INDUSTRIAL HYGIENE STUDY OF THE INTERPACE CORPORATION

Willsboro, New York

Report Prepared By
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Introduction

The National Institute for Occupational Safety and Health (NIOSH) has underway industry-wide studies to assess the chronic health hazards from occupational exposure to respirable fibers. These studies include epidemiological studies of exposed worker populations to determine health effects which may be attributed to the work environment, medical studies to assess chronic health effects, and detailed industrial hygiene studies to characterize the various agents to which these workers have been exposed.

During the week of June 14-16, 1976, Ralph Zumwalde, Mark Boeniger and Robert Wheeler (ALOSH) conducted an industrial hygiene survey of the Interpace Corporation in Willsboro, New York. The purpose of the survey was to collect samples of airborne wollastonite, characterize its composition and evaluate worker exposures. Approximately 60 airborne samples were collected at various mining and milling operations. Of these 60 airborne samples, 45 were personal breathing zone samples with the remaining 15 samples being collected at stationary sites near processing operations. Airborne samples were collected for the determination of respirable and total dust and wollastonite fiber concentrations. All of the respirable and total dust samples were also analyzed for free silica. In addition, all stationary samples were analyzed for trace metal (Cadmium, Chromium, Cobalt, Iron, Manganese, Nickel, and Zinc) content. Settled dust samples were collected at different processing operations and were analysed in the same manner as the airborne. Some high noise levels were apparent due to mill processing operations; consequently, sound level measurements were taken at various locations within the mill.

The following paragraphs describe the sampling and analytical methods employed, sample results, conclusions and recommendations drawn for workplace improvements and worker safety. To help reduce duplication of information, a copy of the February 12, 1976 Preliminary Industrial Hygiene Survey Report of the Interpace Corporation facility is attached (Appendix I). This report documents the mining and milling processes, medical, industrial hygiene and safety practices at the facility and discusses the potential problems with the inhalation of airborne wollastonite.

Survey Procedures

The major portion of the survey was devoted to the collection of personal breathing zone samples for documenting employee exposures at various milling and mining processes. Personal air samples were collected on the employees to determine time-weighted average (TWA) concentrations for respirable and total dust, wollastonite fibers, and free silica. Samples for airborne respirable and total dust were collected at a flow rate of 1.7 liters per minute (lpm) on 37 mm diameter pre-weighed MSA type FWS (polyvinyl chloride) filters. Total dust samples were collected open faced with respirable dust samples collected for trace metal analysis using 37 mm diameter pre-weighed Millipore Type AA (cellulose ester) filters. To determine airborne wollastonite fiber concentrations both personal and stationary air samples were collected on open faced 37 mm Millipore Type AA filters (0.8 μm pore size) at a flow rate of 1.7 lpm. All respirable, total dust and trace metal samples were collected during the majority of the work shift, whereas, wollastonite fiber samples were changed periodically during the work shift as needed to prevent particulate overloading on filters.

Free silica concentrations for air and settled dust samples were determined using X-ray diffraction as specified in the NIOSH Crystalline Silica Criteria Document.[1] Trace metal analyses for Cd, Cr, Co, Fe, Mn, Ni and Zn were determined by atomic absorption spectroscopy on stationary air samples and settled dust. To determine an index of exposure to airborne wollastonite fibers, all fiber samples were analyzed using the NIOSH asbestos counting technique.[2] These samples were analyzed by phase contrast microscopy at 400X magnification with fibers (3:1 length to diameter aspect ratio) counted and sized into groups of less or greater than 5 micrometers (μm) in length. These same samples were further analyzed by transmission electron microscopy (TEM) using selected area electron diffraction and energy dispersive X-ray analysis to identify all fibrous particles. TEM was also used for determining fiber size (length and diameter) distributions using a sample preparation method developed by Ortiz[3] and analyzed on a JEOL, JEM 100-B TEM at a magnification of 10,000X. A minimum of 100 fibers were analysed on each sample.

Sound level measurements were taken at various mining and milling operations for identifying potential excessive noise sources. Decibel measurements were made using a General Radio 1565A sound level meter on the A weighted scale.

Sample Results

Attached as Appendix II is a brief description of each job within the mill and also the mine, a description of sampling and analytical methods utilized, results of all individual samples, and appropriate summary statistics. All job categories have been identified by a 4 digit job code. The first 2 digits represent the general work area while the last 2 digits correspond to specific jobs within those areas. Tabular summaries of time-weighted average concentrations by job category for free silica and respirable and total mass dust samples (wollastonite) are given in Table 1. Presented in Table 2 is a summary of the trace metal analyses of settled dust samples collected at various locations within the mill.

TWA free silica concentrations calculated for each job category appear to be within acceptable limits as recommended by NIOSH.[1] Some individual respirable samples did indicate free silica concentrations in excess of the NIOSH recommended TWA standard of 0.050 mg/m^3. However, there is some questions as to the interpretation of these concentrations since the analysis for free silica on most of the samples was reported near the lower detection limit of the analytical method (0.05 mg per filter). Trace metal (Cd, Cr, Co, Fe, Mn, Ni, Zn) analyses performed on collected airborne samples indicated levels near the lower detection limit of the analytical method, hence, air sample concentrations (µg/m^3) for trace metals reported in Appendix II reflect these low levels. The trace metal analysis of the settled dust samples, as indicated in Table 2, substantiates the low levels found in the air samples. Iron was the only trace metal found in any appreciable quantity (0.5 - 5.5%).

As reported in Table 1 all TWA concentrations for respirable dust were below 5 mg/m^3, however, some TWA concentrations for total dust exceeded 10 mg/m^3. Since there is currently no specific occupational health standard for wollastonite the standards for inert or nuisance dusts are applicable. At present the Mine Enforcement and Safety Administration (MESA) dust standard is 5 mg/m^3 respirable and 10 mg/m^3 total, whereas, the Occupational Safety and Health Administration (OSHA) dust standard is 5 mg/m^3 respirable and 15 mg/m^3 total.

Listed in Table 3 are airborne concentrations for wollastonite fibers at various operations within the mine and mill. These concentrations along with fiber sizing were performed by both optical phase contrast and electron microscopy. It is apparent from the data that fiber concentrations, both total and > 5 μm, within the mine are much lower than those found in the mill. Also, sample concentrations in the mine for > 5 μm fibers were similar for both the optical and electron microscopy analysis. However, those samples collected in the mill indicated higher > 5 μm fiber concentrations when determined by optical microscopy. This difference could be attributed to the high fiber density per counting field which contributed to the difficulty in accurately sizing and counting fibers. All reported fiber concentrations for both mine and mill substantiate those sample results previously reported in the February 12, 1976 Preliminary Industrial Hygiene Survey Report (Appendix I).

Samples evaluated by transmission electron microscopy were also characterized for other fibrous minerals by utilizing selected area electron diffraction and energy dispersive X-ray analysis at a magnification of 17,000X.[4] A few chrysotile asbestos fibers were identified from the 15 analyzed airborne samples.

However, these few asbestos fibers could have resulted through contamination in handling and sample preparation methods. Illustrated in Figure 1 is a typical photomicrograph, selected area electron diffraction pattern, and X-ray spectrum of airborne wollastonite fibers found in the mill.

In addition to determining fiber concentrations on airborne samples, size distributions were also performed on observed fibers using both phase contrast and TEM. Samples analysed by phase contrast microscopy, as illustrated in Table 4, indicated that 92-97% of the airborne fibers observed had diameters less than 3.5 µm, of which, 98% had lengths less than 50 µm. Those same samples were analysed by TEM at 10,000X magnification. Approximately 1300 fibers were sized from both mine and mill airborne samples for the determination of length and diameter medians. As reported in Table 5 the count median was calculated to be 0.22 µm for diameters and 2.5 µm for lengths. This data closely compares with the fiber size data reported in the Preliminary Industrial Hygiene Survey Report. As the TEM fiber size data indicates there are a considerable number of airborne fibers with small diameters and short lengths which were not resolved by phase contrast microscopy.

Sound level measurements taken in the mine ranged from 104-112 dBA near the drilling operations to 78 dBA on the loading dock of the mill. All sound level measurements are reported in Appendix II.

Discussion

In determining any possible chronic respiratory health effects resulting from wollastonite fibers, it is necessary to determine what portion of the airborne fibers actually reach the lung alveolar regions. The respirability of fibers is not clearly understood at the present time. As was discussed in the Preliminary Industrial Hygiene Survey Report, research performed by some investigators have suggested that the physical parameters of the airborne fibers (e.g. size and morphology) dictate its respirability and potential for producing tumorigenic effects.[5,6] In a study to determine the airborne behavior of fibrous particles, Timbrell[7] reviewed the mechanisms by which particles deposit in the respiratory system, and addressed specifically the problem of fiber deposition. His study identified settling, inertial impaction, and Brownian diffusion as deposition mechanisms which operate for both compact particles and fibers. In addition, he identified a fourth mechanism, direct interception, which is of little significance for compact particles but which may be of importance for fibers. Using an aerosol spectrometer he found that the terminal settling velocity of fibers is mainly a function of fiber diameter, with length being of secondary importance and that fibers with diameters less than 3.5 μm could escape upper respiratory deposition by settling and inertial deposition and penetrate deeply into the pulmonary spaces. Timbrell's work was substantiated in a later mathematical model study performed by Harris et al.[8] in which as estimation of lung deposition of fibers was derived based on the aerodynamic behavior of thin straight rods.

These aforementioned studies, in addition to postmortem studies of the lungs of animals and asbestos workers[9,10,11], suggest that the majority of fibers which can penetrate into the alveolar regions are within a size range of less than 3.5 μm in diameter and less than 50 μm in length. The fiber size data which has been presented in this report demonstrates that most (92%-97%) of the airborne wollastonite fibers found in the mine and mill are potentially respirable. In view of this, it would appear prudent that exposures be kept at an absolute minimum by the use of good engineering controls and work practices. In addition, persons working with wollastonite also should receive very close medical surveillance and be advised of the associated potential health hazards.

It is difficult to interpret the free silica results of the airborne samples since the analysis for free silica was determined at the secondary X-ray diffraction quartz peak. It appears that wollastonite has a significant interference at the primary quartz peak and a less intense interference reflection at the secondary peak, making is somewhat subjective in quantifying the amount of quartz. However, the sample data shows that some areas within the mill had total dust concentrations that exceeded 10 mg/m^3. And, with a moderate free silica content (1% to 3%) associated with these high dust levels, the potential for inducing respiratory health problems is enhanced.

