MPPCF	SECONDARY CRUSHER OPERATOR RUNNING CRUSHER AT HEAD FRAME
TIME WEIGHTED AVE.= 2.784									
0204	13	0783	11/04/75	0944	1014	5.0000	3.515	MPPCF	WATCHED BIN SIFT AND CHECKED CONVEYOR, STAYED IN CONTROL ROOM MOST OF TIME.
TIME WEIGHTED AVE.= 3.515									
0204	21	0874	11/03/75			5.0000	1.204	MPPCF	CHECKING INSTRUMENTS FOR 7 MINUTES, STAYED IN CONTROL ROOM FOR 23 MINUTES,NO RESPIRATOR
TIME WEIGHTED AVE.= 1.204									
0206	12	0241	11/04/75	1038	1108	5.0000	3.926	MPPCF	WEIGHING OUT SAMPLES AND CHECKING INSTRUMENTS FOR TOTAL TIME OF 30 MINUTES, HEAVY EXPOSURE, WORE RESPIRA.
TIME WEIGHTED AVE.= 3.926									
0206	23	0131	11/03/75			5.0000	2.884	MPPCF	TAKING HOURLY SAMPLE FOR 5 MINUTES, STAYED IN CONTROL ROOM FOR OTHER 25 MINUTES, WEARS RESPIRATOR
TIME WEIGHTED AVE.= 2.884									
0208	11	0705	11/04/75	0833	0903	5.0000	3.579	MPPCF	LEAK CORRECTIONS AND INSTRUMENTATION CHECK FOR 7 MINUTES, REMAINDER 23 MINUTES OUTSIDE OF CONTROL R.
TIME WEIGHTED AVE.= 3.579									
0208	22	0613	11/03/75			5.0000	2.540	MPPCF	INSPECTING SCALES, COMPRESSOR AND DUST COLLECTORS ON ROOF FOR 10 MINUTES, 20 MINUTES IN CONTROL ROOM, WORE RESPIRATOR
TIME WEIGHTED AVE.= 2.540									

TABLE 4. INDIVIDUAL SAMPLE RESULTS

AGENT: TALC
SAMPLE METHOD/ANALYTICAL TECHNIQUE: IMPINGER SAMPLE/OPTICAL MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME CF	CONC.	UNITS	
0209	1E	0343	11/04/75			5.0000	6.384	MPPCF	
TIME WEIGHTED AVE.= 6.384									
0209	1G	0456	11/04/75			5.0000	3.733	MPPCF	
0209	1G	0485	11/04/75			5.0000	1.968	MPPCF	
TIME WEIGHTED AVE.= 2.851									
0209	27	0516	11/03/75			5.0000	2.481	MPPCF	
TIME WEIGHTED AVE.= 2.481									
0209	2A	0163	11/03/75			5.0000	2.964	MPPCF	
0209	2B	0643	11/03/75			5.0000	3.977	MPPCF	FILLING SACKS WITH PRODUCT BY MACHINE, SEVERAL BAGS BURST DURING SAMPLING
TIME WEIGHTED AVE.= 3.471									
0211	2A	0436	11/03/75			5.0000	2.131	MPPCF	
TIME WEIGHTED AVE.= 2.131									
0213	1P	0095	11/04/75			5.0000	1.638	MPPCF	
TIME WEIGHTED AVE.= 1.638									
0213	2B	0343	11/03/75			5.0000	1.638	MPPCF	
TIME WEIGHTED AVE.= 1.638									
0302	12	0774	11/06/75			2.3992	3.633	MPPCF	
TIME WEIGHTED AVE.= 3.633									
0304	1S	0264	11/06/75	1255	1325	5.0000	1.469	MPPCF	WORKING AT SHAFT STATION
TIME WEIGHTED AVE.= 1.469									

TABLE 5. STATISTICS

AGENT: TALC
SAMPLE METHOD/ANALYTICAL TECHNIQUE: GRAVIMETRIC /POST-PRE WEIGHT

JOB CODE	NO. OF SAMPLES	RANGE MG/M3 (MIN-MAX)	MEAN MG/M3	MEDIAN MG/M3	G.M. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0103	003	000.452-000.125	0.641	0.646	0.644	0.450	0.260	TRAMMER
0104	003	001.723-000.581	1.291	1.569	1.285	0.620	0.358	SCRAPPER MAN
0105	001	000.582-000.582	0.582	0.582	0.582	0.000	0.000	UNDERGROUND LABORER
0106	003	001.414-000.535	0.985	1.001	0.976	0.442	0.255	DRILLER
0115	001	000.233-000.233	0.233	0.233	0.233	0.000	0.000	CAGEMAN
AREA 01	011	001.723-000.125	0.870	0.646		0.527	0.159	
0201	002	000.643-000.516	0.580	0.580	0.578	0.090	0.063	MILL FOREMAN
0203	001	001.137-001.137	1.137	1.137	1.137	0.000	0.000	GENERAL LABORER
0204	002	001.132-000.000	0.866	0.866	0.850	0.376	0.266	CRUSHER OPERATOR
0206	002	001.501-000.049	1.105	1.105	1.088	0.645	0.456	HARDINGE OPERATOR
0208	002	002.733-000.449	1.592	1.592	1.556	1.616	1.143	WHEELER OPERATOR
0209	009	000.947-000.391	0.594	0.499	0.594	0.197	0.066	PACKER
0211	002	000.430-000.395	0.416	0.416	0.415	0.029	0.020	PACKER SERVICEMAN
0212	002	000.282-000.218	0.250	0.250	0.253	0.045	0.032	PACKHOUSE FOREMAN
0213	003	000.439-000.231	0.347	0.372	0.350	0.106	0.061	FORK LIFT OPERATOR/TOW MOTOR OPER.
0214	001	000.314-000.314	0.314	0.314	0.314	0.000	0.000	CAR LINER
0220	001	000.249-000.249	0.249	0.249	0.249	0.000	0.000	BULK CAR LOADER
AREA 02	027	002.733-000.218	0.650	0.460		0.521	0.100	
0301	001	001.137-001.137	1.137	1.137	1.137	0.000	0.000	REPAIRMAN(MINE)
0302	001	000.858-000.858	0.858	0.858	0.858	0.000	0.000	REPAIRMAN'S HELPER
0304	001	000.422-000.422	0.422	0.422	0.422	0.000	0.000	MAINTENANCE MECHANIC
AREA 03	003	001.137-000.422	0.806	0.858		0.360	0.208	
0401	002	004.647-000.158	2.403	2.403	2.372	3.174	2.244	MILLWRIGHT
0402	002	000.593-000.581	0.587	0.587	0.587	0.008	0.006	INSTRUMENT REPAIRMAN
0403	001	000.395-000.395	0.395	0.395	0.395	0.000	0.000	MACHINIST
0405	001	002.957-002.957	2.957	2.957	2.957	0.000	0.000	MILLWRIGHT HELPER
0406	001	000.497-000.497	0.497	0.497	0.497	0.000	0.000	SHEET METAL WORKER
0410	001	000.722-000.722	0.722	0.722	0.722	0.000	0.000	OILER
0411	001	000.752-000.752	0.752	0.752	0.752	0.000	0.000	WELDER
AREA 04	009	004.647-000.158	1.256	0.593		1.514	0.505	
PLANT TOTAL	050	004.647-000.125	0.820	0.582		0.794	0.112	

TABLE 6. STATISTICS

AGENT: TALC
SAMPLE METHOD/ANALYTICAL TECHNIQUE: IMPINGER SAMPLE/OPTICAL MICRO.

JOB CODE	NO. OF SAMPLES	RANGE MPPCF (HI-LOW)	MEAN MPPCF	MEDIAN MPPCF	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0103	003	012.738-005.951	10.361	12.424	10.121	3.822	2.207	TRAMMER
0104	005	024.550-003.048	13.901	16.372	11.830	9.350	4.181	SCRAPPER MAN
0106	001	011.678-011.678	11.678	11.678	11.678	0.000	0.000	DRILLER
0114	001	015.774-015.774	15.774	15.774	15.774	0.000	0.000	EIMCO MAN(MUCKER)
0115	001	001.972-001.972	1.972	1.972	1.972	0.000	0.000	CAGEMAN
AREA 01	011	024.550-001.972	11.846	12.424		7.217	2.176	
0201	002	003.940-001.813	2.877	2.877	2.877	1.504	1.063	MILL FOREMAN
0203	001	000.546-000.546	0.546	0.546	0.546	0.000	0.000	GENERAL LABORER
0204	004	003.515-001.204	2.572	2.784	2.572	0.980	0.490	CRUSHER OPERATOR
0206	002	003.926-002.884	3.405	3.405	3.405	0.737	0.521	HARDINGE OPERATOR
0208	002	003.579-002.540	3.060	3.060	3.060	0.735	0.519	WHEELER OPERATOR
0209	006	000.384-001.968	3.585	3.349	3.585	1.564	0.638	PACKER
0211	001	002.131-002.131	2.131	2.131	2.131	0.000	0.000	PACKER SERVICEMAN
0213	002	001.638-001.638	1.638	1.638	1.638	0.000	0.000	FORK LIFT OPERATOR/TOW MOTOR OPER.
AREA 02	020	000.384-000.546	2.821	2.770		1.287	0.288	
0302	001	003.633-003.633	3.633	3.633	3.633	0.000	0.000	REPAIRMAN'S HELPER
0304	001	001.469-001.469	1.469	1.469	1.469	0.000	0.000	MAINTENANCE MECHANIC
AREA 03	002	003.633-001.469	2.551	2.551		1.530	1.082	
PLANT TOTAL	033	024.550-000.546	5.813	3.579		6.009	1.046	

END OF REPORT

GOUVERNEUR TALC CO.

GOUVERNEUR, N.Y.

DATE OF STUDY: 11/03/75 - 11/07/75

AGENT STUDIED: SILICA

SIC CODE:1496 COUNTY(S): LAWRENCE

TABLE B. INDIVIDUAL SAMPLE RESULTS

AGENT: SILICA
SAMPLE METHOD/ANALYTICAL TECHNIQUES: GRAVIMETRIC /XRAY DIFFRACTION

JOB CODE	SHIFT	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS	
0103	1B	1008	11/06/75	0655	1455	0.8159	0.025	MG/M3	CLEANED UP AND PERFORMED DUTIES AS A HAMMER, PUMP TURNED OFF BETWEEN 11846 AND 12140
TIME WEIGHTED AVE.= 0.025									
0103	1J	1084	11/06/75	0654	1456	0.8193	0.024	MG/M3	MOVED TO 700 LEVEL AT 8130
TIME WEIGHTED AVE.= 0.024									
0103	1G	1024	11/06/75	0703	1455	0.8023	0.012	MG/M3	
TIME WEIGHTED AVE.= 0.012									
0104	1A	1009	11/06/75	0653	1459	0.8261	0.012	MG/M3	PUMP TURNED OFF BETWEEN 11836 AND 12140. DRAGGING TO 700 FOOT LEVEL, LUNCH TAKEN 11836 TO 1214
TIME WEIGHTED AVE.= 0.012									
0104	1E	1358	11/06/75	0659	1455	0.8091	0.012	MG/M3	SCRAPPED DOWN TO 700 FOOT LEVEL. PUMP TURNED OFF BETWEEN 11130 AND 12140
TIME WEIGHTED AVE.= 0.012									
0104	1F	1003	11/06/75	0704	1455	0.8000	0.012	MG/M3	
TIME WEIGHTED AVE.= 0.012									
0105	1F	1041	11/06/75	0659	1459	0.8159	0.012	MG/M3	
TIME WEIGHTED AVE.= 0.012									
0105	13	1023	11/06/75	0700	1455	0.8074	0.000	MG/M3	
TIME WEIGHTED AVE.= 0.000									
0106	1C	1646	11/06/75	0656	1405	0.7292	0.000	MG/M3	
TIME WEIGHTED AVE.= 0.000									
0106	16	1019	11/05/75	1240	1340	0.6833	0.028	MG/M3	
TIME WEIGHTED AVE.= 0.028									
0106	18	1057	11/06/75	0706	1415	0.1019	0.000	MG/M3	X RAY ANALYSIS IMPOSSIBLE DUE TO INTERFERENCES
0201	1H	1049	11/04/75	0719	1420	0.7156	0.014	MG/M3	
TIME WEIGHTED AVE.= 0.014									
0201	2H	1006	11/03/75	1513	2238	0.7564	0.013	MG/M3	
TIME WEIGHTED AVE.= 0.013									

AGENT: SILICA
SAMPLE METHOD/ANALYTICAL TECHNIQUE: GRAVIMETRIC /XRAYDIFFRACTION

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS	
0203	15	1419	11/04/75	0731	1430	0.7122	0.014	MG/M3	GENERAL LABORER
TIME WEIGHTED AVE.= 0.014									
0204	13	1442	11/04/75	0719	1425	0.7241	0.028	MG/M3	
TIME WEIGHTED AVE.= 0.028									
0204	21	1436	11/03/75	1438	2238	0.8159	0.012	MG/M3	
TIME WEIGHTED AVE.= 0.012									
*0206	12	1461	11/04/75	0708	1425	0.8159	0.000	MG/M3	X-RAY ANALYSIS IMPOSSIBLE DUE TO INTERFERENCES
0206	23	1454	11/03/75	1446	2237	0.8006	0.012	MG/M3	
TIME WEIGHTED AVE.= 0.012									
*0208	11	1456	11/04/75	0707	1430	0.8006	0.000	MG/M3	X RAY ANALYSIS IMPOSSIBLE DUE TO INTERFERENCES
0208	22	1429	11/03/75	1444	2236	0.8023	0.012	MG/M3	
TIME WEIGHTED AVE.= 0.012									
0209	18	1445	11/04/75	0740	1417	0.6748	0.015	MG/M3	
TIME WEIGHTED AVE.= 0.015									
0209	18	1431	11/04/75	0743	1420	0.6748	0.000	MG/M3	
TIME WEIGHTED AVE.= 0.000									
*0209	16	1439	11/04/75	0745	1421	0.6748	0.000	MG/M3	X-RAY ANALYSIS IMPOSSIBLE DUE TO INTERFERENCES
0209	17	1404	11/04/75	0711	1427	0.7411	0.000	MG/M3	
TIME WEIGHTED AVE.= 0.000									
*0209	18	1459	11/04/75	0711	1426	0.7411	0.000	MG/M3	X-RAY ANALYSIS IMPOSSIBLE DUE TO INTERFERENCES
0209	19	1459	11/04/75	0714	1429	0.7394	0.014	MG/M3	
TIME WEIGHTED AVE.= 0.014									
0209	27	1472	11/03/75	1520	2248	0.7015	0.013	MG/M3	
TIME WEIGHTED AVE.= 0.013									
0209	28	1445	11/03/75	1526	2253	0.7598	0.013	MG/M3	
TIME WEIGHTED AVE.= 0.013									
0209	29	1430	11/03/75	1520	2250	0.7049	0.013	MG/M3	
TIME WEIGHTED AVE.= 0.013									

TABLE 8. INDIVIDUAL SAMPLE RESULTS

AGENT: SILICA
SAMPLE METHOD/ANALYTICAL TECHNIQUE: GRAVIMETRIC /XRAYDIFFRACTION

JOB CODE	SHIFT	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS	
0211	1A	1427	11/04/75	0730	1428	0.7105	0.000	MG/M3	
TIME WEIGHTED AVE.= 0.000									
0211	2A	1457	11/03/75	1525	2252	0.7598	0.013	MG/M3	
TIME WEIGHTED AVE.= 0.013									
0212	1I	1460	11/04/75	0810	1428	0.6425	0.016	MG/M3	
TIME WEIGHTED AVE.= 0.016									
0212	2S	1477	11/03/75	1521	2300	0.7802	0.013	MG/M3	
TIME WEIGHTED AVE.= 0.013									
*0213	1D	1359	11/04/75	0737	1424	0.7802	0.000	MG/M3	X-RAY ANALYSIS IMPOSSIBLE DUE TO INTERFERENCES
*0213	1G	1443	11/04/75	0715	1424	0.7802	0.000	MG/M3	
0213	2G	1432	11/03/75	1524	2247	0.7530	0.000	MG/M3	
TIME WEIGHTED AVE.= 0.000									
0214	1C	1428	11/04/75	0737	1429	0.7003	0.000	MG/M3	
TIME WEIGHTED AVE.= 0.000									
0220	1A	1436	11/04/75	0755	1413	0.6425	0.016	MG/M3	
TIME WEIGHTED AVE.= 0.016									
*0301	1I	1453	11/06/75	0654	1455	0.6425	0.000	MG/M3	X-RAY ANALYSIS IMPOSSIBLE DUE TO INTERFERENCES
0302	1I	1435	11/06/75	0655	1455	0.8159	0.000	MG/M3	
TIME WEIGHTED AVE.= 0.000									
0304	1S	1648	11/06/75	0701	1455	0.8057	0.000	MG/M3	WORKING ATSHAFT STATION
TIME WEIGHTED AVE.= 0.000									
0401	1B	1405	11/07/75	0715	1327	0.6323	0.016	MG/M3	
TIME WEIGHTED AVE.= 0.016									
0401	1D	1360	11/07/75	0723	1325	0.6153	0.065	MG/M3	
TIME WEIGHTED AVE.= 0.065									
*0402	1G	1450	11/07/75	0729	1330	0.6153	0.000	MG/M3	X-RAY ANALYSIS IMPOSSIBLE DUE TO INTERFERENCES
0402	1H	1870	11/07/75	0746	1300	0.5337	0.000	MG/M3	
TIME WEIGHTED AVE.= 0.000									