It was noted during the survey that improvements had been made with the exhaust ventilation around the bagging operations. These improvements, since our preliminary industrial hygiene survey, have help to reduce total dust exposure throughout the mill. Additional measures to reduce spills, improve clean-up procedures, and maximize existing exhaust ventilation systems still appears warranted.

Drilling operations in the mine and areas around the ore crushing operations in the mill often had sound level measurements exceeding 90 dBA. It was observed, however, that most employees working in these areas wore hearing protection. Other areas throughout the mill often had sound level measurements between 78 and 89 dBA. It has been documented in the NIOSH Noise Criteria Document[12] that 8 to 10 hour time-weighted average exposures to sound levels between 85 and 90 dBA can induce hearing impairments. Therefore, it is recommended that employees exposed to these levels be requested to wear hearing protection. It is also suggested that employees be made aware of areas which have excessive noise levels. Because of the range of sound levels found throughout the mine and mill it would be advisable to initiate a hearing conservation program with periodic hearing examinations.

Table 1. Interpace Corporation Concentrations
Summary of Time-Weighted Average (TWA)
Airborne Concentrations by Job Title

Samples by Job Title	Respirable Mass Free Silica (SiO_2) mg/m^3	Total Mass Free Silica (SiO_2) mg/m^3	Dust Concentrations (Wollastonite) Respirable Mass mg/m^3	Dust Concentrations (Wollastonite) Total Mass mg/m^3
0101 Driller	<0.016	<0.018*	0.409*	0.332*
0102 Loader	<0.066*	<0.017*	--	2.714*
0202 Trucker Crusherman	<0.131*	--	1.346*	--
0203 Beneficiator	<0.065*	--	1.555*	--
0204 Beneficiator Mill-Helper	<0.069*	--	1.488*	--
0205 Miller	--	<0.079*	--	7.250*
0206 F-1 Miller	<0.013*	<0.067*	0.618*	2.887*
0207 Packer	<0.068*	<0.068	1.545*	9.818*
0209 Laborer	<0.013*	<0.066*	2.120*	4.637
0211 Maintenance	<0.065*	<0.162*	1.822	16.092*
0213 Stationary General Area Samples (Milling Operations)	<0.079	<0.353	4.950	16.386

Interference at primary peak for SiO_2 required the use of secondary peaks. Therefore, reported TWA concentrations for respirable and total mass SiO_2 are values determined at the lower limit of detection of the secondary peaks (0.05 mg per filter).

NOTE: (*) Represents one sample
(--) No sample collected

Table 2. Interpace Corporation
Summary of Trace Metal and Free Silica
Analysis of Settled Dust Samples

Sample Location	Trace Metal (ppm)							
	Cadmium	Chromium	Cobalt	Iron	Manganese	Nickel	Zinc	Silica (SiO_2) %
I-1 Settled Dust Collected Near Crusher	<3.0	24.0	<10.0	42800.0 (4.28%)	1050.0	<20.0	31.0	<2.0
I-2 Settled Dust Collected Near Dryer	<3.0	24.0	<10.0	54800.0	1070.0	<20.0	23.0	<2.0
I-3 Settled Dust Collected At F-1 Bagging Operation	<3.0	13.0	<10.0	16200.0	983.0	<20.0	42.0	<2.0
I-4 Settled Dust Collected Near F-1 Bagging Operation	<3.0	10.0	<10.0	5070.0	932.0	<20.0	4.5	<2.0
I-5 Settled Dust Collected Near P-4 and C-1 Bagging Operations	<3.0	7.0	<10.0	5750.0	930.0	<20.0	11.0	<2.0
I-6 Settled Dust Collected On Loading Dock	<3.0	15.0	<10.0	7060.0	972.0	<20.0	9.2	<2.0

NOTE: All SiO_2 results were determined at the secondary peak because of interference at the primary peak.

Table 3. Interpace Corporation
Time-Weighted Average (TWA) Airborne
Concentrations for Wollastonite Fibers

Samples by Job Title	Phase Contrast Microscopy 400X Magnification fibers/cc > 5 μm in Length	Electron Microscopy 10,000X Magnification fibers/cc > 5 μm in length	Electron Microscopy 10,000X Magnification fibers/cc total fibers
<u>Mine</u> Driller 0101 Loader 0102 Utility Man 0103	0.27	0.33	5.4
<u>Mill</u> Trucker Crusherman 0202	0.78	0.91	4.6
<u>Mill</u> Beneficator Mill Helper 0204	20.0	11.1	33.5
<u>Mill</u> F-1 Miller 0206	47.7	17.5	51.9
<u>Mill</u> Packer 0207	32.0	13.1	85.4
<u>Mill</u> Stationary General Area Samples 0213	15.8	9.7	40.1

Table 4. Interpace Corporation
Fiber Size Distribution Data as
Determined By Phase Contrast Microscopy

Mine and Mill Operations (composite of samples)	Percent of All Fibers Counted %				
	Diameters	Lengths			
	≤ 3.5 μm	≤ 5 μm	≤ 10 μm	≤ 25 μm	≤ 50 μm
All Mine Operations	96	79	89	97	100
Beneficiating/Milling	92	27	60	91	98
Packing/Bagging	95				
All other areas in Mill	97				

NOTE: A fiber was defined as any particulate with a 3:1 length to diameter aspect ratio and with a length less than 50 μm.

Table 5. Interpace Corporation
Fiber Size Distribution Data
As Determined by Transmission
Electron Microscopy

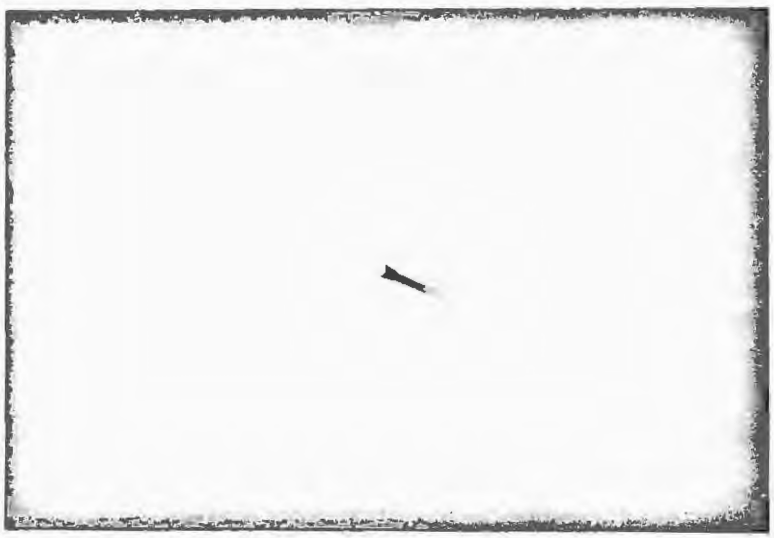
Fibers Measured in both Mine and Mill	Count Median (μm)	Range (μm)
Diameter	0.22	0.1 - 5.2
Length	2.5	0.3 - 41.0

Figure 1. Interpace Corporation

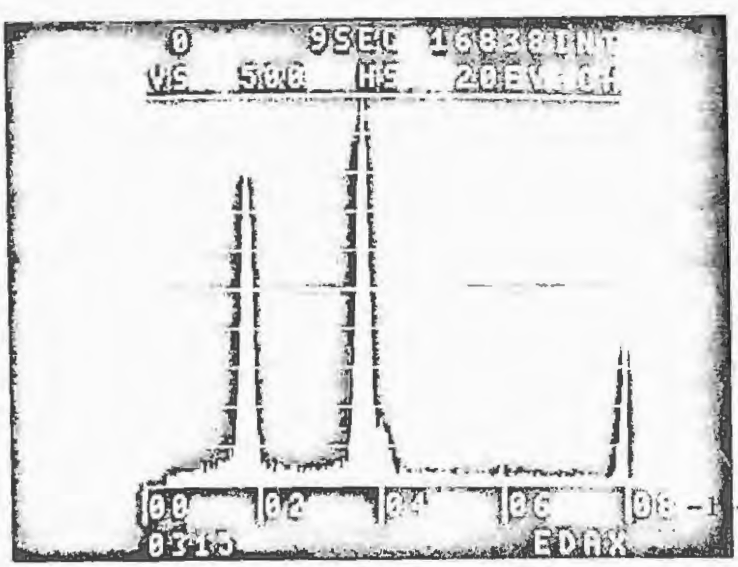
WOLLASTONITE

Photomicrograph

1 micrometer



Selected Area Electron Diffraction



X-Ray Spectrum
Si-Ca

References

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APPENDIX I

PRELIMINARY INDUSTRIAL HYGIENE SURVEY

Interpace Corporation

Willsboro, New York

SURVEY DATE:

February 12, 1976

SURVEY CONDUCTED BY:

Robert Wheeler
Mark Boeniger
Ralph Zumwalde

REPORT PREPARED BY:

Ralph Zumwalde
Mark Boeniger

INTRODUCTION

As part of the National Institute for Occupational Safety and Health (NIOSH) industrywide studies of industries producing and utilizing naturally occurring fibrous minerals, a preliminary industrial hygiene survey was conducted at the wollastonite operation of the Interpace Corporation, Willsboro, New York. This survey was performed by Robert Wheeler (ALOSH) and Mark Boeniger and Ralph Zumwalde of the Division of Surveillance, Hazard Evaluations, and Field Studies on February 12, 1976. In addition to observing the milling process and control measures, preliminary air sampling for characterization of wollastonite was conducted.

BACKGROUND INFORMATION

Wollastonite ($CaSiO_3$) is a naturally occurring fibrous calcium silicate which is rarely found in large amounts because of the rather unique mineralogical conditions required for its formation. It is therefore mined commercially only in a few places around the world.

The Cabot Corporation purchased the mineral rights to the Willsboro, New York, wollastonite deposit in 1951. The deposit was conservatively estimated at 15 million tons. In 1953, the Cabot Corporation completed construction of a 60,000 ton per year mill for processing the ore. This operation was later expanded in 1969 when the Interpace Corporation purchased the mine and mill.

Six grades of wollastonite are processed. These grades are designated by commercial use, fiber content, and particle size. Some of the commonly associated minerals found in the wollastonite deposits are garnet (45%), diopside, epidote, calcite, and quartz, most of which are salvaged as a by-product and marketed primarily as abrasives. Finished wollastonite has found utility in ceramics, paints, welding fluxes, plastics, cements, wallboards, and glass as filler. It has also been experimentally used as a soil conditioner supplying silica and calcium to deficient soil.

DESCRIPTION OF PROCESS

Mining

The mine is located approximately two miles from the mill. The present mining method employed is open stopes with regular pillars advancing up dip. Prior to 1959 ore was recovered from an open pit until the depth of overburden became excessive.

The mine is being presently mined on three levels, No. 1, No. 3, and No. 4. A second haulage drift is being opened at an upper level and several vertical interconnecting shafts have been drilled to improve ventilation. Natural draft ventilation is relied upon during the winter with forced air being produced by vane axial fans positioned at the mine portals during summer. Booster vane axial fans are also provided to establish a continuous flow of air through the working levels.

Most of the employees at the mine are engaged in drilling. The drilling is done wet utilizing two Gardner Denver Jumbo drills, one of which is operated by diesel power, the other by compressed air. When blasting is necessitated, it is always performed at the end of the second shift to allow time for the dust to clear. Ore is collected using a diesel powered pay loader and loaded into dump trucks. Scraping is no longer being utilitized as a means of removing ore from the face of the mine.

Milling

The mill site consists of the mill, mill change house, and office building. The ore is processed to separate the wollastonite from the garnet and diopside and to reduce the wollastonite to six grades of coarseness. The ore from the mine is dumped into a crusher pit, scraped to a pan feeder, and discharged through an 18" X 30" jaw crusher. An operator is stationed at the jaw crusher to direct the rock into the crusher and maintain an even feed. The primary discharge is passed over a screen (Tyler Ty-Rock) with the minus fraction passed through a parrallel flow, oil-fired dryer. The oversize is directed to a gyratory crusher (Telesmith) for additional size reduction. The dryer discharge and secondary crusher discharge are in closed circuit with a screen (Tyler Ty-Rock). The reduced crude ore is metered to one of two roll crushers for further reduction. The roll crusher discharge is passed over high frequency, low amplitude screen (Derrick) for separation in various product size ranges. These size classifications are fed at a predetermined rate through magnetic separators. The garnet and diopside, being feebly magnetic, are held close to the lines of magnetic flux of the induction rotor. The wollastonite being non-magnetic passes through the magnetic field and drops onto a conveyor belt and transferred to storage tanks.

The purified wollastonite can be ground into four product sizes within pebble mills. The pebble mills utilize an air separation system to separate the wollastonite into different size fractions enabling the diversification of end products. Two additional "fibrous" products are manufactured on an attrition mill. All finished products are bagged and/or shipped in bulk by truck. The wollastonite mill processing flow diagram is illustrated in Figure 1.

PERSONNEL

The Willsboro operation currently employs 60 hourly employees, and 12 salaried employees. The number of workers has remained fairly constant since the start of operation in 1953.

The mine operates on two shifts with an average of eight workers per shift. The mill operates on three shifts, employing about twenty workers on each of the first two shifts and three during the third shifts. All hourly employees in the mine and mill are represented by the United Steel Workers of America.

MEDICAL, SAFETY AND INDUSTRIAL HYGIENE PROGRAMS

Medical

All new employees are required to undergo a pre-employment physical. A local physician, Dr. Marconni, performs the physical examinations and is on call if an emergency arises. Up until 1965 every employee was given an annual physical. The mandatory annual exam was then limited to the ten oldest seniority employees. However, any employee will be granted a medical examinaiton if it is requested. A sample medical exam card, which is used on both pre-employment and annual physicals, can be seen in Figure 2.

Safety

A formal safety program is active at the Interpace mine and mill. Each employee is issued a list of safety rules with which he is expected to acquaint himself so that his actions do not provide a hazardous situation to himself or others. The program is under the direction of the mine and plant superintendent. A staff appointed safety man (on a rotational basis) conducts an unannounced inspection of the mine and mill and reports his findings at a monthly staff safety meeting. Two incentive awards are offered to the employees who have demonstrated safe work practices. At least one worker on each shift is trained in performing first aid.

The workers in the mine and mill are all provided with safety glasses, safety shoes, and hard hats. Work clothing is not provided. Self-rescuers are provided for all mine personnel. Change rooms and showers are provided at both the mine and mill.

Industrial Hygiene

No industrial hygienist is employed at the site. However, from recommendations resulting from several surveys performed by government (Mine Enforcement and Safety Administration and New York State Health Department) and private underwriters, changes have been made to improve the general working environment. Eight fabric baghouse filters have been installed to remove dust from local exhaust vents in the mill. These have greatly reduced the dust released at the magnetic separators and the bagging operations. However, installation of additional local exhaust ventillation appears warranted. Accumulations of settled dust were noted on ledges and machinery. The company has provided a central vacuum system with take-off connections on the upper floors. Effort is being directed at recycling baghouse wastes and other settled dust back into the product line without sacrificing the quality of the product.

Dust respirators are not required to be worn by any of the workers, although some workers were observed wearing them. Respirators are available upon request.

DESCRIPTION OF RECORDS SYSTEM

Personnel records are available from 1952 to the present. These include social security numbers, work histories, age, work title, and lost time characterized according to accident or illness. Most present and past workers are easily traceable because of the rural location and stability of the population. Medical records are retained on all past and present workers.

INSPECTION OF THE PLANT

Potential Exposures

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

1. There appears to be significant exposure to respirable wollastonite in various processing areas. No human data presently exists to indicate respiratory problems due to such exposure, however, it must be emphasized that human experience with this mineral is limited. It would appear prudent that exposures to respirable wollastonite fibers be kept at an absolute minimum by the use of good work practices and engineering controls. The use of brooms and hand brushes for cleaning should be eliminated in favor of much cleaner vacuum methods. In addition, those persons working in areas of excessively high dust exposure should be requested to wear respiratory protection unless they have an existing health problem which prohibits it, in which case, they probably should be removed from this work environment.

2. The workers in the mine may be exposed to excessive levels of carbon monoxide and nitrous gases (No_x, NH_3) released during blasting and by the operation of the diesel engine equipment. It is recommended that the mine environment be monitored to determine levels of exposure.

3. High noise levels are prevalent in both the mine and mill. Within the mill, high noise levels existed around the crushing and grinding operations. Sound level measurements should be made to determine if excessive noise levels exist. If excessive, an appropriate hearing conservation program should be set up. Drillers along with others in the immediate mine area should continue to wear hearing protection.

SURVEY PROCEDURES AND DATA ANALYSIS

The major portion of the survey was devoted to observation of milling and mining procedures, exposure control practices, and plant personnel record assessment. Bulk samples of the finished products along with a limited number of air samples were collected for the purpose of characterizing wollastonite. The air samples were collected in the mine and at various process operations within the mill. The collection media used for air sampling were 37 mm Millipore Type AA cellulose ester membrane filters (0.8 μm pore size) and 37 mm Nuclepore membrane filters (0.8 μm pore size). The sampling instruments were calibrated at a flow rate of 2.0 lpm.

Laboratory analyses were performed on all airborne samples and/or bulk samples for trace metals (Cd, Cr, Co, Fe, Mn, Ni. Zn) by atomic absorption, free silica by x-ray diffraction and fiber size distributions and fiber concentrations by optical and transmission electron microscopy.

All Millipore AA air samples were evaluated using phase contrast microscopy at a magnification of 400X. (NIOSH/OSHA method for counting asbestos.)[1] This analytical method was used to establish an index of exposure (fibers/cc) and for determining the relative size of the fibers (diameter and length).

The electron microscopy analysis of the collected samples was performed using a JEOL 100-B side entry transmission electron microscope along with an attached EDAX energy dispersive x-ray analyzer. The collected air samples were prepared using a transfer membrane filter technique utilizing a 200 mesh, formvar/carbon coated grid and observed by transmission electron microscopy.[2] Utilizing this method, the air samples were analyzed at 5,000X, 10,000X, and 20,000X magnificaiton to determine fiber and particulate morphology. To document and verify the observed fibrous material, both energy dispersive x-ray analysis and selected area electron diffraction were performed.

RESULTS

Industrial Hygiene

Due to the fibrous nature of wollastonite both optical and electron microscopy were utilized for determining an index of exposure (fibers/cc). Fibers were defined as having an aspect ratio of 3:1 or greater. All airborne samples were analyzed for total fibers and fibers greater than 5 microns in length. The microscopy analysis was performed at 400X magnification phase contrast and 10,000X magnification transmission electron microscopy. Table 1 illustrates fiber concentrations found at various locations within the mine and mill. By characterizing each sample for fiber size distribution by both optical and electron microscopy, a good comparison between optical and electron microscopy concentrations for fibers greater than 5 microns was achieved. It is apparent that a 2-4 fold increase in total fiber concentrations exists with the electron microscopy analysis. This difference can probably be contributed to the increase in magnification and resolution of the electron microscope.

Along with the tabulation of airborne fiber concentrations, fibers were also sized by diameter and length to determine airborne fiber diameter and length data. This was accomplished by sizing approximately 600 fibers by transmission electron microscopy at 10,000X magnification. All airborne samples were evaluated using randomly selected field for fiber sizing. The fiber size data is shown in Table 2.

To help characterize the mineral, energy dispersive x-ray analysis was performed on individual fibers to determine the elemental make-up. A typical wollastonite fiber x-ray spectra is illustrated in Figure 3. In addition to the x-ray spectra characterization, electron micrographs of typical sample fields were also taken at 2,000X and 10,000X magnification. Two such sample fields are illustrated in Figures 4 and 5.

The analytical results for trace metals (Cd, Cr, Co, Fe, Mn, Ni, Zn) and free silica obtained from six finished products and two settled dust samples are shown in Table 3. These samples were analysed by atomic absorption and x-ray diffraction, respectively.

DISCUSSION AND RECOMMENDATIONS

The fiber size data obtained from the electron microscopy analysis indicates count median measurements of 0.26 microns for diameter and 2.0 microns for lengths for airborne wollastonite. Because of these physical dimensions airborne exposures may be respirable and harmful to health. Although the respirability of airborne fibers is not clearly understood it is thought to be mainly dependent on the fiber diameter. Timbrells'[3] work suggests that the two major mechanisms of fiber deposition in the upper airways (settlement induced by gravity and inertial deposition) are chiefly dependent upon particle free falling speed (i.e. equivalent Stokes' diameter). Fibers with densities less than 3.5 g/cm^3 and less than 3.5 µm in diameter may escape deposition by these two mechanisms and penetrate deeply into the lungs. Airborne wollastonite fibers satisfy both the density and fiber diameter requirements as stated above and may be considered potentially respirable.