TABLE 8. INDIVIDUAL SAMPLE RESULTS

ALPHA SILICA
SAMPLE METHOD/ANALYTICAL TECHNIQUE: GRAVIMETRIC /XRAYDIFFRACTION

JOB CODE	SHIFT	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS
0403	1A	1048	11/07/75	0712	1324	0.6523	0.000	MG/M3
TIME WEIGHTED AVE.= 0.000								
0405	1F	1510	11/07/75	0725	1331	0.6221	0.016	MG/M3
TIME WEIGHTED AVE.= 0.016								
0406	1C	1044	11/07/75	0718	1325	0.6238	0.000	MG/M3
TIME WEIGHTED AVE.= 0.000								
0410	1G	1462	11/04/75	0707	1427	0.7479	0.013	MG/M3
TIME WEIGHTED AVE.= 0.013								
0411	1F	1473	11/07/75	0727	1327	0.6119	0.016	MG/M3
TIME WEIGHTED AVE.= 0.016								

* SAMPLE WAS DELETED FROM THE STATISTICAL RESULTS(TABLE4) AND THE TIME WEIGHTED AVERAGES

AGENT: SILICA
SAMPLE METHOD/ANALYTICAL TECHNIQUE: GRAVIMETRIC /XRAYDIFFRACTION

JOB CODE	NO. OF SAMPLES	RANGE MG/M3 (MI-LUM)	MEAN MG/M3	MEDIAN MG/M3	T.W.A. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0103	003	003.025-000.012	0.020	0.024	0.020	0.007	0.004	TRAMMER
0104	003	000.012-000.012	0.012	0.012	0.012	0.000	0.000	SCRAPPER MAN
0105	002	000.012-000.000	0.006	0.006	0.006	0.008	0.006	UNDERGROUND LABORER
0106	002	000.028-000.000	0.014	0.014	0.014	---	----	DRILLER
AREA								
01	010	000.028-000.000	0.013	0.012		0.059	0.019	
0201	002	000.014-000.013	0.014	0.014	0.013	0.000	0.000	MILL FOREMAN
0203	001	000.014-000.014	0.014	0.014	0.014	0.000	0.000	GENERAL LABORER
0204	002	000.028-000.012	0.020	0.020	0.020	0.011	0.008	CRUSHER OPERATOR
0206	001	000.012-000.012	0.012	0.012	0.012	0.000	0.000	HARDINGE OPERATOR
0208	001	000.012-000.012	0.012	0.012	0.012	0.000	0.000	WHEELER OPERATOR
0209	007	000.015-000.000	0.010	0.013	0.010	0.007	0.002	PACKER
0211	002	000.013-000.000	0.007	0.007	0.007	0.009	0.006	PACKER SERVICEMAN
0212	002	000.016-000.013	0.015	0.015	0.014	0.002	0.001	PACKHOUSE FOREMAN
0213	001	000.000-000.000	0.000	0.000	0.000	0.000	0.000	FORK LIFT OPERATOR/TOW MOTOR-OPER.
0214	001	000.000-000.000	0.000	0.000	0.000	0.000	0.000	CAR LINER
0220	001	000.016-000.016	0.016	0.016	0.016	0.000	0.000	BULK CAR LOADER
AREA								
02	021	000.028-000.000	0.011	0.013		0.007	0.002	
0302	001	000.000-000.000	0.000	0.000	0.000	0.000	0.000	REPAIRMAN'S HELPER
0304	001	000.000-000.000	0.000	0.000	0.000	0.000	0.000	MAINTENANCE MECHANIC
AREA								
03	002	000.000-000.000	0.000	0.000		0.000	0.000	
0401	002	000.065-000.016	0.041	0.041	0.040	0.035	0.024	MILLWRIGHT
0402	001	000.000-000.000	0.000	0.000	0.000	0.000	0.000	INSTRUMENT REPAIRMAN
0403	001	000.000-000.000	0.000	0.000	0.000	0.000	0.000	MACHINIST
0405	001	000.016-000.016	0.016	0.016	0.016	0.000	0.000	MILLWRIGHT HELPER
0406	001	000.000-000.000	0.000	0.000	0.000	0.000	0.000	SHEET METAL WORKER
0410	001	000.013-000.013	0.013	0.013	0.013	0.000	0.000	OILER
0411	001	000.016-000.016	0.016	0.016	0.016	0.000	0.000	WELDER
AREA								
04	008	000.065-000.000	0.016	0.015		0.021	0.007	
PLANT TOTAL								
	041	000.028-000.000	0.012	0.013		0.031	0.005	

END OF REPORT

GOUVERNEUR TALC CO.

GOUVERNEUR, N.Y.

DATE OF STUDY: 11/03/75 - 11/07/75

AGENT STUDIED: ASBESTOS

SIC CODE: 1496

SCIENTIST, LAWRENCE

ABLE 10. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
ASBESTOS	FIBER COUNT	OPTICAL MICRO.	AIRBONE FIBERS ARE COLLECTED ON MILLIPORE TYPE AA MEMBRANE FILTERS AT A FLOW OF 1.7 LITERS PER MINUTE. FIBERS GREATER THAN 5 MICROMETERS IN LENGTH ARE COUNTED WITH PHASE CONTRAST MICROSCOPY AT 430X AS DESCRIBED IN NIOSH CRITERIA DOCUMENT FOR ASBESTOS (1972).
ASBESTOS	FIBER COUNT	ELECTON MICRO.	AIRBORNE FIBERS ARE COLLECTED ON MILLIPORE TYPE AA MEMBRANE FILTERS AT A FLOW OF 1.7 LITERS PER MINUTE. SAMPLES ARE MOUNTED ON 200 MESH(CARBON COATED) COPPER GRIDS USING THE JAFFE METHOD WITH ACETONE. ASBESTOS FIBERS ARE IDENTIFIED USING SELECTED AREA ELECTRON DIFFRACTION AND ENERGY DISPERSIVE XRAY ANALYSIS. ASBESTOS FIBERS ARE COUNTED AND SIZED USING THE GRID OPENING TO DEFINE THE COUNTING FIELD AND CALIBRATED MARKS ON THE MICROSCOPE SCREEN FOR FIBER SIZING.

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0102	11	G198	11/05/75	0936	1025	83,5000	14,673	FB/CC	700 FOOT CRUSHERMAN
*0102	11	G220	11/05/75	1025	1149	83,5000	0,000	FB/CC	1100 FT CRUSHER, TOO HIGH TO COUNT,
0102	11	G221	11/05/75	0652	0805	124,1000	7,714	FB/CC	3 CHARGES SET OFF,DRILLED AND WORKED CRUSHER-DUSTY,
0102	11	G225	11/05/75	0805	0936	154,7000	8,874	FB/CC	WORKING CRUSHER & DRILLING,80-90% AT CRUSHER,
0102	11	G241	11/05/75	1259	1415	129,2000	9,740	FB/CC	20 MIN IN BREAK ROOM,
TIME WEIGHTED AVE.= 9,792									
0103	1A	G155	11/05/75	1250	1403	124,1000	2,571	FB/CC	
0103	1A	G218	11/05/75	1112	1144	54,4000	9,625	FB/CC	
0103	1A	G224	11/05/75	0846	1112	248,2000	2,863	FB/CC	
0103	1A	G236	11/05/75	0700	0846	180,2000	5,079	FB/CC	
TIME WEIGHTED AVE.= 4,067									
0103	1D	G189	11/05/75	1300	1455	127,5000	3,387	FB/CC	
0103	1D	G194	11/05/75	1104	1340	197,2000	3,511	FB/CC	TRAMMING 23 SLOPE TOOK LUNCH BREAK 1130-1215
0103	1D	G195	11/05/75	1041	1144	107,1000	8,096	FB/CC	
0103	1D	G196	11/05/75	0859	1041	173,4000	8,299	FB/CC	
0103	1D	G232	11/05/75	0703	0859	197,2000	6,504	FB/CC	TRAMMING #23 STOPE,
TIME WEIGHTED AVE.= 5,874									
0103	1E	G199	11/05/75	0900	1045	178,5000	5,836	FB/CC	
0103	1E	G211	11/05/75	1045	1151	112,2000	10,787	FB/CC	TRAMMING 23 STOPE,
0103	1E	G217	11/05/75	1151	1455	312,8000	2,300	FB/CC	TRAMMING STOPE 23,TOOK 45 MIN LUNCH BREAK,

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0103	1E	G230	11/05/75	0700	0900	197.2000	2.814	FB/CC	TRAMMER #23 STOPE.
TIME WEIGHTED AVE.= 4.404									
0103	12	G214	11/05/75	0836	1021	178.5000	8.703	FB/CC	DRAGGING ORE,SMALL CAVERN 700FT.
0103	12	G219	11/05/75	1021	1141	136.0000	10.626	FB/CC	
0103	12	G222	11/05/75	0653	0836	175.1000	3.748	FB/CC	
TIME WEIGHTED AVE.= 7.405									
0103	17	G156	11/05/75	1240	1455	229.5000	2.672	FB/CC	
0103	17	G207	11/05/75	1019	1100	69.7000	14.599	FB/CC	
0103	17	G226	11/05/75	0659	0902	209.1000	4.319	FB/CC	DRAGGING ROCK DOWN FROM 500FT LEVEL,LARGE CAVERN.
0103	17	G228	11/05/75	0902	1019	130.9000	3.174	FB/CC	
TIME WEIGHTED AVE.= 4.614									
0103	19	G149	11/05/75	1325	1415	85.0000	4.209	FB/CC	SPENT 20 MIN IN BREAK ROOM.
0103	19	G193	11/05/75	0832	1022	187.0000	9.724	FB/CC	
0103	19	G213	11/05/75	1102	1145	73.1000	11.037	FB/CC	
0103	19	G237	11/05/75	0700	0832	156.4000	4.697	FB/CC	DRAGGING ORE,SMALL CAVERN 700ET LEVEL.
0103	19	G242	11/05/75	1022	1102	68.0000	11.157	FB/CC	
TIME WEIGHTED AVE.= 7.860									
0106	16	G188	11/05/75	1340	1457	130.9000	4.644	FB/CC	
0106	16	G200	11/05/75	0917	1040	141.1000	6.828	FB/CC	
0106	16	G209	11/05/75	1040	1240	204.0000	4.722	FB/CC	TOOK 45 MIN LUNCH BREAK.
0106	16	G229	11/05/75	0658	0917	230.3000	2.574	FB/CC	DRILLER,#23 STOPE
TIME WEIGHTED AVE.= 4.412									
0106	18	G204	11/05/75	0900	1415	467.5000	0.876	FB/CC	TOOK LUNCH BREAK FOR 45 MIN,SPENT AFTERNOON IN LUNCH

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENTS ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUES FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN HRS.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
									AREA.
*0115	1A	G210	11/05/75	0659	0900	467.5000	0.000	FB/CC	
TIME WEIGHTED AVE = 0.876									TOO HIGH TO COUNT.
0115	1S	G208	11/05/75	0901	1004	107.1000	8.377	FB/CC	
0115	1S	G215	11/05/75	1004	1100	95.2000	18.152	FB/CC	
0115	1S	G223	11/05/75	1200	1415	161.5000	5.965	FB/CC	
0115	1S	G233	11/05/75	1104	1240	163.2000	11.068	FB/CC	
									HIGH CONCENTRATION, ESTIMATED COUNT ONLY.
0115	1S	G235	11/05/75	0656	0901	212.5000	7.735	FB/CC	
TIME WEIGHTED AVE.= 9.518									
0201	1J	G122	11/04/75	1205	1300	93.5000	16.035	FB/CC	
TIME WEIGHTED AVE.= 16.035									
0201	1A	G61	11/04/75	0719	0839	136.0000	3.630	FB/CC	
									USUALLY MOVES AROUND OUTSIDE WEARS RESPIRATOR ALMOST ALL THE TIME
0201	1A	G76	11/04/75	0839	1046	215.9000	2.371	FB/CC	
0201	1A	G99	11/04/75	1046	1205	134.3000	7.532	FB/CC	
0201	1A	G103	11/04/75	1300	1420	136.0000	4.693	FB/CC	
TIME WEIGHTED AVE.= 4.208									
0201	2A	G00	11/03/75	1513	1755	275.4000	5.816	FB/CC	
0201	2A	G02	11/03/75	1755	1959	210.8000	5.284	FB/CC	
0201	2A	G43	11/03/75	1959	2129	153.0000	3.306	FB/CC	
0201	2A	G52	11/03/75	2129	2238	117.3000	3.703	FB/CC	
TIME WEIGHTED AVE.= 4.832									
*0203	1K	G110	11/04/75	1047	1155	117.3000	0.000	FB/CC	TOO HIGH TO COUNT
0203	1S	G08	11/04/75	0731	0840	117.3000	13.243	FB/CC	
									CONSTANTLY MOVING THROUGHOUT THE AREA WEARS RESPIRATOR ALL OF THE TIME
0203	1S	G09	11/04/75	0840	0945	110.5000	5.473	FB/CC	

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0203	15	G98	11/04/75	0945	1047	105.4000	5.941	FB/CC	TOO HIGH TO COUNT
0203	15	G136	11/04/75	1155	1335	170.0000	1.507	FB/CC	WORKED OUTSIDE MOVING RUSTY PIPE FOR 45 MIN.
0203	15	G146	11/04/75	1335	1430	93.5000	2.927	FB/CC	OUTSIDE WORKING
TIME WEIGHTED AVE.= 5.554									
0204	1W	G190	11/07/75	0706	0905	134.3000	1.686	FB/CC	
TIME WEIGHTED AVE.= 1.686									
0204	10	G115	11/04/75	1040	1150	119.0000	4.776	FB/CC	
TIME WEIGHTED AVE.= 4.776									
0204	13	G56	11/04/75	0719	0826	113.9000	7.612	FB/CC	1 RUN TO SWEEP AND BRUSH UP FOR 10 MIN.USUALLY STAYS INSIDE WEARS RESPIRATOR MOST OF THE TIME
0204	13	G77	11/04/75	0826	0945	134.3000	3.848	FB/CC	
0204	13	G103	11/04/75	0945	1040	93.5000	8.372	FB/CC	
0204	13	G138	11/04/75	1150	1255	110.5000	8.664	FB/CC	
0204	13	G139	11/04/75	1255	1345	85.0000	11.617	FB/CC	
0204	13	G145	11/04/75	1350	1425	59.5000	11.030	FB/CC	
TIME WEIGHTED AVE.= 7.990									
0204	1A	G63	11/04/75	0711	0827	129.2000	9.367	FB/CC	15 MIN BREAK.
TIME WEIGHTED AVE.= 9.367									
0204	21	G01	11/03/75	1438	1655	232.9000	1.865	FB/CC	MADE 6 CHECKS ON MACHINERY.AFTER 1900 WILL BE MAKING SAMPLE RUNS IN ADDITION TO CHECKING MACHINERY.
0204	21	G24	11/03/75	1655	1752	96.9000	2.368	FB/CC	4 RUNS TO CHECK MACHINERY,6 MIN.
0204	21	G26	11/03/75	1752	1852	102.0000	4.632	FB/CC	1 RUN TO DISENGAGE BY HAMMERING,HEAVY EXPOSURE,2 RUNS TO CHECK MACHINERY,8MIN.
0204	21	G38	11/03/75	1852	1954	112.2000	2.168	FB/CC	5 RUNS,10 MIN.