Recent studies utilizing fibrous particulates have indicated potential adverse physiological effects. One such animal study performed by Pott[4] has shown that the fibrous structure of chrysotile, with lengths of 2-3 µm, are carcinogenic. Pott concluded that fiber shape and size was a more important factor in carcinogenesis than trace metal contamination. In another study conducted by Pott, et.al.,[5] it was demonstrated that other fibrous dusts, after intraperitoneal injection into rats, induced tumors equivalent to that produced by the same dose of fibrous chrysotile.

A study performed by Hefner, et.al.,[6] showed a comparison of the relative rates of hemolysis induced by various fibrogenic and non-fibrogenic particulates with rat erthrocytes in vitro. Attempts were made to measure the amount of hemolysis of the cell with a variety of particulates (i.e., chrysotile, talc, kaolin, brucite, actinolite, wollastonite, Min-U-Sil silica, etc.). The percent of hemoglobin not released from the cells by hemolysis was measured with a function of time. Results indicated that only Min-U-Sil silica, chrysotile and wollastonite were all potentially hemolytic. Both chrysotile and Min-U-Sil silica have been shown to be fibrogenic in vivo as well as hemolytic in vitro by nummerous investigators, hence, for these two particulates a direct correlation between in vivo fibrogenesis and in vitro hemolysis exists. The fibrogenic activity of wollastonite has not been evaluated in vivo, however, the hemolytic potential of wollastonite is in the same range as that obtained for other fibrogenic particualtes.

The conclusions indicate a need for an epidemiological evaluation of the relationship of worker exposure to wollastonite. Because of the small work force and employment stability it would be advantageous to perform a follow-up morbidity study. As a guideline for the detection of possible chronic effects, the medical study which was performed at the Interpace facility by Dr. Kleinfield and staff, New York State Department of Labor, in October, 1964 could be utilized. This study included a complete medical work-up (i.e. physical examinations, chest roentogenograms, electrocardiograms, pulmonary function tests, etc.) conducted on fifty-five plant workers (miners and millers) with an additional thirty-two males serving as a control group.[7]

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7. Medical Summary Data of the Cabot Corporation, Willsboro, New York. Data forwarded by Dr. Messite, New York Department of Labor to Dr. Blejer, DSHEFS, NIOSH. October 7, 1975.

TABLE 1

Interpace Corporation

SUMMARY OF FIBER CONCENTRATIONS* (FIBERS/CC) FOUND IN A WOLLASTONITE MINE AND MILL

SAMPLE LOCATIONS	OPTICAL MICROSCOPY 400X		ELECTRON MICROSCOPY 10,000X	
	Total Fibers fibers/cc	Fibers > 5 microns	Total Fibers fibers/cc	Fibers > 5 microns
Mine 1st Level	0.35	0.26	1.14	0.33
Mine 2nd Level	1.4	0.9	7.2	0.9
Mine 3rd Level	0.43	0.3	1.68	0.24
Mill Primary Crusher	40.4	25.5	161.2	24.5
Mill Secondary Crusher	70.0	41.0	132.0	30.3
Mill Dryer	85.0	43.3	236.0	67.9
Mill Bagging Operations	20.5	10.3	39.9	5.1

* ONLY FIBERS WITH DIAMETERS LESS THAN 3.5 MICRONS AND LENGTHS LESS THAN 50 MICRONS WERE COUNTED

TABLE 2

Interpace Corporation

SUMMARY OF AIRBORNE WOLLASTONITE FIBER SIZE DATA

DETERMINED BY ELECTRON MICROSCOPY

Fiber Measured	Count Median (μm)	Range (μm)	Geometric Standard Deviation σ_g
Diameter	0.26	0.1- 3.2	2.7
Length	2.0	0.4-26.0	2.5

TABLE 3

Interpace Corporation

RESULTS OF TRACE METAL AND FREE SILICA ANALYSIS

WOLLASTONITE

Bulk and Settled Dust Samples	Trace Metals µg/g							Free Silica %
	Cd	Cr	Co	Fe	Mn	Ni	Zn	
F - 1	0.8	3.5	3.3	6060	1070	7.0	9.7	< 3
C - 6	0.5	3.7	6.7	6870	1020	2.0	7.4	< 3
C -101	1.0	4.1	-	3510	930	-	1.0	< 3
P - 4	0.5	1.8	4.0	4840	1020	3.0	9.6	< 3
P - 1	0.5	2.0	3.6	5830	1100	2.0	14.0	< 3
C - 1	0.5	2.0	3.6	5800	1050	3.0	7.3	< 3
10	0.5	3.6	4.6	5340	990	4.0	4.5	< 3
11	1.0	10.0	6.0	5980	1030	10.0	14.0	< 3

FIGURE 1

Wollastonite Mill

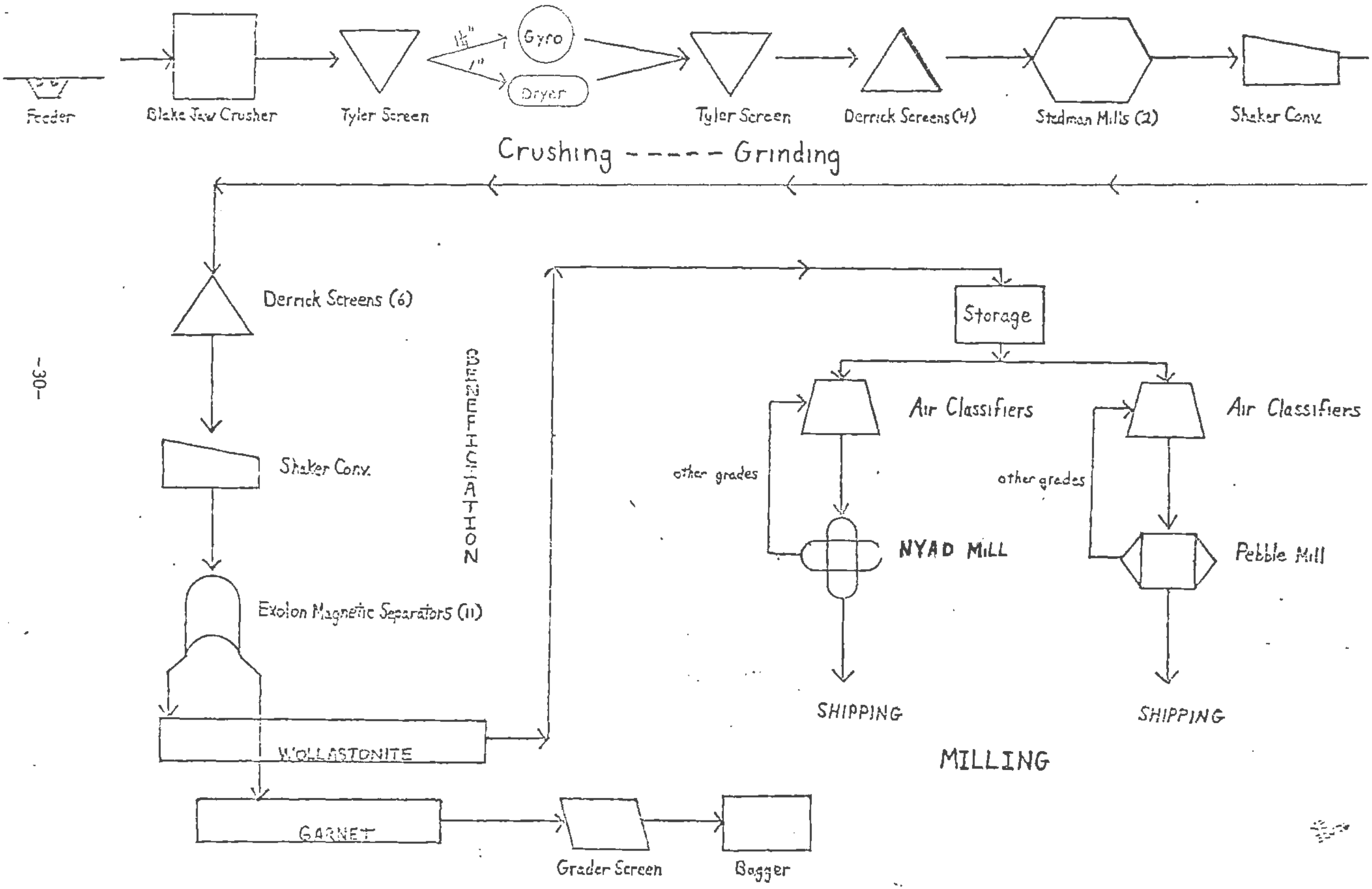


FIGURE 2

Medical Examination Card

Interpace Corporation

610-12-6 11/67

MEDICAL EXAMINATION

DATE 2/3/76 ORIGINAL YEARLY EXAM. SPECIAL EXAM.

FULL NAME [redacted] DATE OF BIRTH 1/2/46

MARRIED ✓ SINGLE WIDOWED DIVORCED SEPARATED

OPERATIONS AP

SYMPTOMS: IF ANY Amputation of (L) 5th Digit

COLOR OF EYES BROWN HEIGHT 6-1 WEIGHT 225 COLOR BLIND no

GENERAL APPEARANCE Healthy APPARENT INTELLIGENCE nl CHEST MEAS. INSP. EXP.

VISION R-20/ 20 L-20/ 20 WITH GLASSES R-20/ L-20/ EYE CONDITION no

HEARING R-20/ nl L-20/ nl EARS nl TEETH nl GUMS nl

NOSE nl MOUTH nl TONSILS nl GLANDS nl BREASTS nl

CHEST nl LUNGS clear ARTERIES nl SKIN clear

HEART SIZE WNL RATE 80 RHYTHM reg MURMURS no

BLOOD PRESSURE-SYSTOLIC 110/70 DIASTOLIC 110/70 ABDOMEN nl

HERNIA no SPINE nl DEFORMITIES as above JOINTS nl

PENIS nl TESTICLES nl VARICOCELE HYDROCELE neg

REFLEXES nl TREMORS no FEET VAGINAL EXAM. MENSTRUATION

RECTAL EXAM. neg URINE ALBUMIN SUGAR HINTON HEMOGLOBIN BLOOD SMEAR

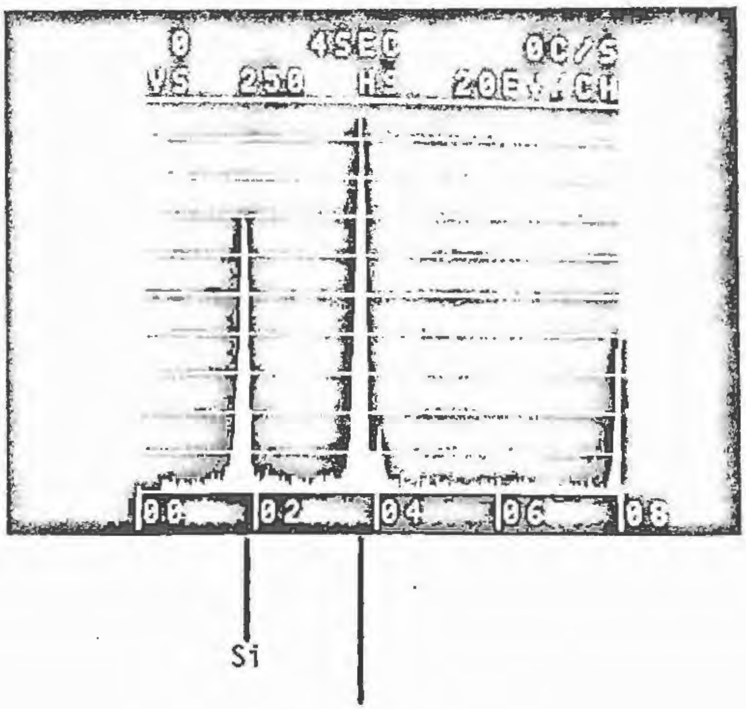
X-RAY CHEST EXAM. Hct = 49

IMPRESSION Healthy

SIGNATURE Marcone
MEDICAL EXAMINER

FIGURE 3

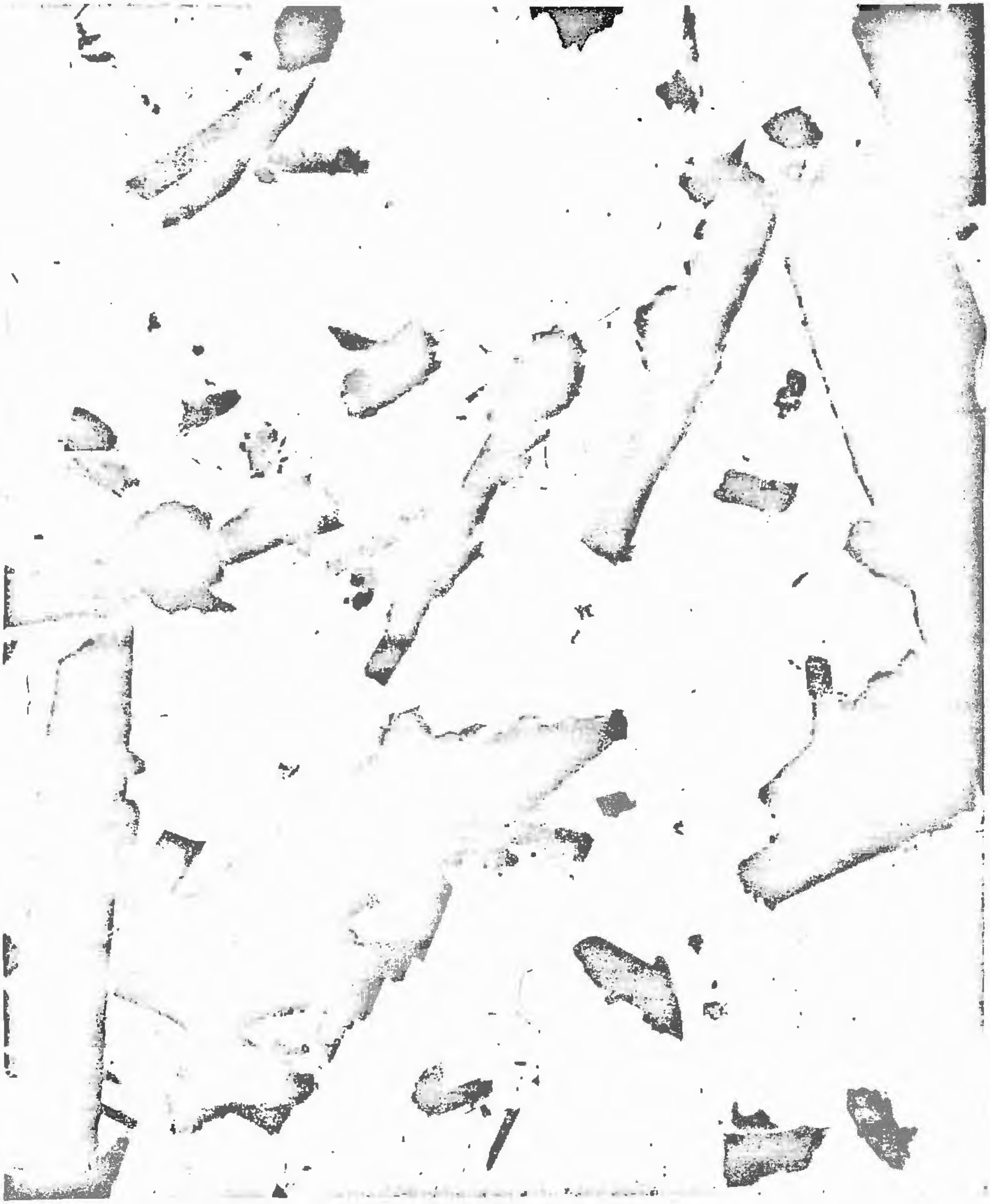
Interpace Corporation



Wollastonite
X-ray Spectra

FIGURE 4

Interpace Corporation



Wollastonite

2,000X Magnification

1 micron

FIGURE 5

Interpace Corporation

Wollastonite
10,000 Magnification

1 micron

APPENDIX II

INTERPACE CORPORATION

WILLSBORO NEW YORK

DATE OF STUDY: 06/14/76 - 06/16/76

AGENT STUDIED: WOLLASTONITE

SIC CODE: 3291 COUNTY:ESSEX

PRODUCTION AT THIS FACILITY STARTED AROUND 1953, PRESENT OWNERSHIP WAS ACQUIRED IN 1969, COMPANY EMPLOYS APPROXIMATELY 60 HOURLY EMPLOYEES AND 12 SALARIED EMPLOYEES, THE MINE OPERATES ON TWO SHIFTS WITH AN AVERAGE OF 6 WORKERS PER SHIFT, THE MILL OPERATES ON THREE SHIFTS, EMPLOYING ABOUT 20 WORKERS ON EACH OF THE FIRST TWO SHIFTS AND 3 DURING THE THIRD SHIFT,

TABLE 1. JOB DICTIONARY

CODE	JOB TITLE	DUTIES
0101	DRILLER	CAPABLE OF DRILLING, PLACING EXPLOSIVES AND SCALING
0102	LOADER	LOADS ORE FROM MINE INTO TRUCKS, HELPS MOVE ORE OUT OF MINE
0103	UTILITY MAN	SERVICES ALL MINE EQUIPMENT, INCLUDING WIRING AND WELDING
0104	STATIONARY GENERAL AREA SAMPLES	STATIONARY SAMPLES COLLECTED AT VARIOUS LOCATIONS WITHIN THE MINE
0201	TRUCKDRIVER	LOAD AND OPERATES TRUCK, TRANSFERS ORE FROM MINE TO MILL
0202	TRUCKER CRUSHERMAN	OPERATES PRIMARY CRUSHER DRYING, SCREENING AND ASSOCIATED EQUIPMENT, INCLUDING CLEANING AND TAKING SAMPLES
0203	BENEFICIATOR	OPERATES FINE CRUSHING, SIZING/BENEFICIATION AND ASSOCIATED EQUIPMENT INCLUDING CLEANING AND TAKING SAMPLES
0204	BENEFICIATOR MILLER-HELPER	PERFORMS SAME DUTIES AS MILLER AND BENEFICIATOR, HELPS OPERATE AND CARE FOR EQUIPMENT
0205	MILLER	OPERATES ALL MILLING, SEPARATING, CLEANING, TAKING AND TESTING SAMPLES, PEFORMS QUALITY CONTROL WHEN NECESSARY
0206	F-1 MILLER	OPERATES F-1 MILLING, CLEANS AND TAKES SAMPLES, RESPONSIBLE FOR QUALITY CONTROL FOR F-1 PRODUCT, HELPS BAG F-1 PRODUCT
0207	PACKER	HELPS BAG, PERFORMS SOME MAINTENANCE AND ASSISTS IN LOADING TRUCKSAND BOX CARS
0208	TRACTOR TRAILERMAN	CAPABLE OF DRIVING TRUCK AND ASSISTING IN REPAIRS
0209	LABORER	ASSISTS PACKER, HELPS LOAD TRUCKS AND BOX CARS, MISC. JOBS AS REQUIRED
0210	SHIFT BREAKER	FILLS IN FOR CRUSHERMAN, BENEFICIATOR, MILLER AND PACKING CLASSIFICATIONS
0211	MAINTENANCE	SKILLED IN THE REPAIR AND MAINTENANCE OF MILL AND MINE MACHINERY. SPENDS

TABLE 1. JOB DICTIONARY

CODE	JOB TITLE	DUTIES
		MOST OF THE TIME IN VARIOUS LOCATIONS IN THE MILL AND MINE
0213	STATIONARY GENERAL AREA SAMPLES	STATIONARY SAMPLES COLLECTED AT VARIOUS LOCATIONS WITHIN THE MILL

TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
WOLLASTONITE	TOTAL DUST	FIBER SIZE OPT.	TOTAL DUST SAMPLES ARE COLLECTED ON OPEN FACE AA MIL-LIPORE FILTERS (0.8 UM PORE SIZE) 37MM DIAMETER WITH A FLOW RATE OF 1.7 LITERS PER MINUTE. SAMPLES WERE P-REPARED AND ANALYSED USING THE NIOSH/OSHA ASBESTOS C-OUNTING METHOD. FIBERS WERE SIZED BY LENGTH AND DIAM-ETER WITH FIBER CONCENTRATIONS DETERMINED FOR FIBERS-GREATER THAN 5.0 UM IN LENGTH AND EXPRESSED AS FIBER-S PER CC. OPTICAL MICROSCOPY/PHASE CONTRAST.
WOLLASTONITE	TOTAL MASS	GRAVIMETRIC	TOTAL MASS SAMPLES ARE COLLECTED ON MSA POLYVINYL CH-LORIDE FILTERS (5.0 UM PORE SIZE) 37MM DIAMETER WIT-H A FLOW RATE OF 1.7 LITERS PER MINUTE. FILTERS ARE W-EIGHED TO THE NEAREST 0.1 MG USING A CAHN GRAM ELEC-TROBALANCE AND DUST CONCENTRATIONS REPORTED AS MG/M3.
WOLLASTONITE	RESPIRABLE MASS	GRAVIMETRIC	RESPIRABLE MASS SAMPLES ARE COLLECTED ON MSA POLYVIN-YL CHLORIDE FILTERS (5.0 UM PORE SIZE) WITH A FLOW R-ATE OF 1.7 LITERS PER MINUTE. NYLON CYCLONES (10MM) -ARE USED FOR SIZE SEPARATION. FILTERS ARE WEIGHED TO-THE NEAREST 0.1MG USING A CAHN GRAM ELECTROBALANCE A-ND DUST CONCENTRATIONS REPORTED AS MG/M3.