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0204	21	G45	11/03/75	1958	2059	103.7000	1.935	FB/CC	5 RUNS,6 MIN.
0204	21	G51	11/03/75	2059	2154	93.5000	5.913	FB/CC	1 RUN TO CLEAN UP PER SHIFT,2 SAMPLE RUNS PER SHIFT.
0204	21	G54	11/03/75	2154	2236	71.4000	2.607	FB/CC	MADE 3 RUNS,10 MIN.
TIME WEIGHTED AVE.= 2.854									
0206	11	G114	11/04/75	1055	1200	110.5000	6.593	FB/CC	
TIME WEIGHTED AVE.= 6.593									
0206	12	G58	11/04/75	0708	0841	158.1000	11.197	FB/CC	1 SAMPLE RUN PER HR TAKES CARE OF SPILLS TOO USUALLY STAYS OUTSIDE WEARS RESPIRATOR SOME OF THE TIME
0206	12	G74	11/04/75	0841	0946	110.5000	13.622	FB/CC	BLEW HIMSELF OFF WITH AIR GUN
0206	12	G101	11/04/75	0946	1055	117.3000	8.932	FB/CC	
0206	12	G126	11/04/75	1200	1255	93.5000	8.822	FB/CC	BLEW HIMSELF OFF WITH AIR GUN.
0206	12	G142	11/04/75	1255	1345	85.0000	16.930	FB/CC	
0206	12	G152	11/04/75	1345	1425	68.0000	26.829	FB/CC	
TIME WEIGHTED AVE.= 13.391									
0206	23	G03	11/03/75	1446	1648	207.4000	1.725	FB/CC	2 SAMPLE RUNS,FOR 5 MIN,1 RUN PER HR,ALSO CLEANS UP 3 PILLS,ACCOUNTS FOR 2 TO 3 HRS OF TOTAL SHIFT WORK.
0206	23	G22	11/03/75	1648	1748	102.0000	5.527	FB/CC	3 SAMPLE RUNS,5 MIN.
0206	23	G27	11/03/75	1748	1850	105.4000	3.570	FB/CC	2 SAMPLES RUN ,3 MIN
0206	23	G40	11/03/75	1850	2005	127.5000	2.891	FB/CC	2 SAMPLE RUNS,1 CLEAN UP,TOOK 15 MIN.
0206	23	G48	11/03/75	2005	2105	102.0000	6.233	FB/CC	1 RUN TO SWEEP UP PER SHIFT,2 SAMPLE RUNS,15 MIN.
0206	23	G50	11/03/75	2105	2155	85.0000	5.962	FB/CC	2 SAMPLE RUNS,10 MIN

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0206	21	G55	11/03/75	2155	2237	71.4000	3.469	FB/CC	3 SAMPLE RUNS,5 MIN.
TIME WEIGHTED AVE.= 3.817									
0208	11	G121	11/04/75	1040	1145	110.5000	5.394	FB/CC	
TIME WEIGHTED AVE.= 5.394									
0208	11	G57	11/04/75	0707	0820	124.1000	14.070	FB/CC	1 CLEANUP OF SPILL 1 SWEEP UP 1 SAMPLE RUN OUTSIDE MOST ALL OF THE TIMEWEARS RESPIRATOR MOST OF THE TIME
0208	11	G75	11/04/75	0820	0930	119.0000	7.084	FB/CC	1 RUN TO CLEAN UP SPILL,DURING SAMPLE PERIOD.
0208	11	G100	11/04/75	0930	1040	119.0000	5.060	FB/CC	
0208	11	G125	11/04/75	1105	1220	59.5000	29.144	FB/CC	USED AIR GUN ON EQUIPMENT,HEAVY EXPOSURE
0208	11	G144	11/04/75	1220	1330	119.0000	6.831	FB/CC	
0208	11	G148	11/04/75	1330	1408	64.6000	23.115	FB/CC	
0208	11	G159	11/04/75	1408	1430	37.4000	15.639	FB/CC	
TIME WEIGHTED AVE.= 12.164									
0208	22	G02	11/03/75	1408	1649	212.5000	5.979	FB/CC	MADE 2 SAMPLE RUNS 1 RUN PER HOUR
0208	22	G23	11/03/75	1649	1749	102.0000	8.441	FB/CC	3 SAMPLE RUNS,8 MIN
0208	22	G25	11/03/75	1749	1848	100.3000	2.610	FB/CC	1 SAMPLE RUN,3 MIN.
0208	22	G29	11/03/75	2008	2108	102.0000	3.472	FB/CC	1 RUN TO CLEAN UP,BLOWS THE MILLS WITH AIR GUN,ONE TIME PER SHIFT,2 SAMPLE RUNS,15 MIN.
0208	22	G39	11/03/75	1848	2008	136.0000	5.844	FB/CC	2 SAMPLE RUNS,5 MIN.
0208	22	G53	11/03/75	2155	2236	69.7000	6.170	FB/CC	2 SAMPLE RUNS,5 MIN.
TIME WEIGHTED AVE.= 5.898									
0209	1E	G71	11/04/75	0740	0922	173.4000	4.722	FB/CC	WEARING RESPIRATOR.

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0209	1E	G07	11/04/75	0922	1031	117.3000	5.800	FB/CC	
0209	1E	G105	11/04/75	1031	1233	207.4000	4.268	FB/CC	CHANGED FROM NYTAL 100 TO CERAMATALC HPT AT 11:15, TOOK 30 MIN LUNCH BREAK.
TIME WEIGHTED AVE.= 4.747									
0209	1F	G07	11/04/75	0743	0909	146.2000	4.118	FB/CC	WEARING RESPIRATOR
0209	1F	G108	11/04/75	1235	1420	178.5000	5.195	FB/CC	
0209	1F	G109	11/04/75	1029	1235	214.2000	20.111	FB/CC	CHANGED FROM NYTAL 100 TO CERAMATALC HOTAT 11:15, TOOK 30 MIN LUNCH BREAK.
0209	1F	G111	11/04/75	0909	1029	136.0000	5.091	FB/CC	
0209	1F	G127	11/04/75	1233	1417	176.8000	7.186	FB/CC	
TIME WEIGHTED AVE.= 9.158									
0209	1G	G72	11/04/75	0745	0914	151.3000	6.208	FB/CC	
0209	1G	G110	11/04/75	1030	1145	127.5000	7.414	FB/CC	
0209	1G	G112	11/04/75	0914	1030	129.2000	5.453	FB/CC	
0209	1G	G120	11/04/75	1232	1421	185.3000	3.574	FB/CC	
0209	1G	G141	11/04/75	1145	1232	79.9000	8.968	FB/CC	TOOK 30 MIN LUNCH BREAK.
TIME WEIGHTED AVE.= 5.898									
0209	1I	G59	11/04/75	0711	0811	102.0000	8.087	FB/CC	15 MIN BREAK AT 8:15, 45 MIN LUNCH AT 11:45.
0209	1I	G80	11/04/75	0911	1011	102.0000	9.681	FB/CC	
0209	1I	G87	11/04/75	1011	1111	102.0000	13.872	FB/CC	
0209	1I	G93	11/04/75	0811	0911	102.0000	7.733	FB/CC	
0209	1I	G124	11/04/75	1111	1230	134.3000	5.066	FB/CC	
0209	1I	G131	11/04/75	1230	1330	102.0000	7.202	FB/CC	
0209	1I	G103	11/04/75	1330	1427	96.9000	4.930	FB/CC	
TIME WEIGHTED AVE.= 7.972									

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN HR.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0209	18	G29	11/04/75	1027	1136	117.3000	9.291	FB/CC	
0209	18	G25	11/04/75	0929	1027	98.6000	9.038	FB/CC	
0209	18	G96	11/04/75	0827	1027	204.0000	1.181	FB/CC	
0209	18	G130	11/04/75	1240	1340	102.0000	7.792	FB/CC	
0209	18	G133	11/04/75	1136	1240	108.8000	6.088	FB/CC	
0209	18	G157	11/04/75	1340	1426	78.2000	9.394	FB/CC	
TIME WEIGHTED AVE.= 6.226									
0209	19	G60	11/04/75	0714	0811	96.9000	6.649	FB/CC	19 MIN BREAK,45 MIN LUNCH
0209	19	GA1	11/04/75	0914	1014	102.0000	3.011	FB/CC	
0209	19	G90	11/04/75	1014	1114	102.0000	6.434	FB/CC	
0209	19	G92	11/04/75	0812	0914	105.4000	3.808	FB/CC	
0209	19	G123	11/04/75	1114	1237	141.1000	5.334	FB/CC	
0209	19	G129	11/04/75	1237	1337	102.0000	5.903	FB/CC	
0209	19	G153	11/04/75	1337	1429	88.4000	12.941	FB/CC	
TIME WEIGHTED AVE.= 6.110									
0209	24	G06	11/03/75	1520	1047	1983.9000	0.202	FB/CC	
TIME WEIGHTED AVE.= 0.202									
0209	27	G19	11/03/75	1647	1906	236.3000	4.306	FB/CC	TOOK COFFEE BREAK.
0209	27	G35	11/03/75	1906	2016	119.0000	6.780	FB/CC	
0209	27	G04	11/03/75	2101	2248	113.9000	3.420	FB/CC	
0209	27	G47	11/03/75	2016	2141	144.5000	3.237	FB/CC	TOOK 15 MIN COFFEE BREAK.
TIME WEIGHTED AVE.= 4.370									
0209	28	G08	11/03/75	1526	1648	139.4000	2.400	FB/CC	BAG BURST AT 1600 HRS.
0209	28	G12	11/03/75	1648	1856	217.6000	7.499	FB/CC	

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN HR.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0209	2A	G33	11/03/75	2130	2229	100.3000	15.908	FB/CC	BAG BURST AT 2225
0209	2A	G36	11/03/75	2005	2130	144.5000	10.063	FB/CC	TOOK 15 MIN COFFEE BREAK,CLEANED HIMSELFWITH COMPRESSED AIR,BAG BURST 2125.
0209	2A	G37	11/03/75	2229	2253	40.8000	20.956	FB/CC	
TIME WEIGHTED AVE.= 9.136									
0209	2A	G07	11/03/75	1520	1647	147.9000	3.016	FB/CC	
0209	2A	G13	11/03/75	1645	1904	236.3000	6.013	FB/CC	TOOK DINNER BREAK 30 MIN
0209	2A	G15	11/03/75	1904	2012	115.6000	6.354	FB/CC	
0209	2A	G28	11/03/75	2144	2250	112.2000	6.037	FB/CC	
0209	2A	G46	11/03/75	2012	2144	156.4000	3.080	FB/CC	TOOK 15 MIN. COFFEE BREAK.
TIME WEIGHTED AVE.= 4.898									
0211	1B	G66	11/04/75	0730	0832	105.4000	5.713	FB/CC	15 MIN BREAK.
0211	1B	G85	11/04/75	0433	1033	612.0000	1.604	FB/CC	
0211	1B	G86	11/04/75	1033	1138	110.5000	6.430	FB/CC	
0211	1B	G94	11/04/75	0832	0932	102.0000	7.438	FB/CC	
0211	1B	G134	11/04/75	1140	1230	85.0000	8.288	FB/CC	
0211	1B	G135	11/04/75	1232	1332	102.0000	7.585	FB/CC	
0211	1B	G158	11/04/75	1332	1428	95.2000	5.515	FB/CC	
TIME WEIGHTED AVE.= 4.171									
0211	2A	G10	11/03/75	1525	1654	151.3000	4.218	FB/CC	
0211	2A	G14	11/03/75	1858	2031	158.1000	2.176	FB/CC	
0211	2A	G20	11/03/75	1654	1858	210.8000	3.142	FB/CC	TOOK DINNER BREAK,30MIN.
0211	2A	G32	11/03/75	2031	2252	239.7000	1.812	FB/CC	TOOK 15 MIN COFFEE BREAK.

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHEET MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
TIME WEIGHTED AVE.= 2.736									
0212	11	G78	11/04/75	0810	1007	196.9000	1.911	FB/CC	
0212	11	G113	11/04/75	1007	1428	443.7000	1.588	FB/CC	
									TOOK 30 MIN LUNCH BREAK.
TIME WEIGHTED AVE.= 1.688									
0212	25	G05	11/03/75	1521	1816	297.5000	1.079	FB/CC	
									WENT TO #3 MILL DURING SAMPLE FOR 10 MIN.
0212	25	G16	11/03/75	1816	2030	227.8000	1.859	FB/CC	
0212	25	G41	11/03/75	2030	2300	255.0000	1.015	FB/CC	
									TOOK 15 MIN BREAK.
TIME WEIGHTED AVE.= 1.286									
0213	1A	G65	11/04/75	0715	0830	127.5000	5.478	FB/CC	
									15 MIN BREAK.
0213	1A	G84	11/04/75	0930	1030	102.0000	4.722	FB/CC	
0213	1A	G88	11/04/75	0830	0930	102.0000	5.420	FB/CC	
0213	1A	G91	11/04/75	1030	1137	113.9000	6.284	FB/CC	
0213	1A	G128	11/04/75	1235	1335	102.0000	7.261	FB/CC	
0213	1A	G132	11/04/75	1137	1235	98.6000	4.614	FB/CC	
0213	1A	G167	11/04/75	1335	1429	83.3000	6.592	FB/CC	
TIME WEIGHTED AVE.= 5.750									
0213	1D	G62	11/04/75	0737	0911	159.8000	3.135	FB/CC	
0213	1D	G83	11/04/75	0911	1101	187.0000	1.146	FB/CC	
0213	1D	G118	11/04/75	1101	1237	163.2000	1.653	FB/CC	
									CHANGED FROM NYTAL 100 TO CERMATALC HOT AT 1115 TOOK 30 MIN LUNCH BREAK
0213	1D	G139	11/04/75	1237	1421	176.8000	2.598	FB/CC	
TIME WEIGHTED AVE.= 2.103									
0213	26	G09	11/03/75	1521	1700	168.3000	2.581	FB/CC	
									PACKING NYTAL 200 UNTIL 6:00PM, THEN NYTAL 300.
0213	26	G18	11/03/75	1700	1953	294.1000	3.340	FB/CC	

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
									TOOK DINNER BREAK.
0213	26	G30	11/03/75	1953	2150	196.9000	3.814	FB/CC	
									TOOK 15 MIN COFFEE BREAK.
0213	26	G31	11/03/75	2150	2247	96.9000	8.264	FB/CC	
TIME WEIGHTED AVE.= 3.925									
0214	1C	G70	11/04/75	0734	0918	176.8000	1.336	FB/CC	
0214	1C	G102	11/04/75	0918	1044	146.2000	5.354	FB/CC	
									HAND SWEEPING DUST FROM BROKEN BAGS DURING SURVEY.
0214	1C	G108	11/04/75	1044	1337	294.1000	2.938	FB/CC	
									TOOK 30 MIN LUNCH BREAK.
0214	1C	G151	11/04/75	1337	1429	88.4000	5.558	FB/CC	
TIME WEIGHTED AVE.= 3.365									
0220	1H	G79	11/04/75	0855	0926	154.7000	1.573	FB/CC	
0220	1H	G92	11/04/75	0926	1245	338.3000	2.367	FB/CC	
0220	1H	G106	11/04/75	1245	1413	149.6000	1.750	FB/CC	
TIME WEIGHTED AVE.= 2.032									
0303	1A	G154	11/05/75	1241	1455	227.8000	4.414	FB/CC	
0303	1A	G203	11/05/75	1108	1241	158.1000	3.736	FB/CC	
									WORKING AT SHAFT STATION, TOOK LUNCH BREAK FOR 30 MIN.
0303	1A	G227	11/05/75	0701	1108	419.9000	1.195	FB/CC	
									MAINTENANCE AT SHAFT STATION.
TIME WEIGHTED AVE.= 2.604									
0304	1A	G234	11/05/75	0655	0904	219.3000	0.763	FB/CC	
									REPAIRING SLUSHER, 4FN RAMP.
TIME WEIGHTED AVE.= 0.763									
0304	1C	G205	11/05/75	1110	1457	385.9000	1.447	FB/CC	
									TOOK 30 MIN LUNCH BREAK.
0304	1C	G251	11/05/75	0702	1112	425.0000	1.269	FB/CC	
									MAINTENANCE AT SHAFT STATION.
TIME WEIGHTED AVE.= 1.354									
0304	1F	G181	11/05/75	1410	1455	76.5000	3.878	FB/CC	

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0304	1F	G187	11/05/75	1324	1410	78.2000	1.063	FB/CC	
0304	1F	G206	11/05/75	1021	1137	129.2000	2.716	FB/CC	
0304	1F	G210	11/05/75	1137	1324	181.9000	2.786	FB/CC	
									MAINT.AT 4FW RAMP,TOOK LUNCH BREAK,45 MIN.
TIME WEIGHTED AVE.= 2.657									
0304	13	G178	11/05/75	1325	1455	153.0000	2.361	FB/CC	
0304	13	G197	11/05/75	0904	0959	93.5000	2.323	FB/CC	
0304	13	G201	11/05/75	0959	1147	183.6000	2.454	FB/CC	
0304	13	G212	11/05/75	1147	1325	166.6000	0.239	FB/CC	
									MAINTENANCE AT SLUSHER 4FW RAMP-TOOK LUNCH BREAK AT 1130-1215
0304	13	G239	11/05/75	0654	0904	221.0000	1.112	FB/CC	
									MAINTENANCE REPAIRING SLUSHER 4FW RAMP.
TIME WEIGHTED AVE.= 1.608									
0401	1A	G168	11/07/75	1132	1324	190.4000	2.580	FB/CC	
0401	1A	G186	11/07/75	0715	0952	266.9000	0.916	FB/CC	
TIME WEIGHTED AVE.= 1.609									
*0401	1D	G171	11/07/75	1133	1324	266.9000	0.000	FB/CC	
									TOO HIGH TO COUNT.
*0401	1D	G238	11/07/75	0955	1133	266.9000	0.000	FB/CC	
									TOO HIGH TO COUNT.
0401	1P	G159	11/07/75	0723	0955	258.4000	2.346	FB/CC	
TIME WEIGHTED AVE.= 2.346									
0402	1G	G181	11/07/75	0900	0937	62.9000	3.025	FB/CC	
0402	1G	G182	11/07/75	0729	0900	154.7000	2.912	FB/CC	
0402	1G	G196	11/07/75	0937	1130	192.1000	2.299	FB/CC	
0402	1G	G176	11/07/75	1131	1325	193.8000	1.218	FB/CC	
TIME WEIGHTED AVE.= 2.165									
0402	1H	G183	11/07/75	1145	1300	127.5000	3.148	FB/CC	
0402	1H	G184	11/07/75	0905	1145	272.0000	4.029	FB/CC	

TABLE II. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO.