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: WOLLASTONITE (fibers greater than 5um in length)
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL DUST /FIBER SIZE OPT.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
0101	17	0018	06/16/76	0820	0916	95,2000	0,221	FB/CC	DRILLING ON FIRST LEVEL
TIME WEIGHTED AVE.= 0,221									
0102	16	0013	06/16/76	0856	0933	62,9000	0,383	FB/CC	LOADING ORE ON LEVEL 4
TIME WEIGHTED AVE.= 0,383									
0103	19	0023	06/14/76	0828	0902	57,8000	0,208	FB/CC	SCALING ON THIRD LEVEL
TIME WEIGHTED AVE.= 0,208									
0202	24	0008	06/14/76	1644	1715	52,7000	0,777	FB/CC	AT CRUSHER
TIME WEIGHTED AVE.= 0,777									
0204	21	0001	06/14/76	1650	1718	47,6000	19,986	FB/CC	OPERATING BENEFICIATING EQUIPMENT,
TIME WEIGHTED AVE.= 19,986									
0206	25	0010	06/14/76	1648	1718	51,0000	47,697	FB/CC	BAGGING F-1
TIME WEIGHTED AVE.= 47,697									
0207	22	0002	06/14/76	1655	1747	88,4000	56,942	FB/CC	LOADING BOX CAR
TIME WEIGHTED AVE.= 56,942									
0207	23	0003	06/14/76	1652	1745	90,1000	0,454	FB/CC	NEAR F-1 BAGGING, NOT BAGGING AT TIME OF SAMPLE
0207	23	0015	06/14/76	1723	1733	17,0000	47,461	FB/CC	BAGGING F-1
0207	23	0020	06/14/76	1753	1809	27,2000	15,725	FB/CC	BAGGING F-1
TIME WEIGHTED AVE.= 9,942									
0207	25	0019	06/14/76	1656	1748	8[illegible],4000	12,124	FB/CC	LOADING TRAILER TRUCK
0207	28	0020	06/14/76	1733	1805	54,4000	80,134	FB/CC	BAGGING F-1
TIME WEIGHTED AVE.= 38,033									
0213	12	0004	06/16/76	1025	1150	144,5000	14,534	FB/CC	

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: WOLLASTONITE (fibers greater than 5μm in length)
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL DUST /FIBER SIZE OPT.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME LITERS	CONC.	UNITS	
									LEVEL ABOVE MAGNETIC SEPARATORS
0213	10	0012	06/16/76	1034	1152	132,6000	17,255	FB/CC	BELOW SEPARATORS NEAR BAGGING STATION
0213	10	0017	06/16/76	1022	1148	146,2000	15,979	FB/CC	SAMPLE COLLECTED NEXT TO DRYER, FIRST FLOOR

TIME WEIGHTED AVE.= 15,617

TABLE 4. STATISTICS

AGENT: WOLLASTONITE (fibers greater than 5um in length)
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL DUST /FIBER SIZE OPT.

JOB CODE	NO. OF SAMPLES	RANGE FB/CC (HI-LOW)	MEAN FB/CC	MEDIAN FB/CC	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0101	001	000,221-000,221	0,221	0,221	0,221	0,000	0,000	DRILLER
0102	001	000,383-000,383	0,383	0,383	0,383	0,000	0,000	LOADER
0103	001	000,208-000,208	0,208	0,208	0,208	0,000	0,000	UTILITY MAN
AREA 01	003	000,383-000.208	0,271	0,221		0,097	0,056	
0202	001	000,777-000,777	0,777	0,777	0,777	0,000	0,000	TRUCKER CRUSHERMAN
0204	001	019,986-019,986	19,986	19,986	19,986	0,000	0,000	BENEFICIATOR MILLER-HELPER
0206	001	047,697-047,697	47,697	47,697	47,697	0,000	0,000	F-1 MILLER
0207	006	080,134-000.454	35,140	30.593	31,972	31,123	12,706	PACKER
0213	003	017,255-014,334	15,856	15,979	15,817	1,464	0,845	STATIONARY GENERAL AREA SAMPLES
AREA 02	012	080,134-000,454	27,239	16,617		24,830	7,168	
PLANT TOTAL	015	080,134-000,208	21,845	14,334		24,680	6,372	

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: WOLLASTONITE
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /GRAVIMETRIC

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS	
0101	10	019	06/15/76	0916	1435	0,5422	0,332	MG/M3	IN SPUR LEVEL OF MINE
TIME WEIGHTED AVE.= 0,332									
0102	10	025	06/15/76	0846	1435	0,5932	2,714	MG/M3	LOADING TRUCK FIRST MINE LEVEL
TIME WEIGHTED AVE.= 2,714									
0205	11	020	06/16/76	0846	1456	0,6289	7,250	MG/M3	NEAR DRYER
TIME WEIGHTED AVE.= 7,250									
0206	10	017	06/15/76	0734	1452	0,7445	2,887	MG/M3	
TIME WEIGHTED AVE.= 2,887									
0207	10	023	06/16/76	0745	1454	0,7292	9,818	MG/M3	BAGGING P=4
TIME WEIGHTED AVE.= 9,818									
0209	10	016	06/16/76	0743	1454	0,7326	2,893	MG/M3	MOVING BAGS HELPING PACKER
0209	10	022	06/16/76	0723	1447	0,7547	6,333	MG/M3	BAGGING F=1
TIME WEIGHTED AVE.= 4,639									
0211	10	018	06/16/76	0720	1450	0,7649	16,092	MG/M3	WORKING AROUND MILLING OPERATIONS
TIME WEIGHTED AVE.= 16,092									
0213	12	013	06/16/76	0852	1500	0,6255	22,714	MG/M3	NEXT TO MILLS SAMPLED WITH NO, 15
TIME WEIGHTED AVE.= 22,714									
0213	13	024	06/16/76	0906	1510	0,6187	21,105	MG/M3	NEXT TO P=4 BAGGING OPERATION SAMPLED WITH NO,8
TIME WEIGHTED AVE.= 21,105									
0213	14	014	06/16/76	0910	1510	0,6119	8,301	MG/M3	NEXT TO F=1 BAGGING OPERATION
TIME WEIGHTED AVE.= 8,301									
0213	15	026	06/16/76	916	1510	0,6017	13,177	MG/M3	STATIONARY NEXT TO F=1 BAGGING BELOW SEPARATORS
TIME WEIGHTED AVE.= 13,177									

TABLE 4. STATISTICS

AGENT: WOLLASTONITE
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /GRAVIMETRIC

JOB CODE	NO. OF SAMPLES	RANGE MG/M3 (HI-LOW)	MEAN MG/M3	MEDIAN MG/M3	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0101	001	000,332-000,332	0,332	0,332	0,332	0,000	0,000	DRILLER
0102	001	002,714-002,714	2,714	2,714	2,714	0,000	0,000	LOADER
AREA 01	002	002,714-000,332	1,523	1,523		1,684	1,191	
0205	001	007,250-007,250	7,250	7,250	7,250	0.000	0,000	MILLER
0206	001	002,887-002,887	2,887	2,887	2,887	0,000	0,000	F-1 MILLER
0207	001	009,818-009,818	9,818	9,818	9,818	0.000	0,000	PACKER
0209	002	006,333-002,893	4,613	4,613	4,639	2,432	1,720	LABORER
0211	001	016,092-016,092	16,092	16,092	16,092	0.000	0,000	MAINTENANCE
0213	004	022,714-008,301	16,324	17,141	16,366	6,781	3,391	STATIONARY GENERAL AREA SAMPLES
AREA 02	010	022,714-002,887	11,057	9,060		7,040	2,226	
PLANT TOTAL	012	022,714-000,332	9,468	7,776		7,388	2,133	

TABLE 3, INDIVIDUAL SAMPLE RESULTS

AGENT: WOLLASTONITE
SAMPLE METHOD/ANALYTICAL TECHNIQUE: RESPIRABLE MASS/GRAVIMETRIC

JOB CODE	SHIFT MAN NO,	SAMPLE NO,	DATE	TIME ON	TIME OFF	VOLUME M3	CONC,	UNITS	
0101	10	002	06/15/76	0830	1435	0,6204	0,306	MG/M3	CHARGING NEAR DRILLER
0101	10	021	06/15/76	0855	1435	0,5779	0,519	MG/M3	DRILLING THIRD LEVEL
TIME WEIGHTED AVE,= 0,409									
0202	10	007	06/16/76	0720	1450	0,7649	1,346	MG/M3	
TIME WEIGHTED AVE,= 1,346									
0203	10	012	06/15/76	0710	1444	0,7717	1,555	MG/M3	NEXT TO CRUSHER
TIME WEIGHTED AVE,= 1,555									
0204	10	006	06/16/76	0736	1443	0,7258	1,488	MG/M3	NEAR CRUSHER
TIME WEIGHTED AVE,= 1,488									
0206	1B	011	06/16/76	0734	1452	0,7445	0,618	MG/M3	AROUND F-1 MILL
TIME WEIGHTED AVE,= 0,618									
0207	10	001	06/16/76	0740	1454	0,7377	1,545	MG/M3	LOADING BOX CAR
TIME WEIGHTED AVE,= 1,545									
0209	1A	005	06/16/76	0723	1447	0,7547	2,120	MG/M3	BAGGING F-1
TIME WEIGHTED AVE,= 2,120									
0211	10	003	06/16/76	0719	1448	0,7632	1,808	MG/M3	ALL AROUND MILL
0211	10	004	06/16/76	0717	1449	0,7683	1,835	MG/M3	ALL OVER MILL
TIME WEIGHTED AVE,= 1,822									
0213	11	009	06/16/76	0846	1456	0,6289	1,415	MG/M3	NEXT TO DRYER SAMPLED WITH NO,15
TIME WEIGHTED AVE,= 1,415									
0213	12	010	06/16/76	0852	1500	0,6255	8,504	MG/M3	NEXT TO MILLS SAMPLED WITH NO, 13
TIME WEIGHTED AVE,= 8,504									