JOB CODE	SHIFT MAN HRS.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
TIME WEIGHTED AVE.= 3.748									
0403	1A	G165	11/07/75	1133	1324	188.7000	0.542	FB/CC	
0403	1A	G174	11/07/75	0951	1133	173.4000	0.285	FB/CC	
0403	1A	G180	11/07/75	0712	0951	270.3000	3.586	FB/CC	
TIME WEIGHTED AVE.= 1.773									
0405	1E	G173	11/07/75	1134	1324	270.3000	0.000	FB/CC	TOO HIGH TO COUNT.
0405	1E	G177	11/07/75	0725	0954	253.3000	0.677	FB/CC	
0405	1E	G182	11/07/75	0954	1134	170.0000	8.855	FB/CC	
TIME WEIGHTED AVE.= 3.961									
0406	1C	G172	11/07/75	0950	1134	176.8000	2.197	FB/CC	
0406	1C	G191	11/07/75	0718	0950	258.4000	1.235	FB/CC	
0406	1C	G192	11/07/75	1135	1324	185.3000	1.913	FB/CC	
TIME WEIGHTED AVE.= 1.712									
0410	1G	G64	11/04/75	0707	0958	290.7000	4.453	FB/CC	
0410	1G	G107	11/04/75	0958	1142	176.8000	4.019	FB/CC	
0410	1G	G137	11/04/75	1142	1342	204.0000	4.339	FB/CC	
0410	1G	G147	11/04/75	1342	1427	76.5000	1.656	FB/CC	
TIME WEIGHTED AVE.= 4.033									
0411	1F	G154	11/07/75	0727	0957	255.0000	1.574	FB/CC	HIGH CONC. ESTIMATED CONC. ONLY
0411	1F	G176	11/07/75	0957	1152	195.5000	3.141	FB/CC	
0411	1F	G185	11/07/75	1152	1324	156.4000	0.751	FB/CC	WORKER TURNED OFF PUMP DURING 30 MIN FOR LUNCH.
TIME WEIGHTED AVE.= 1.867									

TABLE 12. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /ELECTRON MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0103	10	G194	11/05/75	1140	1340	197.2000	20.152	FB/CC	
									TRAMMING 23 SLOPE TOOK LUNCH BREAK 1130-1215.
TIME WEIGHTED AVE.= 20.152									
0103	17	G156	11/05/75	1240	1455	229.5000	22.563	FB/CC	
TIME WEIGHTED AVE.= 22.563									
0103	19	G149	11/05/75	1325	1415	85.0000	13.223	FB/CC	
									SPENT 20 MIN IN BREAK ROOM.
0103	19	G237	11/05/75	0700	0832	156.4000	8.855	FB/CC	
									DRAGGING ORE, SMALL CAVERN 700 FT LEVEL.
TIME WEIGHTED AVE.= 10.393									
0106	18	G240	11/05/75	0659	0940	273.7000	9.460	FB/CC	
									TOO HIGH TO COUNT.
TIME WEIGHTED AVE.= 9.460									
0115	15	G223	11/05/75	1240	1415	161.5000	17.523	FB/CC	
TIME WEIGHTED AVE.= 17.523									
0201	24	G04	11/03/75	1513	1755	275.4000	18.365	FB/CC	
0201	24	G42	11/03/75	1755	1959	210.8000	33.705	FB/CC	
TIME WEIGHTED AVE.= 25.016									
0203	15	G98	11/04/75	0945	1047	105.4000	36.561	FB/CC	
									TOO HIGH TO COUNT
0203	15	G146	11/04/75	1335	1430	93.5000	9.016	FB/CC	
									OUTSIDE WORKING
TIME WEIGHTED AVE.= 23.612									
0204	13	G77	11/04/75	0836	0945	134.3000	8.967	FB/CC	
TIME WEIGHTED AVE.= 8.967									
0204	21	G38	11/03/75	1852	1958	112.2000	15.563	FB/CC	
									5 RUNS, 10 MIN.
TIME WEIGHTED AVE.= 15.563									
0206	12	G101	11/04/75	0946	1055	117.3000	102.662	FB/CC	
TIME WEIGHTED AVE.=102.662									
0206	23	G22	11/03/75	1648	1748	102.0000	33.647	FB/CC	
									3 SAMPLE RUNS, 5 MIN.
TIME WEIGHTED AVE.= 33.647									

TABLE 12. INDIVIDUAL SAMPLE RESULTS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /ELECTRON MICRO.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0208	11	G148	11/04/75	1220	1330	119.0000	18.215	FB/CC	
TIME WEIGHTED AVE.= 18.215									
0208	22	G002	11/03/75	1444	1649	212.5000	25.501	FB/CC	MADE 2 SAMPLE RUNS 1 RUN PER HOUR
TIME WEIGHTED AVE.= 25.501									
0209	1A	G96	11/04/75	0827	1027	204.0000	31.877	FB/CC	
TIME WEIGHTED AVE.= 31.877									
0209	27	G47	11/03/75	2016	2141	144.5000	41.752	FB/CC	TOOK 15 MIN COFFEE BREAK.
TIME WEIGHTED AVE.= 41.752									
0211	1A	G45	11/04/75	0433	1033	612.0000	7.280	FB/CC	
TIME WEIGHTED AVE.= 7.280									
0211	2A	G10	11/03/75	1525	1654	151.3000	26.663	FB/CC	
TIME WEIGHTED AVE.= 26.663									
0212	11	G113	11/04/75	1007	1428	443.7000	13.570	FB/CC	TOOK 30 MIN LUNCH BREAK.
TIME WEIGHTED AVE.= 13.570									
0212	25	G05	11/03/75	1521	1816	297.5000	16.191	FB/CC	WENT TO #3 MILL DURING SAMPLE FOR 10 MIN.
TIME WEIGHTED AVE.= 16.191									
0213	2A	G31	11/03/75	2150	2247	96.9000	36.040	FB/CC	
TIME WEIGHTED AVE.= 36.040									
0304	13	G197	11/05/75	0904	0959	93.5000	16.743	FB/CC	
TIME WEIGHTED AVE.= 16.743									
0403	1A	G140	11/07/75	0712	0951	270.3000	24.949	FB/CC	
TIME WEIGHTED AVE.= 24.949									
0411	1F	G176	11/07/75	0957	1152	195.5000	9.856	FB/CC	
TIME WEIGHTED AVE.= 9.856									

E
67 SAMPLE WAS DELETED FROM THE STATISTICAL RESULTS(TABLE4) AND THE TIME WEIGHTED AVERAGES

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /OPTICAL MICRO,

JOB CODE	NO. OF SAMPLES	RANGE FB/CC (MI-LOW)	MEAN FB/CC	MEDIAN FB/CC	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0102	004	014.673-007.714	10.250	9.307	9.792	3.063	1.531	CRUSHER OPERATOR
0103	025	014.599-002.300	6.413	5.079	5.575	3.544	0.709	TRAMMER
0106	005	006.828-000.876	3.929	4.644	3.011	2.275	1.017	DRILLER
0115	005	018.152-005.965	10.259	8.377	9.518	4.778	2.137	CAGEMAN
AREA 01	039	018.152-000.876	6.982	6.504		3.949	0.632	
0201	009	016.935-002.371	5.819	4.693	5.305	4.128	1.376	MILL FOREMAN
0203	005	013.293-001.507	5.818	5.473	5.554	4.533	2.027	GENERAL LABORER
0204	014	011.617-001.886	5.529	4.704	5.074	3.460	0.865	CRUSHER OPERATOR
0206	014	020.829-001.725	8.736	6.413	7.901	6.743	1.802	HARDINGE OPERATOR
0208	014	029.144-002.619	9.918	6.501	8.393	7.838	2.095	WHEELER OPERATOR
0209	048	020.956-000.202	6.892	6.063	5.073	4.174	0.602	PACKER
0211	011	008.256-001.004	4.902	5.515	3.618	2.447	0.738	PACKER SERVICEMAN
0212	005	001.911-001.015	1.490	1.588	1.467	0.424	0.189	PACKHOUSE FOREMAN
0213	015	008.264-001.186	4.460	4.614	3.962	2.096	0.541	FORK LIFT OPERATOR/TON MOTOR OPER.
0214	004	005.554-001.336	3.797	4.146	3.365	2.026	1.013	CAR LINER
0220	003	002.367-001.573	1.897	1.750	2.032	0.417	0.241	BULK CAR LOADER
AREA 02	144	029.144-000.202	6.327	5.476		4.810	0.401	
0303	003	004.414-001.195	3.115	3.736	2.604	1.697	0.980	BLACKSMITH
0304	012	003.878-000.239	1.868	1.885	1.650	1.046	0.302	MAINTENANCE MECHANIC
AREA 03	015	004.414-000.239	2.117	2.323		1.240	0.320	
0401	003	002.580-000.916	1.947	2.306	1.875	0.901	0.520	MILLWRIGHT
0402	005	004.029-001.218	2.772	2.969	2.807	0.943	0.385	INSTRUMENT REPAIRMAN
0403	003	003.546-000.285	1.471	0.542	1.773	1.836	1.060	MACHINIST
0405	002	008.855-000.677	4.766	4.766	3.961	5.783	4.089	MILLWRIGHT HELPER
0406	003	002.197-001.235	1.782	1.913	1.712	0.494	0.285	SHEET METAL WORKER
0410	004	004.453-001.656	3.617	4.179	4.033	1.320	0.660	OILER
0411	003	003.141-000.751	1.822	1.574	1.867	1.214	0.701	WELDER
AREA 04	024	008.855-000.285	2.571	2.323		1.836	0.375	
PLANT TOTAL	252	029.144-000.202	5.751	4.722		4.536	0.304	

TABLE 14. STATISTICS

AGENT: ASBESTOS
SAMPLE METHOD/ANALYTICAL TECHNIQUE: FIBER COUNT /ELECTRON MICRO.

JOB CODE	NO. OF SAMPLES	RANGE FB/CC (MIN-MAX)	MEAN FB/CC	MEDIAN FB/CC	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0103	004	022.563-008.855	16.198	16.688	17.454	6.296	3.148	TRAMMER
0106	001	009.460-009.460	9.460	9.460	9.460	0.000	0.000	DRILLER
0115	001	017.523-017.523	17.523	17.523	17.523	0.000	0.000	CAGEMAN
AREA 01	008	022.563-008.855	15.296	15.373		5.678	2.318	
0201	002	033.705-018.365	26.035	26.035	25.016	10.847	7.670	MILL FOREMAN
0203	002	036.561-009.016	22.789	22.789	23.612	19.477	13.772	GENERAL LABORER
0204	002	015.563-008.967	12.265	12.265	11.969	4.664	3.298	CRUSHER OPERATOR
0206	002	102.662-033.647	68.155	68.155	70.562	48.801	34.509	HARDINGE OPERATOR
0208	002	025.591-018.215	21.858	21.858	22.886	5.152	3.643	WHEELER OPERATOR
0209	002	041.752-031.077	36.815	36.815	35.972	6.983	4.937	PACKER
0211	002	020.853-007.280	16.972	16.972	11.122	13.706	9.691	PACKER SERVICEMAN
0212	002	016.191-013.570	14.881	14.881	14.622	1.853	1.310	PACKHOUSE FOREMAN
0213	001	036.040-036.040	36.040	36.040	36.040	0.000	0.000	FORK LIFT OPERATOR/TOW MOTOR OPER.
AREA 02	017	102.662-007.280	27.975	25.501		22.124	5.366	
0304	001	016.743-016.743	16.743	16.743	16.743	0.000	0.000	MAINTENANCE MECHANIC
AREA 03	001	016.743-016.743	16.743	16.743		0.000	0.000	
0403	001	024.949-024.949	24.949	24.949	24.949	0.000	0.000	MACHINIST
0411	001	009.856-009.856	9.856	9.856	9.856	0.000	0.000	WELDER
AREA 04	002	024.949-009.856	17.403	17.403		10.672	7.546	
PLANT TOTAL	026	102.662-007.280	23.804	18.290		18.941	3.715	

END OF REPORT

FINAL REPORT

INDUSTRIAL HYGIENE STUDY OF THE GOUVERNEUR TALC COMPANY, NUMBER ONE MINE AND MILL

Balmat, New York

Volume II
Talc Bulk Sample Analyses
By NIOSH, W.C. McCrone and
Mt. Sinai School of Medicine

Department of Health, Education, and Welfare
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Surveillance, Hazard Evaluations and Field Studies
Cincinnati, Ohio

Electron Microscopic Analyses of R.T. Vanderbilt Talcs Collected from Talc Suppliers

Analyses Performed By

John M. Dement
Ralph D. Zumwalde

Date
October, 1976

Department of Health, Education, and Welfare
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Surveillance, Hazard Evaluations and Field Studies
Cincinnati, Ohio

INTRODUCTION

As a part of ongoing research by the National Institute for Occupational Safety and Health (NIOSH) concerning health effects of occupational exposures to talc and as requested by the Occupational Safety and Health Administration, seven bulk talcs produced by the R.T. Vanderbilt were analyzed for asbestos content. These talcs were obtained from independent talc suppliers and have been "certified" by Vanderbilt not to contain asbestos. Samples were analysed for asbestos content by analytical electron microscopy. The following paragraphs describe sample preparation and analytical methods employed along with results.

METHODS

Given in Table 1 are descriptive data for the 7 talcs obtained and analyzed including source and NIOSH sample number assigned.

Samples for transmission electron microscopic analyses were prepared by dispersing the powder samples in ethyl acetate by ultrasoneration. Approximately 10 mg of each powder was placed in 10-20 ml. of ethyl acetate followed by vigorous ultrasoneration for 10-15 minutes using a cell disrupter. Samples were prepared using a micro capillary tube to place a drop of the solution onto 200 mesh Formvar/carbon substrate copper electron microscope grids. The ethyl acetate was allowed to evaporate in a laboratory clean hood. If necessary, an additional drop of the solution was used to insure sufficient material for efficient analysis by electron microscopy. Blank grids were prepared in the same manner as the samples.

Samples were analyzed by first scanning the entire grid at low magnification to ascertain the suitability of the preparation for analysis. At a magnification of approximately 17,000X, all particles with an aspect ratio (length to diameter) of 3 to 1 or greater were identified using both selected area electron diffraction and energy dispersive microchemical analysis for fiber identification. A total of 25 to 50 individual fibers were so analyzed for each sample. A JEOL, JEM 100B transmission/scanning electron microscope equipped with an EDAX energy dispersive x-ray analyzer was used for all analyses. Electron micrographs of typical fibers along with their diffraction patterns and x-ray spectrum were recorded for each sample.

Table 1

Sources of R.T. Vanderbilt Talcs Produced at the Gouverneur Talc Company, Number One Mine and Mill and Obtained from Suppliers

Product Name	Source	NIOSH #
Nytal 300	Crone Chemical P.O. Box 14042 Houston, Texas 77021	001
Nytal 400		002
5X	Paul Crazier Company 1115 Silver St. Houston, Texas 77007	003
325		004
X		005
FT		006
3X		007

RESULTS AND DISCUSSION

Results of all analyses are shown in Table 2 and typical micrographs of fibers in these samples along with electron diffraction patterns and x-ray spectra are shown in the Appendix. Based on their selected area electron diffraction patterns, fibers were classified as positive amphiboles, positive chrysotile, non-asbestos or "ambiguous" meaning that the pattern was not sufficiently clear for positive identification. The energy dispersive x-ray spectra were used to classify the amphiboles as to type and for further confirmation of chrysotile identification by electron diffraction.

As shown in Table 2, results of these analyses show all talcs analyzed to be of essentially the same fiber composition. The major fiber component is asbestiform anthophyllite, ranging from 67 to 88% of the fibers present in addition to fibrous tremolite (4 to 12%). Aspect ratios for these fibers ranged up to 1000 to 1, with the longer, thinner fibers being anthophyllite. Trace quantities of chrysotile were found in two of the samples. Chrysotile fibers observed were small in diameter (< 0.1 μm) and short in length (most < 1.0 μm).

Table 2

Summary of NIOSH Electron Microscopic
Analyses of Talc Produced at the
Gouverneur Talc Company
Number One Mine and Mill
Samples Obtained From Talc Suppliers

Talc Sample	Range of Fiber Aspect Ratios	Fiber Identification (Percent)				
		Positive Amphiboles		Positive Chrysotile	Non Asbestos	Not* Identified
		Tremolite	Anthophyllite			
Nytal 400	3/1 to 1000/1	8	88	N.D.	4	---
Nytal 300	3/1 to 100/1	12	72	N.D.	4	12
5X	5/1 to 100/1	11	80	Trace	4	5
X	8/1 to 80/1	6	80	N.D.	2	12
3X	5/1 to 100/1	12	67	N.D.	4	16
FT	3/1 to 50/1	16	72	N.D.	4	8
325	3/1 to 50/1	4	88	Trace	7	---

* Selected area diffraction patterns not sufficient for positive identification

ND - None Detected

CONCLUSIONS

Using present "state-of-the art" techniques for asbestos fiber analyses, all 7 talcs analyzed demonstrated large quantities of asbestiform tremolite and anthophyllite to present. Only trace quantities of chrysotile were detected in 2 of the 7 talcs. Based on these analyses, all talcs analyzed should be labeled with the OSHA asbestos warning label.

APPENDIX

Electron Micrographs, Electron Diffraction Patterns and X-Ray Specta for Typical Fibers in R.T. Vanderbilt Talcs.

MOUNT SINAI SCHOOL OF MEDICINE
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FIFTH AVENUE AND 100TH STREET • NEW YORK N.Y. 10029

Department of Community Medicine

April 29 1976

Mr. John Dement
NIOSH Room 527
Post Office Building
Fifth and Walnut Street
Cincinnati, Ohio 45202

Dear Mr. Dement:

This report covers the results of analyses of seven NYTAL samples; 400, 3X, X, FT, 300, 325 and 5X.

The seven samples were analyzed quantitatively for three varieties of asbestos minerals - chrysotile, anthophyllite and tremolite and also for quartz. Analytical techniques included polarized optical microscopy, x-ray diffraction, transmission electron microscopy and scanning electron microscopy with energy dispersive analytical systems.

Quantitative determinations by x-ray diffraction of the four minerals in question were made by comparison with dilution standards of these minerals. A uniform method of back mounting in which the sample is remounted and re-run four times at identical instrumental settings over diagnostic reflections has been shown to be reproducible and accurate. Quantitation of these minerals was also done by x-ray diffraction in the step-scan, fixed count mode.

Integrated intensities for diagnostic x-ray reflections were measured using both the back-mounting and step-scan techniques. When referred to calibration curves prepared by each technique, the NYTAL unknowns showed agreement, averaging about 10% standard error. The results are as follows:

	SERPENTINE PHASE	TREMOLITE	ANTHOPHYLLITE	QUARTZ
	%	%	%	%
NYTAL 400	14-18	24	2-3	7-10
" 3X	31-35	32	not detected	7-8
" X	26-30	50-60	not determined	9-10
" FT	26-30	17	not detected	not detected
" 300	14-18	18	4-5	9-10
" 32	19-23	24	5-7	3-4
" 5X	14-18	27	7-9	8-9

Because of the large amounts of tremolite (50-60%) present in sample X anthophyllite could not be quantitatively determined by x-ray diffraction. However micro-

Mr. John Dement

chemical analysis of fibers on the SEM shows that anthophyllite is present. X-ray diffraction indicated the presence of serpentine phases in all samples, but the specific mineral species of this group which includes chrysotile, antigorite and lizardite, could not be positively identified although the latter most closely fitted the x-ray patterns. Examination by TEM and SEM with energy dispersive analysis system confirmed that virtually all of the sperpentine phase consists of lizardite. Chrysotile was detected by electron microscopy in the samples. (See accompanying photomicrographs).

The samples were prepared for analysis by transmission electron microscopy by means of a technique which did not alter the size distributiin of particles. Two squares from three EM grids were scanned at 25,000x magnification on a Hitachi HU 125 microscope. Fibrous particles were abundant in all seven samples. Morphological and crystal cleavage characteristics indicated the presence of amphiboles. This was verified by observing a typical layer-type selected area electron diffraction pattern on the fibrous particles. The layer line distance normal to the long fiber axis was consistently observed to be 5.3Å, which is characteristic of the c-axis repeat of amphiboles. These particles were defined as amphibole and their location on a grid facsimile recorded. The specimens were transferred to a scanning electron microscope (CWIKSCAN) equipped with an energy dispersive x-ray spectrometer. The amphibole particles were analyzed by point count and were found to fall into two general morphological-chemical types of populations which permits them to be defined as different mineral species. The long, thin fibers (aspect ratio 10/1 or more) showed Si/Mg in ratios consistent with anthophyllite composition. These fibers contained little or no iron. Short prismatic fibers with aspect ratios from about 3/1 to 5/1 contained Si/Ca/Mg proportions consistent with tremolite. No iron was found in tremolite.

Respectfully submitted,

Arthur N. Rohl, Ph.D.
Environmental Sciences Laboratory

ANR:sl
Enc.

Chrysotile- talc standard dilution - step-scanned 0.02 degrees two theta over 3.66 Å (004) reflection (2×10^3)

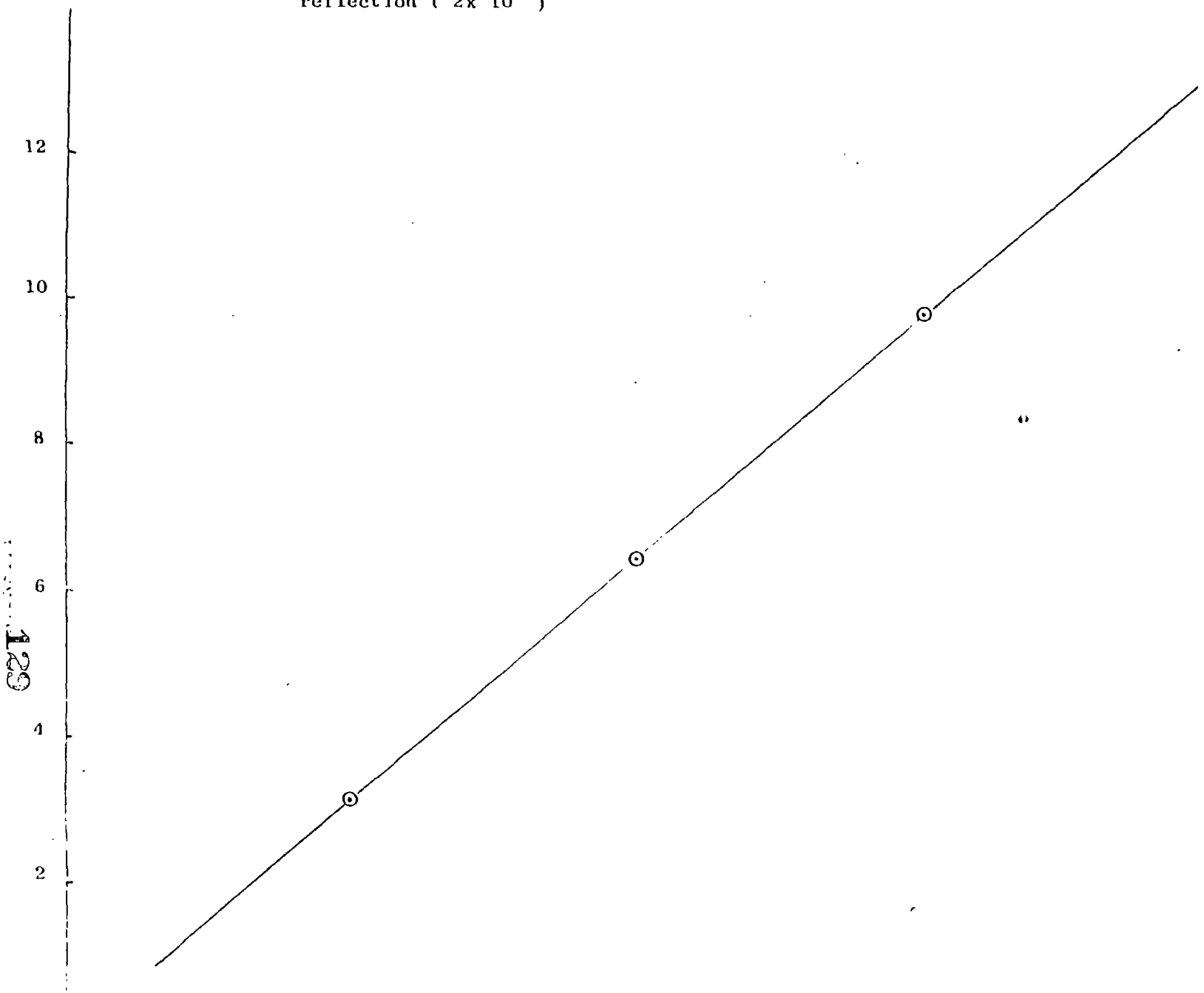
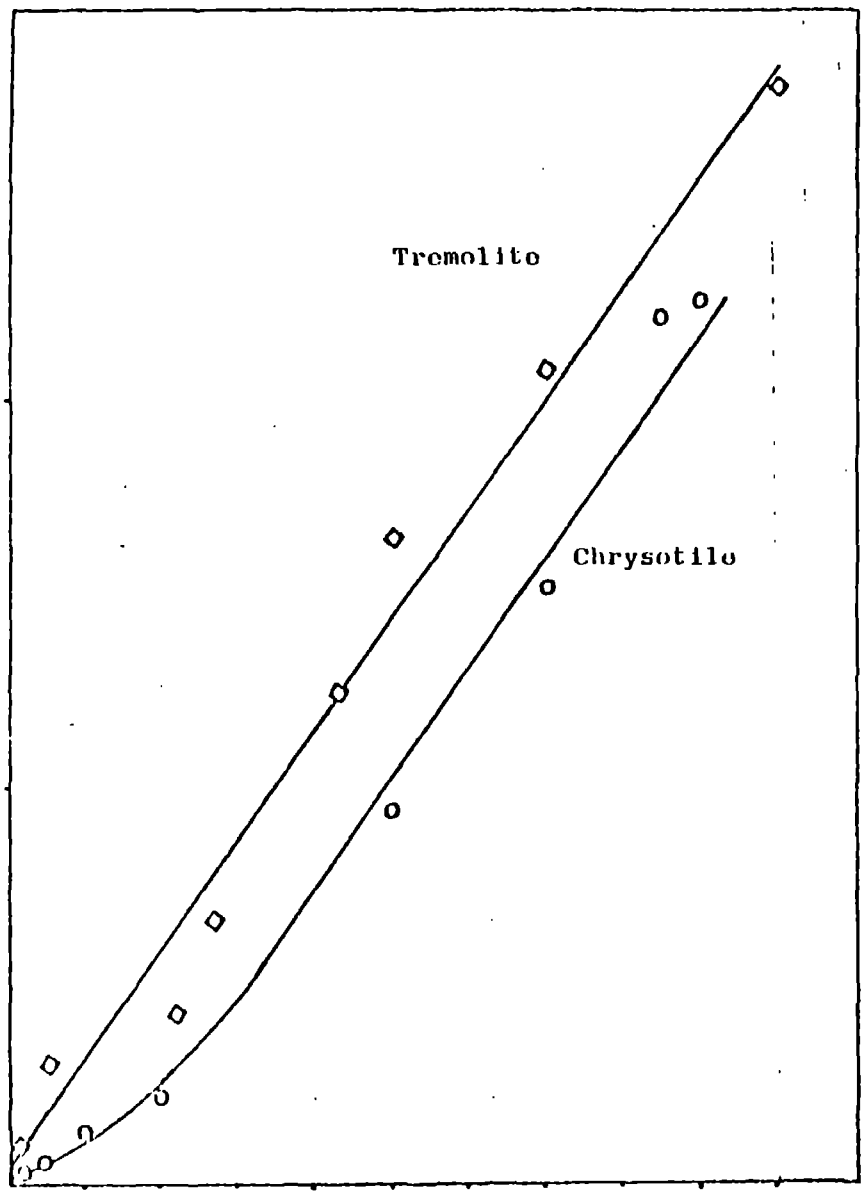
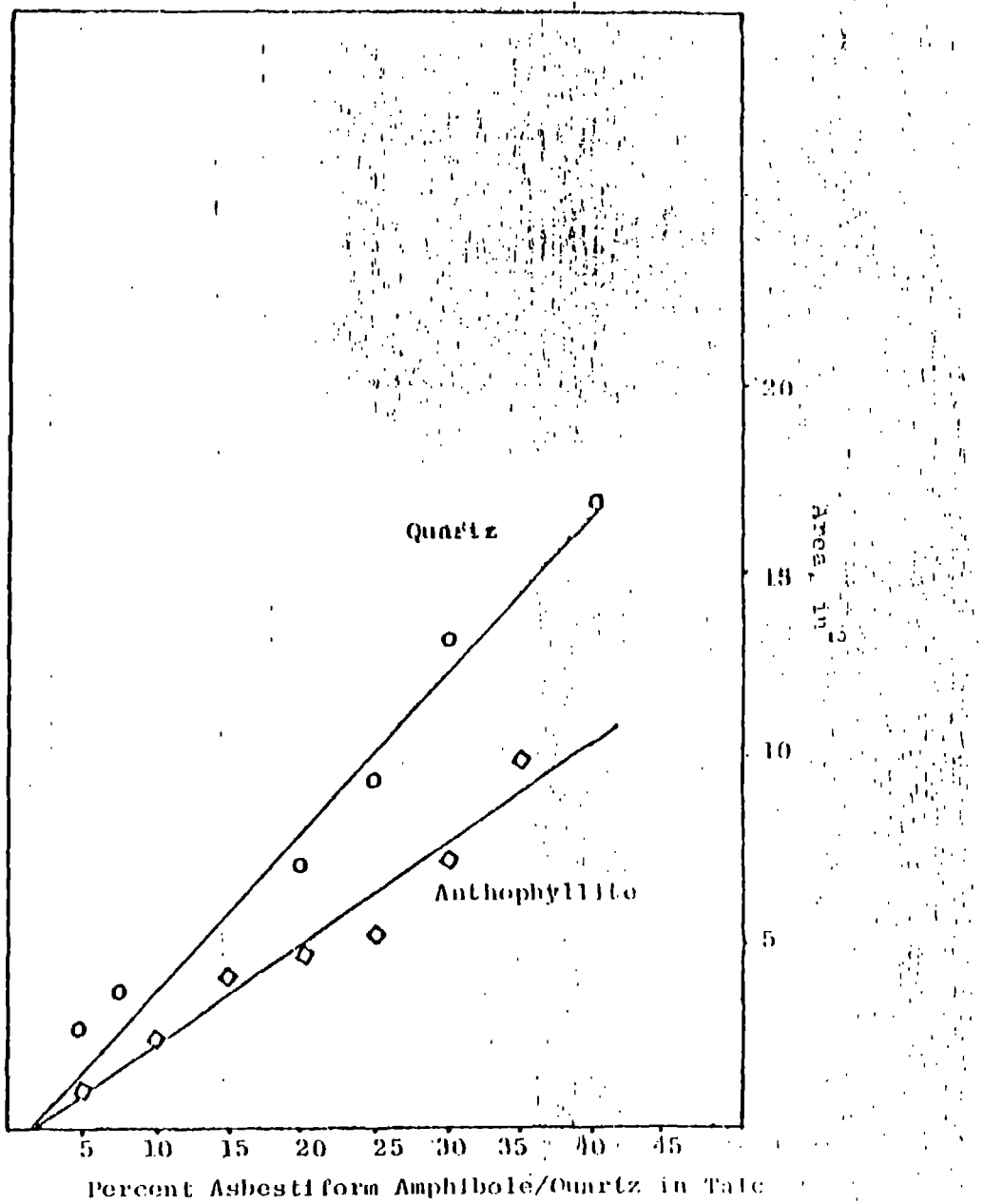
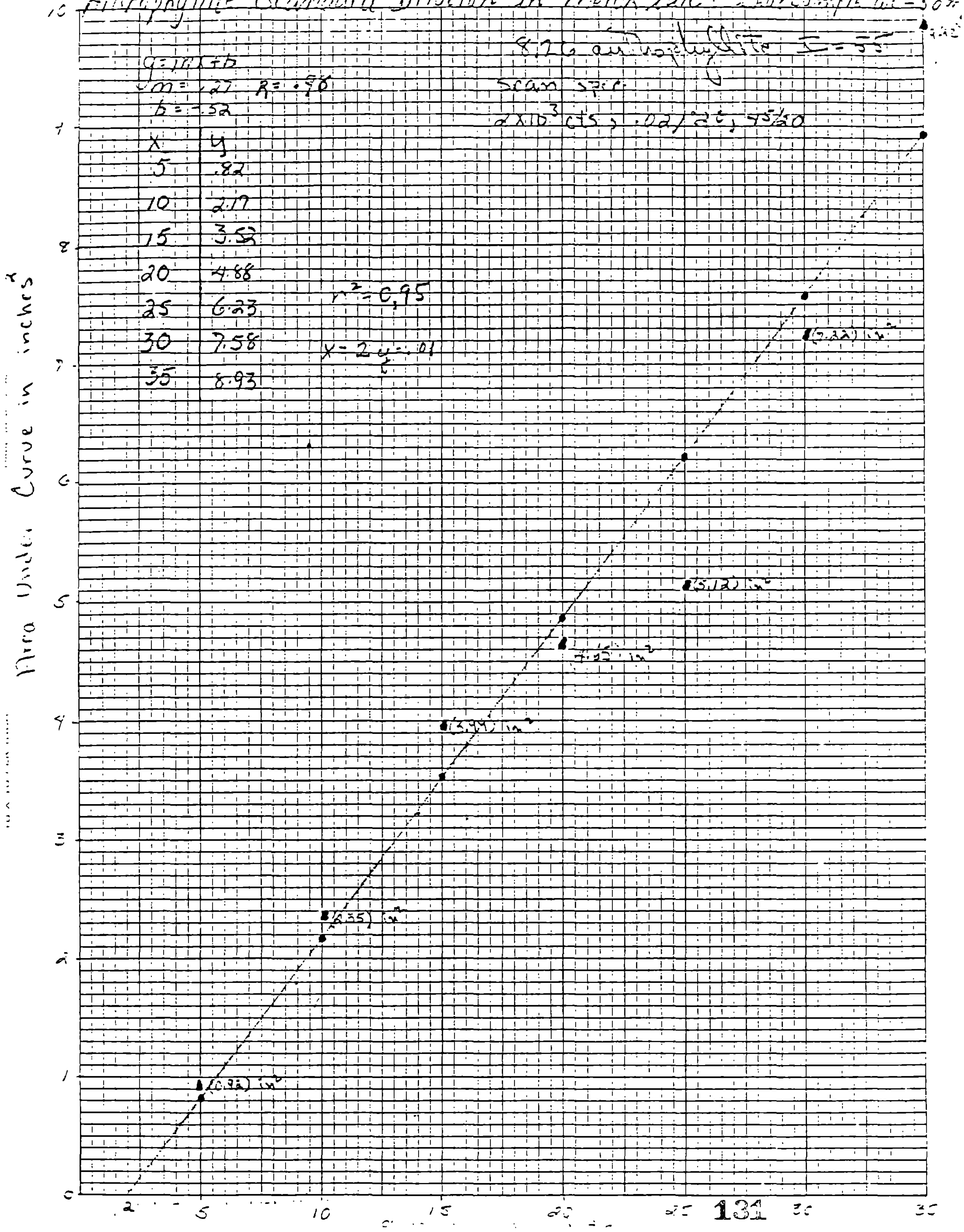