TABLE 4. STATISTICS

AGENT: WOLLASTONITE
SAMPLE METHOD/ANALYTICAL TECHNIQUE: RESPIRABLE MASS/GRAVIMETRIC

JOB CODE	NO. OF SAMPLES	RANGE MG/M3 (HI-LOW)	MEAN MG/M3	MEDIAN MG/M3	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0101	002	000,519-000,306	0,413	0,413	0,409	0,151	0,106	DRILLER
AREA 01	002	000,519-000,306	0,413	0,413		0,151	0,106	
0202	001	001,346-001,346	1,346	1,346	1,346	0,000	0,000	TRUCKER CRUSHERMAN
0203	001	001,555-001,555	1,555	1,555	1,555	0,000	0,000	BENEFICIATOR
0204	001	001,488-001,488	1,488	1,488	1,488	0,000	0,000	BENEFICIATOR MILLER-HELPER
0206	001	000,618-000,618	0,618	0,618	0,618	0,000	0,000	F-1 MILLER
0207	001	001,545-001,545	1,545	1,545	1,545	0,000	0,000	PACKER
0209	001	002,120-002,120	2,120	2,120	2,120	0,000	0,000	LABORER
0211	002	001,835-001,808	1,822	1,822	1,822	0,019	0,013	MAINTENANCE
0213	002	008,504-001,415	4,960	4,960	4,950	5,013	3,544	STATIONARY GENERAL AREA SAMPLES
AREA 02	010	008,504-000,618	2,223	1,550		2,242	0,709	
PLANT TOTAL	012	008,504-000,306	1,922	1,517		2,147	0,620	

END OF REPORT

TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
SILICA	TOTAL MASS	X-RAY DIFFRACT.	TOTAL MASS SAMPLES ARE COLLECTED ON MSA POLYVINYL CHLORIDE FILTERS (5.0 UM PORE SIZE) 37MM DIAMETER WITH A FLOW RATE OF 1.7 LITERS PER MINUTE. FILTERS ARE WEIGHED TO THE NEAREST 0.1 MG USING A CAHN GRAM ELECTROBALANCE. FREE SILICA DETERMINATIONS ARE MADE USING QUANTITATIVE X-RAY DIFFRACTION WITH SILICA CONCENTRATIONS REPORTED AS MG/M3.
SILICA	RESPIRABLE MASS	X-RAY DIFFRACT.	RESPIRABLE MASS SAMPLES ARE COLLECTED ON MSA POLYVINYL CHLORIDE FILTERS (5.0 UM PORE SIZE) 37MM DIAMETER WITH A FLOW RATE OF 1.7 LITERS PER MINUTE. NYLON CYCLONES (10MM) ARE USED FOR SIZE SEPARATION. FILTERS ARE WEIGHED TO THE NEAREST 0.1MG USING A CAHN GRAM ELECTROBALANCE. FREE SILICA DETERMINATIONS ARE MADE USING QUANTITATIVE X-RAY DIFFRACTION WITH SILICA CONCENTRATIONS REPORTED AS MG/M3.

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: SILICA
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /X-RAY DIFFRACT.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS	FREE SILICA (SiO_2) ANALYSIS
0101	10	019	06/15/76	0916	1435	0.5422	<0.018	MG/M3	<.01 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0.018									
0102	10	025	06/15/76	0846	1435	0.5932	<0.017	MG/M3	<.01 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0.017									
0205	11	020	06/16/76	0846	1456	0.6289	<0.079	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0.079									
0206	18	017	06/16/76	0734	1452	0.7445	<0.067	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0.067									
0207	10	016	06/16/76	0743	1454	0.7326	<0.068	MG/M3*	<.05 SiO_2 mg/filter
0207	10	023	06/16/76	0745	1454	0.7292	<0.069	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0.068									
0209	14	022	06/16/76	0723	1447	0.7547	<0.066	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0.066									
0211	13	018	06/16/76	0906	1510	0.6187	0.162	MG/M3*	.1 SiO_2 mg/filter
TIME WEIGHTED AVE.= 0.162									
0213	12	013	06/16/76	0852	1500	0.6255	<0.799	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0.799									
0213	14	014	06/16/76	0910	1510	0.6119	<0.082	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0.082									
0213	15	026	06/16/76	0916	1510	0.6017	0.166	MG/M3*	.1 SiO_2 mg/filter
TIME WEIGHTED AVE.= 0.166									

NOTE: (*) Indicates interference at primary peak forced use of secondary peak for determination.

TABLE 4, STATISTICS

AGENT: SILICA
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /X-RAY DIFFRACT,

JOB CODE	NO, OF SAMPLES	RANGE MG/M3 (HI-LOW)	MEAN MG/M3	MEDIAN MG/M3	T,W, AVE,	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0101	001	000,018-000,018	0,018	0,018	<0,018	0,000	0,000	DRILLER
0102	001	000,017-000,017	0,017	0,017	<0,017	0,000	0,000	LOADER
AREA 01	002	000,018-000,017	0,018	0,018		0,000	0,000	
0205	001	000,079-000,079	0,079	0,079	< 0,079	0,000	0,000	MILLER
0206	001	000,067-000,067	0,067	0,067	< 0,067	0,000	0,000	F-1 MILLER
0207	002	000,069-000,068	0,069	0,069	< 0,068	0,000	0,000	PACKER
0209	001	000,066-000,066	0,066	0,066	<0,066	0,000	0,000	LABORER
0211	001	000,162-000,162	0,162	0,162	0,162	0,000	0,000	MAINTENANCE
0213	003	000,799-000,082	0,349	0,166	<0,353	0,392	0,226	STATIONARY GENERAL AREA SAMPLES
AREA 02	009	000,799-000,066	0,173	0,079		0,238	0,079	
PLANT TOTAL	011	000,799-000,017	0,145	0,069		0,222	0,067	

TABLE 3. I-DIVIDUAL SAMPLE RESULTS

AGENT: SILICA
SAMPLE METHOD/ANALYTICAL TECHNIQUE: RESPIRABLE MASS/X-RAY DIFFRACT.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS	FREE SILICA (SiO_2) ANALYSIS
0101	10	002	06/15/76	0850	1435	0,6274	<0,016	MG/M3	<.01 SiO_2 mg/filter
0101	10	021	06/15/76	0855	1435	0,5779	<0,017	MG/M3	<.01 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0,016									
0102	10	003	06/16/76	0719	1448	0,7632	<0,066	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0,066									
0202	10	007	06/16/76	0720	1450	0,7609	0,131	MG/M3*	.1 SiO_2 mg/filter
TIME WEIGHTED AVE.= 0,131									
0203	10	012	06/15/76	0710	1444	0,7717	<0,065	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0,065									
0204	10	006	06/16/76	0736	1443	0,7258	<0,069	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0,069									
0206	18	011	06/16/76	0734	1452	0,7445	<0,013	MG/M3	<.01 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0,013									
0207	10	001	06/16/76	0740	1454	0,7377	<0,068	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0,068									
0209	1A	005	06/16/76	0723	1447	0,7547	<0,013	MG/M3	<.01 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0,013									
0211	10	004	06/16/76	0717	1449	0,7683	<0,065	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0,065									
0213	11	009	06/16/76	0846	1456	0,6289	<0,079	MG/M3*	<.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= <0,079									
0213	12	010	06/16/76	0852	1500	0,6255	0,080	MG/M3	.05 SiO_2 mg/filter
TIME WEIGHTED AVE.= 0,080									

NOTE: (*) Indicates interference at primary peak forced use of secondary peak for determination.

TABLE 4. STATISTICS

AGENT: SILICA
SAMPLE METHOD/ANALYTICAL TECHNIQUE: RESPIRABLE MASS/X-RAY DIFFRACT.

JOB CODE	NO. OF SAMPLES	RANGE MG/M3 (HI-LOW)	MEAN MG/M3	MEDIAN MG/M3	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0101	002	000,017-000,016	0,017	0,017	<0,016	0,000	0,000	DRILLER
0102	001	000,066-000,066	0,066	0,066	<0,066	0,000	0,000	LOADER
AREA 01	003	000,066-000,016	0,033	0,017		0,029	0,016	
0202	001	000,131-000,131	0,131	0,131	0,131	0,000	0,000	TRUCKER CRUSHERMAN
0203	001	000,065-000,065	0,065	0,065	<0,065	0,000	0,000	BENEFICIATION
0204	001	000,069-000,069	0,069	0,069	<0,069	0,000	0,000	BENEFICIATOR MILLER-HELPER
0206	001	000,013-000,013	0,013	0,013	<0,013	0,000	0,000	F-1 MILLER
0207	001	000,068-000,068	0,068	0,068	<0,068	0,000	0,000	PACKER
0209	001	000,013-000,013	0,013	0,013	<0,013	0,000	0,000	LABORER
0211	001	000,065-000,065	0,065	0,065	<0,065	0,000	0,000	MAINTENANCE
0213	002	000,080-000,079	0,080	0,080	<0,079	0,000	0,000	STATIONARY GENERAL AREA SAMPLES
AREA 02	009	000,131-000,013	0,065	0,068		0,036	0,012	
PLANT TOTAL	012	000,131-000,013	0,057	0,066		0,036	0,010	

END OF REPORT

TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
CADMIUM	TOTAL MASS	ATOMIC ABSORP.	TOTAL MASS SAMPLES ARE COLLECTED ON AA MILLIPORE FILTERS (0.8UM PORE SIZE) 37MM DIAMETER WITH A FLOW RATE OF 1.7 LITERS PER MINUTE. FILTERS ARE PRE AND POST-DESICATED AND WEIGHED TO THE NEAREST 0.1MG USING A CAHN GRAM ELECTROBALANCE. TRACE METAL DETERMINATIONS ARE MADE BY ATOMIC ABSORPTION WITH CONCENTRATIONS REPORTED AS UG/M3.