Figure 2: Calibration of Asbestiform Amphiboles and Quartz in Talc





Anthophyllite Standard Dilution in Merck talc total sample wt = 50 mg



Report to

Dr. John Dement

NIOSH
Cincinnati, Ohio 45202

EXAMINATION OF TALCS FROM

GOUVERNEUR DISTRICT — NEW YORK

Date: 12 December 1975

MA Number: 4800

Copy 3 of 4

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EXAMINATION OF SEVEN TALCS FROM THE GOUVERNEUR DISTRICT, NEW YORK

SUMMARY

An extensive examination has been carried out of seven talcs submitted by the National Institute of Occupational Safety and Health, to determine their asbestos content. These talcs all originated from the Gouverneur District of New York State and were identified by number code in the series 83775-83761.

Examination was carried out by a combination of light microscopy, using both polarized light and dispersion staining, x-ray diffraction, and electron microscopy combining electron diffraction and elemental analysis.

The results of the examination showed the presence of asbestiform amphibole in all seven samples. The amounts of the total amphibole and of the fibrous amphibole differed between the various samples. In all cases the principal asbestiform amphibole was identified as tremolite, but this was of a low calcium variety, containing approximately 2-3% calcium.

In Sample 83757, x-ray diffraction examination suggested that a small percentage of anthophyllite was also present. Examination by light microscopy, however, could not conclusively differentiate between anthophyllite and tremolite in this sample. The identification of tremolite rather than a calcium bearing anthophyllite in all samples was based on the extinction angle, observed under crossed polars, of the fibrous amphibole.

INTRODUCTION

The National Institute of Occupational Safety and Health is currently sponsoring a study of occupationally related disease in the talc industry. As part of this study, Walter C. McCrone Associates, Inc., has been contracted to study and characterize the raw talc ores. The present work is related to this major program and is concerned with a study of seven specific samples from the Gouverneur talc ore body.

Material and Method of Conducting Tests

Seven talc samples were submitted to Walter C. McCrone Associates, by John Dement of NIOSH. These samples were identified by numbers running in sequence from 83755-83761. No indication was given of the sample location within the Gouverneur talc body. The samples were examined by light microscopy, using both polarized light and dispersion staining, x-ray diffraction, and transmission electron microscopy combined with electron diffraction and elemental analysis.

Light microscopy

Permanent mounts were prepared for all seven samples, using Aroclor 5442 as a mounting medium. These preparations were examined under partially uncrossed polars to obtain a general indication of the mineral types present together with their shapes and sizes. Samples for examination by dispersion staining were prepared using Cargille high dispersion refractive index liquids with n values of 1.550 and 1.605. The lower refractive index was used to examine the serpentine content of the talcs; the higher value was chosen to enable identification of the amphibole present. Examination by dispersion staining was at a magnification of approximately 200X in plane polarized light.

X-ray diffraction

For x-ray diffraction examination, samples of the powders were packed into aluminum cup holders and placed in the Norelco diffractometer. The samples were rotated around an axis perpendicular to the axis of the diffractometer which was scanned through a 2θ range from approximately 6° to approximately

60° with a scanning speed of 1° per minute and a chart speed of 1/2 inch per minute. Cu radiation, nickel filtered, was used at an accelerating voltage of 42 kV, and a current of 25 milliamps. The quartz content of the samples was determined by step scanning through the 3.35 Å line for quartz and comparing the resulting data with that for "spiked" standards of quartz in talc. The step increment was 0.01°, 2θ with a counting time per step of 50 secs., an 8 sec. time constant and a chart speed of 1/8 inch per minute.

Electron microscopy

For electron microscopic examination samples of the powder were suspended in isopropanol and lightly ultrasonerated. A drop of this suspension was placed on carbon coated Nylon grids. Examination of the samples was carried out in a combined electron-microscope-microprobe-analyzer, EMMA-IV. The samples were examined and photographed at several different magnifications, electron diffraction patterns were obtained from typical fibers present and energy dispersive x-ray analysis was performed on these fibers.

RESULTS

1) Light microscopy

The following general statements can be made:

All the samples contained a serpentine which, on the basis of dispersion staining and morphology, has been identified as lizardite. Chrysotile (the asbestiform variety of serpentine) and antigorite were not detected.

All the samples contain tremolite identified by dispersion staining and polarized light microscopy and, although it would be possible to miss a small percentage of anthophyllite particles,since most anthophyllites give nearly the same dispersion staining colors as tremolite, appreciable amounts of anthophyllite would not be missed because a significant number of particles would lie in the proper orientation for positive identification. With the exception of an occasional particle in Sample 83757, all the particles which showed the tremolite/anthophyllite dispersion colors showed oblique extinction under crossed polars ($\gamma \wedge c = 17\text{-}18°$), thus identifying them as tremolite.

All samples contain talc in a form which looks like fibers. These give typical talc colors by dispersion staining. The majority of these talc fibers are apparently long talc rods. These talc fibers are especially long in Sample 83759.

Most samples are believed to contain a little quartz on the basis of the light microscopical examination. It is difficult to put an accurate value to the amount of quartz present, since it is extremely difficult to distinguish between quartz and lizardite under dispersion staining conditions.

A calculation of the percentage of amphibole present and of the portion of this amphibole which was fibrous was made as follows. First the portion by volume of the total tremolite present as fibers was estimated taking cognizance of both particle size and numbers present. Subsequently, 30 fields in each sample were examined in detail and the percentage by area of the total particle area occupied by amphibole particles was estimated.

Table 1 summarizes the observations made by light microscopy.

X-ray diffraction

All samples showed the presence of talc, an amphibole and a serpentine. Inconclusive evidence of quartz was detected by x-ray diffraction on the normal scan. By step scanning, however, low levels of quartz were found. The quartz data are presented in Table 2 and Figure 1.

The serpentine minerals are difficult to distinguish from each other by x-ray diffraction. A paper by Mumpton[1] indicates certain lines which may be used to distinguish the three serpentine polymorphs provided that the samples are relatively monomineralic. Specifically, Mumpton mentions that lizardite is characterized by a strong doublet at 1.531 Å. This doublet has indeed been observed on our x-ray diffraction trace, thereby confirming the light microscopical identification of lizardite by dispersion staining.

---

[1] Characterization of chrysotile asbestos and other members of the serpentine group of minerals, Siemens review XLI (1974) 7th special issue, X-ray and Electron Microscopy News.

Table I
Summary of Light Microscopical Data

	Nytal 300	Nytal 400	3X	225	X	FH	3X
Sample	83755	83756	83757	83758	83759	83760	83761
Total tremolite (% of sample by area)	25-30	15-20	20-25	25-30	25-30	15-20	25-30
Fibrous tremolite (estimated % by vol. of total tremolite)	5	25	8-10	5	1	25	10
Quartz	+	possible	+	+	-?	+?	+?
Serpentine	+	?	-	+?	+	probable	probable
Talc "fibers" (rolls, shards etc.)	+	+	+	+	+(long)	+	+
Comments				large tremolite plates	large particle size	small particle size	

Table II
Tremolite and Quantity Content of Talc Samples

Sample	83755	83756	83757	83758	83759	83760	83761
Quartz Content**	2%	1/2-1%	~1 1/2%	~1 1/2%	<1/2%	below detection limit	1/2-1%
Content tremolite	40-50%	50-60%*?	40-50%*	~60%	>50-60%*	50-60%	40-50%

** Step scanning data.

* Indicates possible anthophyllite present in addition to tremolite.

This leaves only the amphibole to be characterized in all seven samples. The primary amphibole observed is tremolite. The diffraction lines observed are consistent with ASTM Card 13-437 for tremolite and with published data for tremolites from the Gouverneur district. In one sample, however, Sample 83757, a distinct side peak on the tremolite 8.410 line is observed and it is believed that this side peak is due to the presence of some anthophyllite. Less distinct evidence of this side peak is also present on Sample 83756 and possibly also 83759 (see Figures 2-8 for a comparison of the 6°-12°, 2θ range on these samples). As is clear from these figures, in addition to the side peak attributed to anthophyllite there is considerable variation in the ratio of talc to amphibole in these samples. An attempt to quantitate this relationship in terms of percentage of amphibole present is also given in Table 2.

Electron microscopical examination

Electron microscopical examination showed that all seven samples contain substantial amounts of fibrous material. This was highest in Sample 83757 and lowest for Samples 83756 and 83761. Several typical electron micrographs showing general areas of the samples are appended to this report (Figures 9-17). The electron microscopical examination concentrated on the fibrous material and an attempt was made to estimate how much of this material was in fact asbestiform, that is, a fibrous amphibole as distinct from the fiber forms of talc consisting of ribbons, shards, rolls, etc. This examination was conducted both by electron diffraction and by elemental analysis using energy dispersive x-ray. The results of these examinations are summarized in Table 3, the estimated percentages being based on occluded area. Some typical electron micrographs, diffraction patterns and energy dispersive x-ray spectra are appended. In none of these fibers examined was there a particularly high percentage of calcium noted; however, calcium was observed at the level of the order of 1-3% in all the amphibole fibers examined. The only conclusion which

Table III
Electron Microscopical Estimates of Fiber Content

Sample	83755	83756	83757	83758	83759	83760	83761
Total fibers	~10%	~10%	~40%	~30%	~5-10%	~20%	~10%
Fibrous amphibole (as % of total sample)	<5%	<5%	15-20%	10-15%	<5%	~5%	<5%

Table IV
Overall Data Summary

Sample	83755	83756	83757	83758	83759	83760	83761
Total fibers (TEM)	10%	10%	40%	30%	5-10%	20%	10%
Amphibole fibers[1] (TEM)	<5%	<5%	15-20%	10-15%	<5%	5%	<5%
Total amphibole[2] (XRD)	40-50%	50-60%	40-50%	~60%	>50%	50-60%	40-50%
Total amphibole[3] (LM)	25-30%	15-20%	20-25%	25-30%	25-30%	15-20%	25-30%
Fibrous amphibole[4] (LM)	1-2%	3-5%	1-3%	1-2%	<1/2%	3-5%	2-3%
Serpentine[2,5] (XRD)	10-15%	10-15%	10-12%	10-12%	~15%	~20%	~30%
Quartz[2,6] (S.S. X-RD)	2%	1/2-1%	~1 1/2%	~1 1/2%	<1/2%	B.D.L.	1/2-1%

NOTES:

1. Based on occluded area
2. Estimated weight percentage
3. Based on occluded area
4. Derived from estimated % of total amphibole which was fibrous. See also Table I.
5. Identified as lizardite by light microscopy
6. S.S. XRD = Step scanning x-ray diffraction

can be drawn from the electron diffraction and energy dispersive x-ray analysis is that one has a fibrous amphibole of the tremolite or anthophyllite type. It is generally not possible to distinguish between tremolite and anthophyllite by electron diffraction and one would therefore be tempted to suggest that the fibers were anthophyllite with a trace amount of calcium. Taken in conjunction with the light microscopical examination, however, during which a diligent search was made, particularly on Sample 83757, for fibers which might be anthophyllite rather than tremolite, one is forced to the conclusion that, rather than being a calcium bearing anthophyllite, the fibers are in fact a low calcium tremolite. The aspect ratios of many of the fibers observed are quite high and numerous fibers, such as those shown in Figures 20, 22, 24 and 30 showed the classic fibrous structure of the asbestos minerals. There is no doubt in our minds that these are indeed asbestos fibers rather than cleavage fragments of a more massive amphibole. Massive forms of the amphibole are, however, present and the fibrous amphibole content represents only a fraction of the total amphibole content of the samples.

CONCLUSIONS

Table 4 summarizes the results of all the investigations which we have carried out. In answer to the specific question, "Do these particular talc samples contain any asbestos minerals?", the answer must be an unequivocal yes. The asbestos mineral present appears to be a low calcium tremolite and is definitely asbestiform by any definition of the word. The asbestos content in the samples varies from less than 5% to approximately 20%, based on occluded areas observed in the transmission electron microscope.

Respectfully submitted,

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Research Chemist

Lucy B. McCrone
Senior Research Scientist

Richard J. Shimps
Research Chemist

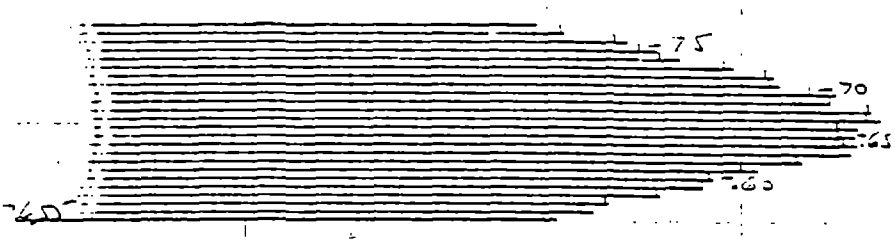
Ian M. Stewart
Manager, Electron Optics Group

FIGURES 1 THROUGH 40

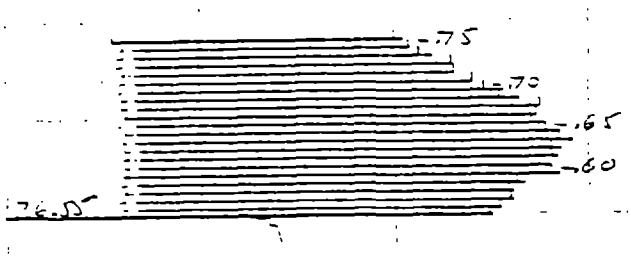
EXAMINATION OF TALCS FROM

GOUVERNEUR DISTRICT — NEW YORK

Figure 1 Step scanning data for quartz



Sample 83755 (001) Talc (α -SiO_2-)



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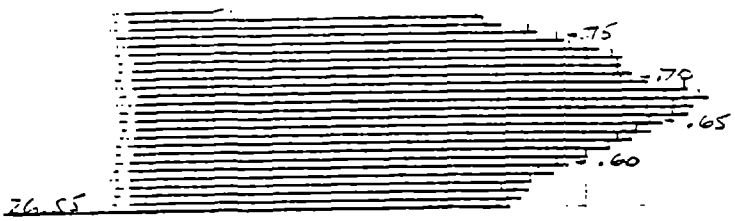

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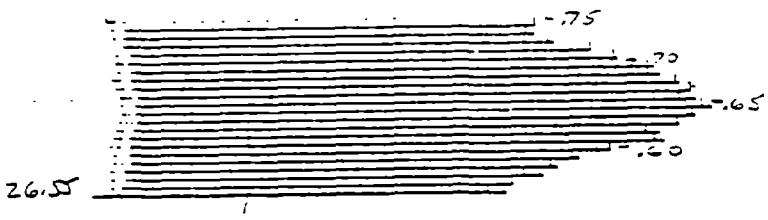
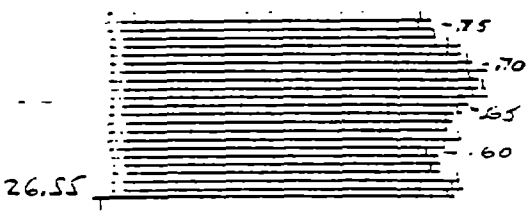
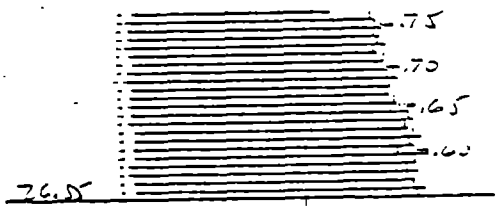


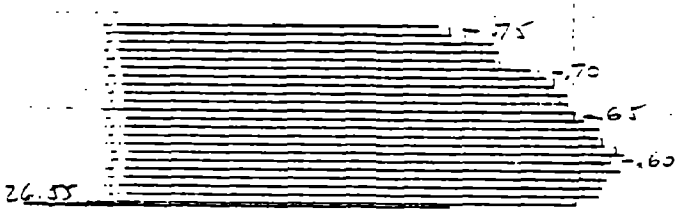
Sample 83758 (004) Talc (α -SiO_2+)



Sample 83759 (005) Talc (α -SiO_2+)

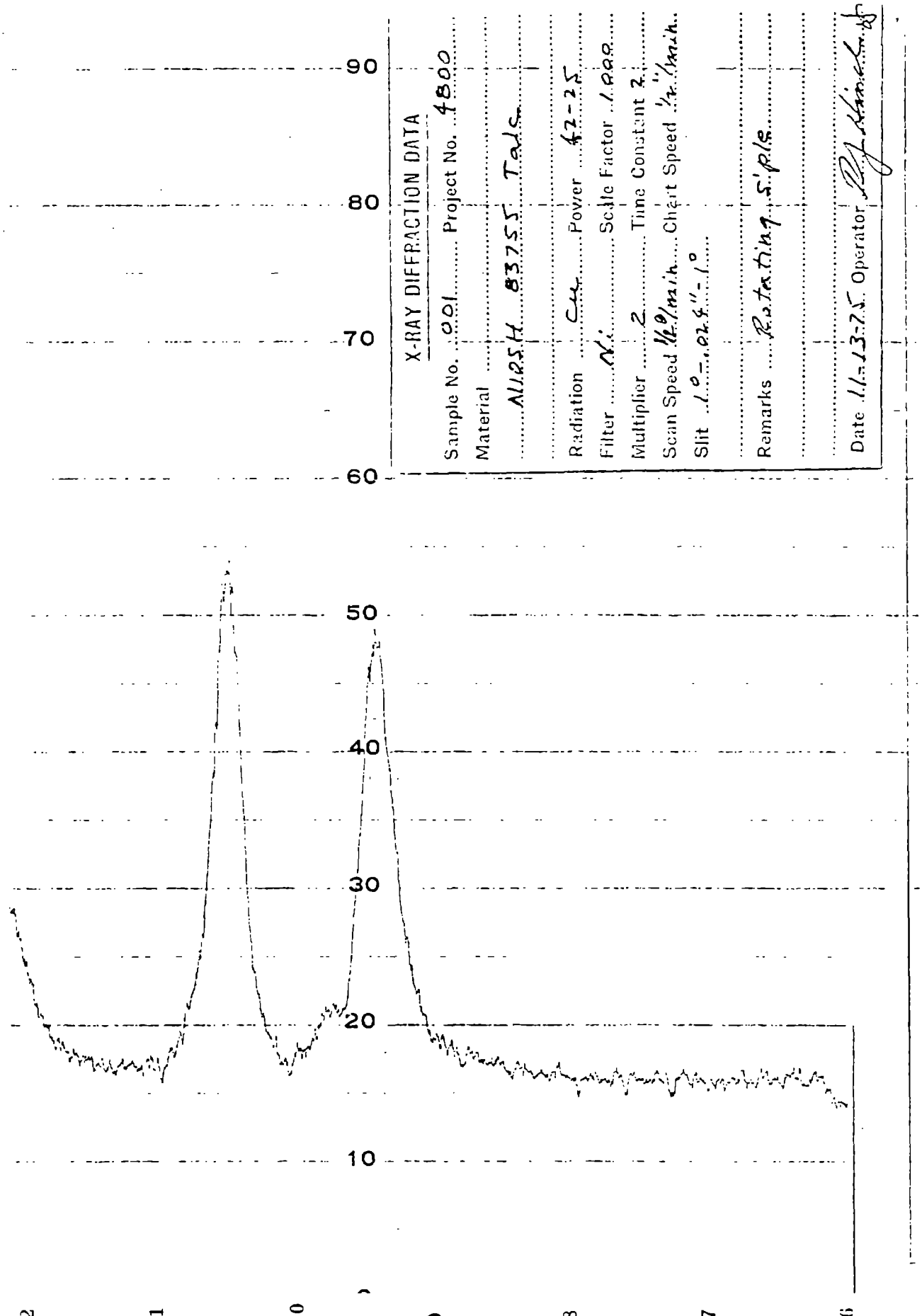


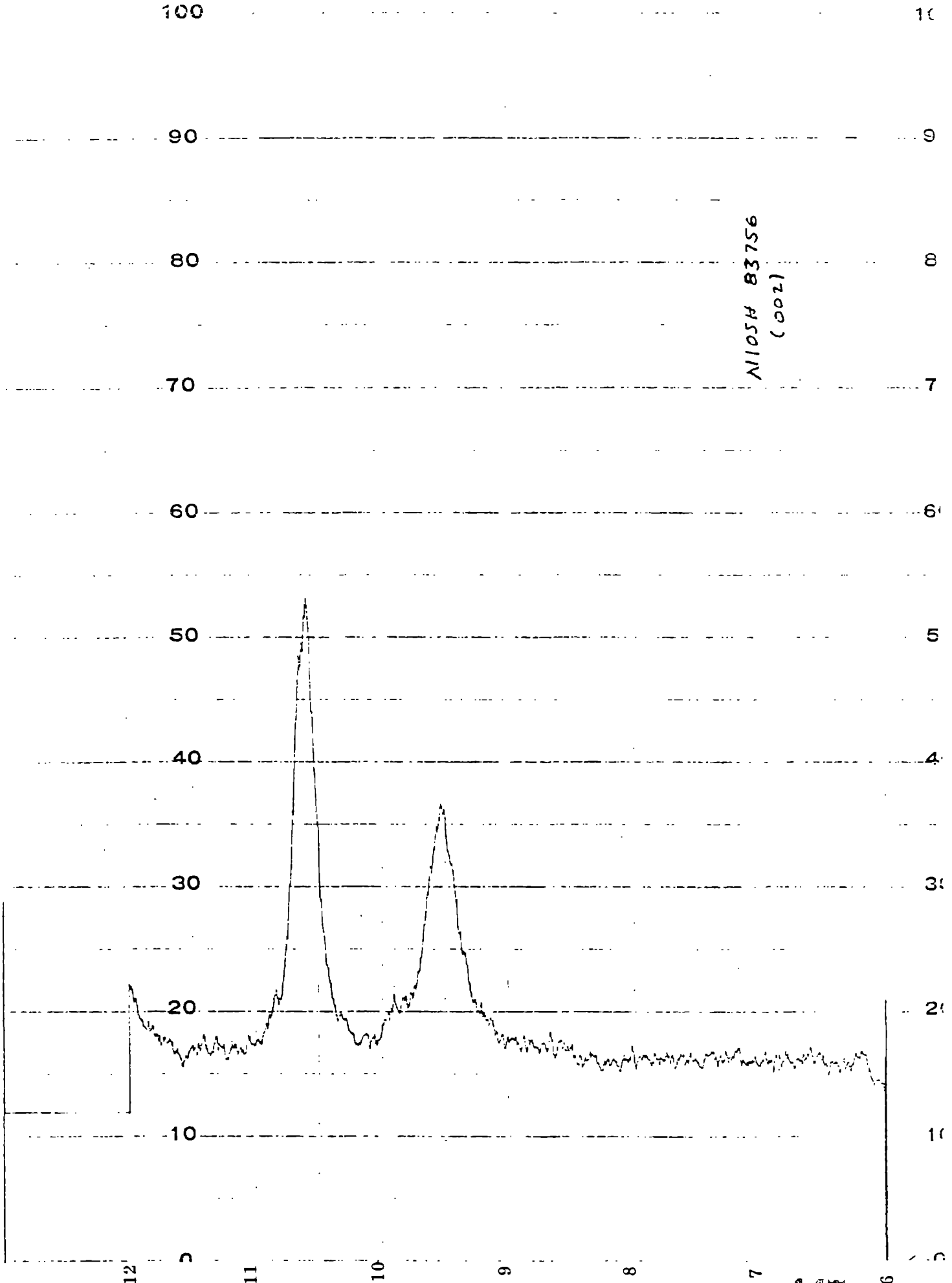
Sample 83760 (006) Talc (α -SiO_2+)



Sample 83761 (007) Talc (α -SiO_2+)

Figures 2-8 6°-12° range of 2θ for Samples 83755-83761

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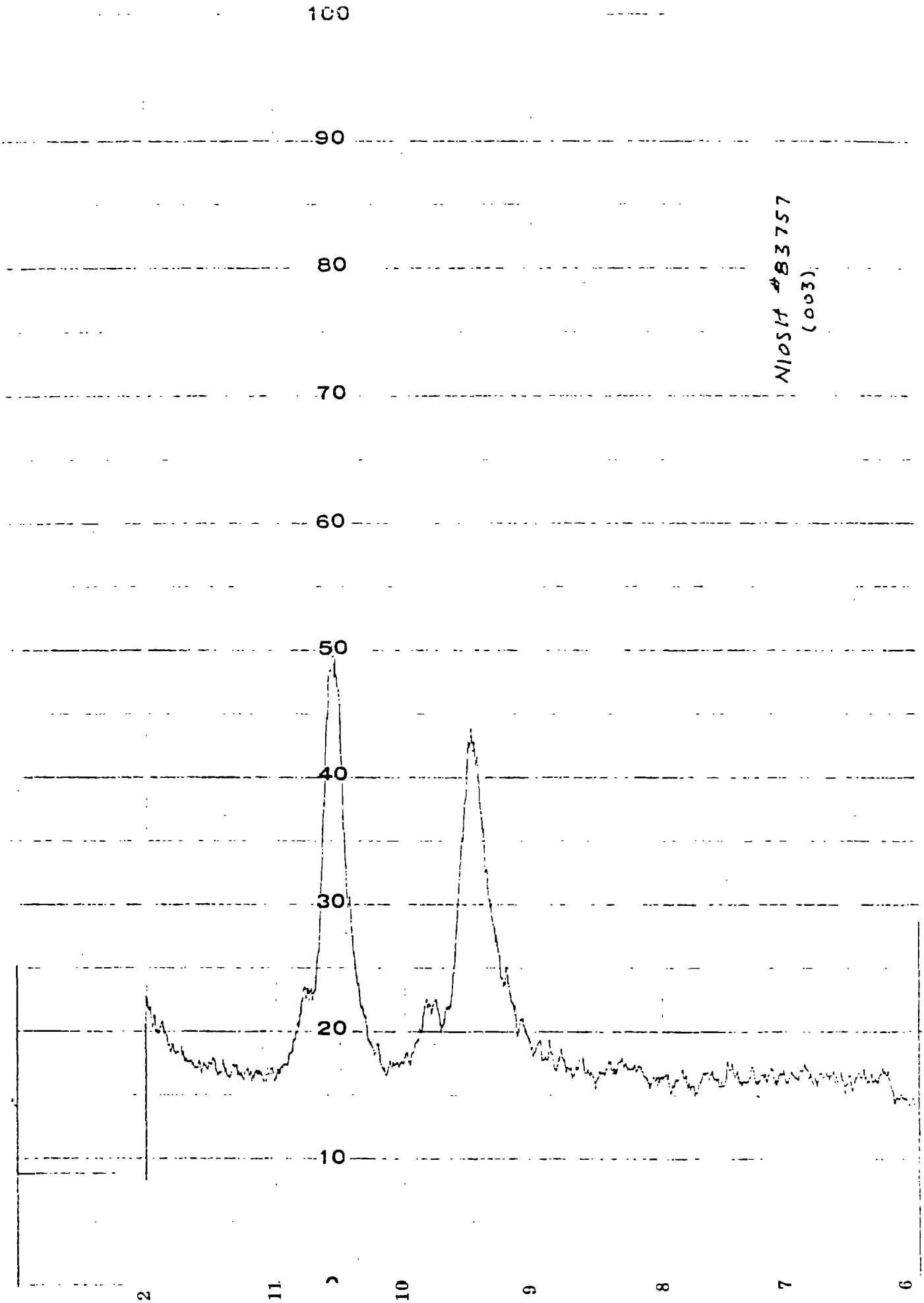
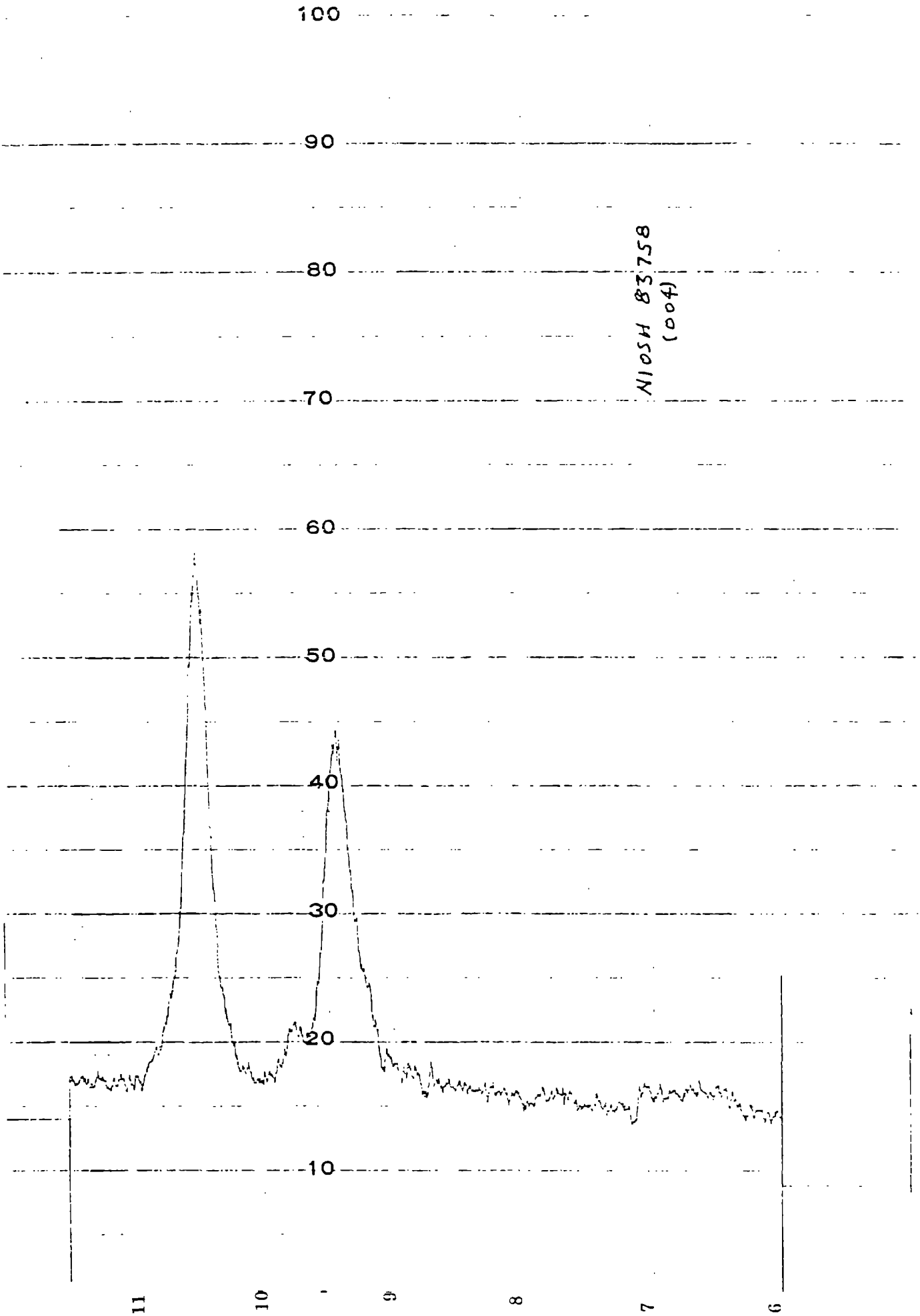


Figure 4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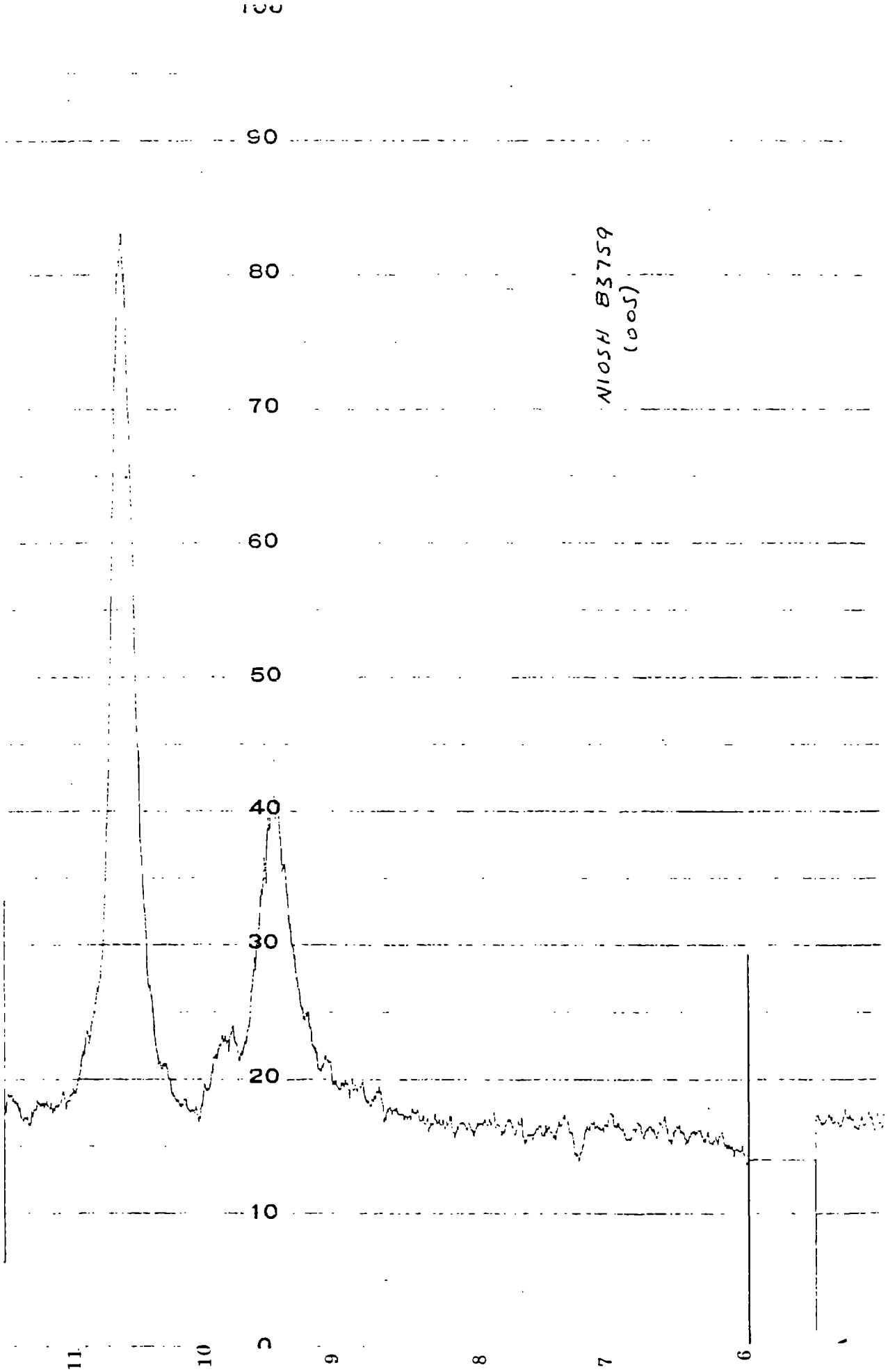

Figure 6

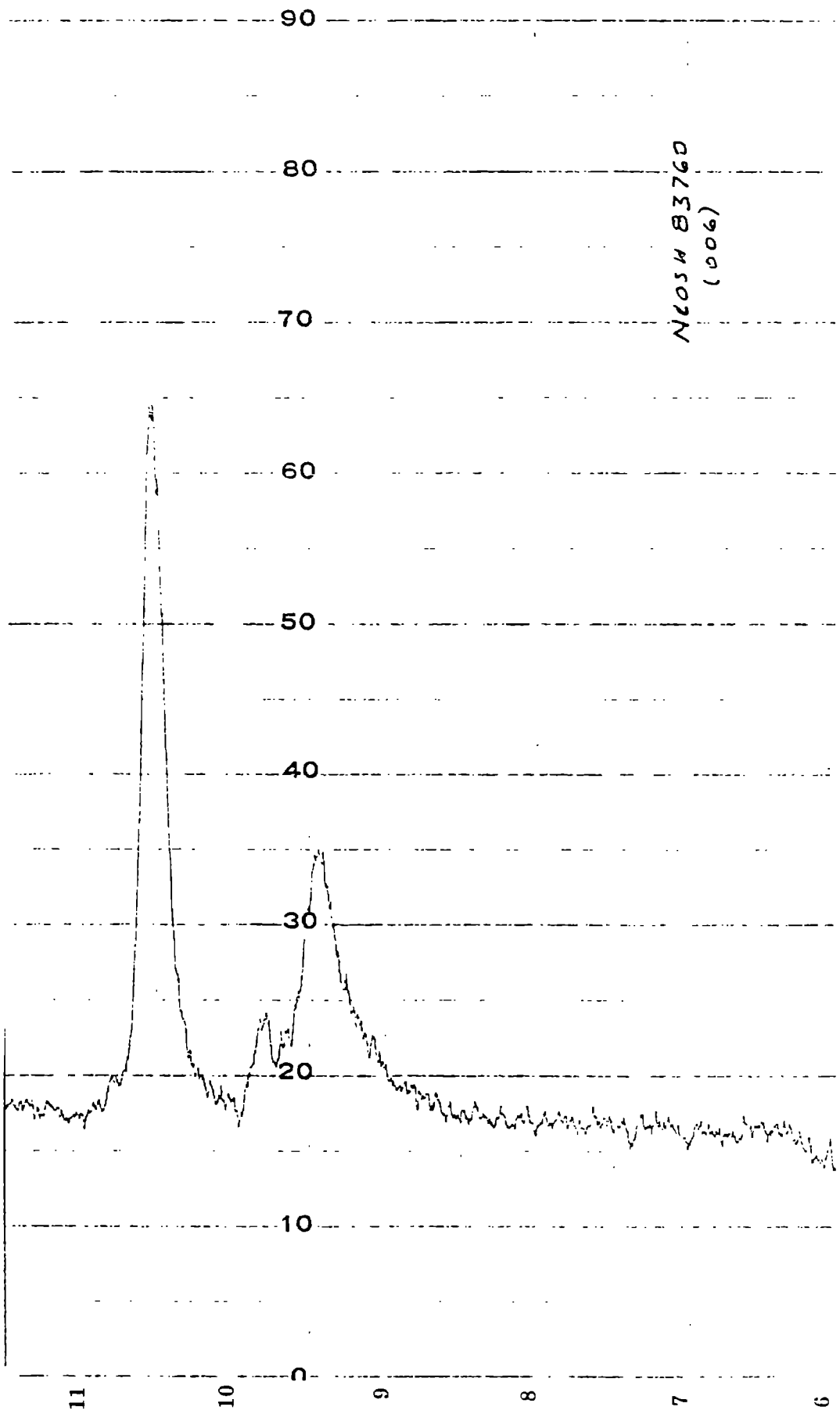

Figure 7

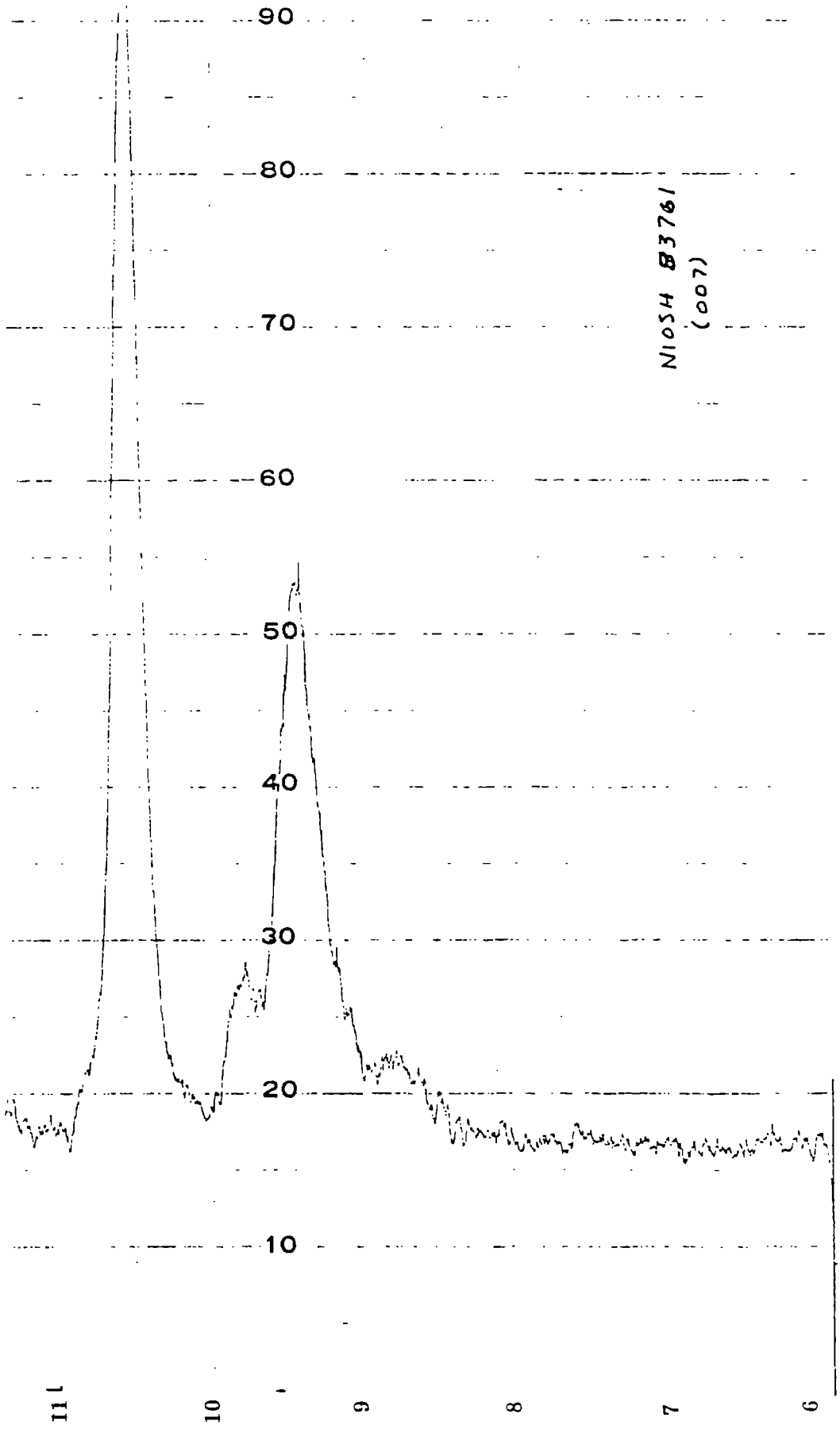

Figure 8

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16. Abstract (Limit: 200 words)

Worker exposures to respirable dust, free silica and asbestos were surveyed at the R.T. Vanderbilt Gouverneur Talc Company (SIC-1496) number One Mine and Mill in Balmat, New York, November 3-7, 1975. Bulk samples of talc were collected and personal air sampling was conducted in the mine and the mill. X-ray diffraction and optical or electron microscope analysis was conducted by NIOSH and two independent laboratories. All laboratories confirmed the presence of asbestiform tremolite and anthophyllite in the bulk talc samples at concentrations of 67 to 88 and 4 to 12 percent, respectively. Time weighted average (TWA) values for fiber and dust personal exposures for almost 30 job categories ranged from 1.7 to 9.8 fibers greater than 5 microns per cubic centimeter, and 0.25 to 2.96 milligrams per cubic meter, respectively. Free silica exposures were very low. Analysis of the impinger samples revealed excessive exposure to asbestos at almost every mine and mill operation. The authors conclude that excessive exposures to airborne fibers exist in both mine and mill. Recommendations include improved ventilation, upgraded equipment maintenance, and provision of respiratory protection to employees.

17. Document Analysis a. Descriptors

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