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: CADMIUM
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS	
0213	12	AA5	06/16/76	852	1500	0.6255	0.080	UG/M3	LESS THAN THE REPORTED CONCENTRATION
TIME WEIGHTED AVE.= 0.080									
0213	13	AA6	06/16/76	906	1510	0.6187	0.081	UG/M3	LESS THAN THE REPORTED CONCENTRATION
TIME WEIGHTED AVE.= 0.081									
0213	14	AA1	06/16/76	910	1510	0.6119	0.082	UG/M3	LESS THAN THE REPORTED CONCENTRATION
TIME WEIGHTED AVE.= 0.082									
0213	15	AA2	06/16/76	916	1510	0.6017	0.083	UG/M3	LESS THAN THE REPORTED CONCENTRATION
TIME WEIGHTED AVE.= 0.083									

TABLE 4, STATISTICS

AGENT: CADMIUM
SAMPLE MET-OD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	NO. OF SAMPLES	RANGE µG/M3 (HI-LOW)	MEAN µG/M3	MEDIAN µG/M3	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0213	004	000.083-000.080	0.082	0.082	0.081	0.001	0.000	STATIONARY GENERAL AREA SAMPLES
AREA 02	004	000.083-000.080	0.082	0.082		0.001	0.000	
PLANT TOTAL	004	000.083-000.080	0.082	0.082		0.001	0.000	

END OF REPORT

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TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
CHROMIUM	TOTAL MASS	ATOMIC ABSORP.	TOTAL MASS SAMPLES ARE COLLECTED ON AA MILLIPORE FILTERS (0.8UM PORE SIZE) 37MM DIAMETER WITH A FLOW RATE OF 1.7 LITERS PER MINUTE. FILTERS ARE PRE AND POST-DESICATED AND WEIGHED TO THE NEAREST 0.1MG USING A CAHN GRAM ELECTROBALANCE. TRACE METAL DETERMINATIONS ARE MADE BY ATOMIC ABSORPTION WITH CONCENTRATIONS REPORTED AS UG/M3.

TABLE 4, INDIVIDUAL SAMPLE RESULTS

AGENT: CHROMIUM
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS
0213	12	AA5	06/16/76	852	1500	0.6255	0.320	UG/M3
TIME WEIGHTED AVE.= 0.320								
0213	13	AA6	06/16/76	906	1510	0.6187	0.323	UG/M3
TIME WEIGHTED AVE.= 0.323								
0213	14	AA1	06/16/76	910	1510	0.6119	0.327	UG/M3
TIME WEIGHTED AVE.= 0.327								
0213	15	AA2	06/16/76	916	1510	0.6017	0.332	UG/M3
TIME WEIGHTED AVE.= 0.332								

TABLE 4, STATISTICS

AGENT: CHROMIUM
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	NO. OF SAMPLES	RANGE µG/M3 (HI-LOW)	MEAN µG/M3	MEDIAN µG/M3	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0213	004	000.332-000.320	0.326	0.325	0.325	0.005	0.002	STATIONARY GENERAL AREA SAMPLES
AREA								
02	004	000.332-000.320	0.326	0.325.		0.005	0.002	
PLANT TOTAL								
	004	000.332-000.320	0.326	0.325		0.005	0.002	

END OF REPORT

TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
COBALT	TOTAL MASS	ATOMIC ABSORP.	TOTAL MASS SAMPLES ARE COLLECTED ON AA MILLIPORE FILTERS (0.8UM PORE SIZE) 37MM DIAMETER WITH A FLOW RATE OF 1.7 LITERS PER MINUTE. FILTERS ARE PRE AND POST-DESICATED AND WEIGHED TO THE NEAREST 0.1MG USING A CAHN GRAM ELECTROBALANCE. TRACE METAL DETERMINATIONS ARE MADE BY ATOMIC ABSORPTION WITH CONCENTRATIONS REPORTED AS UG/M3.

TABLE 3, INDIVIDUAL SAMPLE RESULTS

AGENT: COBALT
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS	
0213	12	AA5	06/16/76	852	1500	0.6255	0.160	µG/M3	LESS THAN THE REPORTED CONCENTRATION
TIME WEIGHTED AVE.= 0.160									
0213	13	AA6	06/16/76	906	1510	0.6187	0.162	µG/M3	LESS THAN THE REPORTED CONCENTRATION
TIME WEIGHTED AVE.= 0.162									
0213	14	AA1	06/16/76	910	1510	0.6119	0.163	µG/M3	LESS THAN THE REPORTED CONCENTRATION
TIME WEIGHTED AVE.= 0.163									
0213	15	AA2	06/16/76	916	1510	0.6017	0.166	µG/M3	
TIME WEIGHTED AVE.= 0.166									

TABLE 4. STATISTICS

AGENT: COBALT
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	NO. OF SAMPLES	RANGE µG/M3 (HI-LOW)	MEAN µG/M3	MEDIAN µG/M3	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0213	004	000.166-000.160	0.163	0.163	0.163	0.002	0.001	STATIONARY GENERAL AREA SAMPLES
AREA 02	004	000.166-000.160	0.163	0.163		0.002	0.001	
PLANT TOTAL	004	000.166-000.160	0.163	0.163		0.002	0.001	

END OF REPORT

TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
IRON	TOTAL MASS	ATOMIC ABSORP.	TOTAL MASS SAMPLES ARE COLLECTED ON AA MILLIPORE FILTERS (0.8UM PORE SIZE) 37MM DIAMETER WITH A FLOW RATE OF 1.7 LITERS PER MINUTE. FILTERS ARE PRE AND POST-DESICATED AND WEIGHED TO THE NEAREST 0.1MG USING A CAHN GRAM ELECTROBALANCE. TRACE METAL DETERMINATIONS ARE MADE BY ATOMIC ABSORPTION WITH CONCENTRATIONS REPORTED AS UG/M3.

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: IRON
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS
0213	12	AA5	06/16/76	852	1500	0.6255	100.384	UG/M3
TIME WEIGHTED AVE.=100.384								
0213	13	AA6	06/16/76	906	1510	0.6187	76.115	UG/M3
TIME WEIGHTED AVE.= 76.115								
0213	14	AA1	06/16/76	910	1510	0.6119	34.641	UG/M3
TIME WEIGHTED AVE.= 34.641								
0213	15	AA2	06/16/76	916	1510	0.6017	61.482	UG/M3
TIME WEIGHTED AVE.= 61.482								

TABLE 4. STATISTICS

AGENT: IRON
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	NO. OF SAMPLES	RANGE µG/M3 (HI-LOW)	MEAN µG/M3	MEDIAN µG/M3	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0213	004	100,384-034,641	68,156	68,799	68,364	27,506	13,753	STATIONARY GENERAL AREA SAMPLES
AREA 02	004	100,384-034,641	68,156	68,799		27,506	13,753	
PLANT TOTAL	004	100,384-034,641	68,156	68,799		27,506	13,753	

END OF REPORT

TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
MANGANESE	TOTAL MASS	ATOMIC ABSORP.	TOTAL MASS SAMPLES ARE COLLECTED ON AA MILLIPORE FIL-TERS (0.8UM PORE SIZE) 37MM DIAMETER WITH A FLOW RAT-E OF 1.7 LITERS PER MINUTE. FILTERS ARE PRE AND POST-DESICATED AND WEIGHED TO THE NEAREST 0.1MG USING A C-AHN GRAM ELECTROBALANCE. TRACE METAL DETERMINATIONS ARE MADE BY ATOMIC ABSORPTION WITH CONCENTRATIONS RE-PORTED AS UG/M3.

TABLE 3, INDIVIDUAL SAMPLE RESULTS

AGENT: MANGANESE
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS
0213	12	AA5	06/16/76	852	1500	0.6255	12.628	µG/M3
TIME WEIGHTED AVE.= 12.628								
0213	13	AA6	06/16/76	906	1510	0.6187	17.130	µG/M3
TIME WEIGHTED AVE.= 17.130								
0213	14	AA1	06/16/76	910	1510	0.6119	5.719	µG/M3
TIME WEIGHTED AVE.= 5.719								
0213	15	AA2	06/16/76	916	1510	0.6017	7.644	µG/M3
TIME WEIGHTED AVE.= 7.644								

TABLE 4. STATISTICS

AGENT: MANGANESE
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	NO. OF SAMPLES	RANGE µG/M3 (HI-LOW)	MEAN µG/M3	MEDIAN µG/M3	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0213	004	017.130-005.719	10.780	10.136	10.821	5.138	2.569	STATIONARY GENERAL AREA SAMPLES
AREA 02	004	017.130-005.719	10.780	10.136		5.138	2.569	
PLANT TOTAL	004	017.130-005.719	10.780	10.136		5.138	2.569	

END OF REPORT

TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
NICKEL	TOTAL MASS	ATOMIC ABSORP.	TOTAL MASS SAMPLES ARE COLLECTED ON AA MILLIPORE FIL- TERS (0.8UM PORE SIZE) 37MM DIAMETER WITH A FLOW RAT- E OF 1.7 LITERS PER MINUTE. FILTERS ARE PRE AND POST- DESICATED AND WEIGHED TO THE NEAREST 0.1MG USING A C- AHN GRAM ELECTROBALANCE. TRACE METAL DETERMINATIONS - ARE MADE BY ATOMIC ABSORPTION WITH CONCENTRATIONS RE- PORTED AS UG/M3.

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: NICKEL
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS
0213	12	AA5	06/16/76	852	1500	0.6255	0.927	UG/M3
TIME WEIGHTED AVE.= 0.927								
0213	13	AA6	06/16/76	906	1510	0.6187	0.129	UG/M3
TIME WEIGHTED AVE.= 0.129								
0213	14	AA1	06/16/76	910	1510	0.6119	0.245	UG/M3
TIME WEIGHTED AVE.= 0.245								
0213	15	AA2	06/16/76	916	1510	0.6017	0.166	UG/M3
TIME WEIGHTED AVE.= 0.166								

TABLE 4. STATISTICS

AGENT: NICKEL
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	NO. OF SAMPLES	RANGE UG/M3 (HI-LOW)	MEAN UG/M3	MEDIAN UG/M3	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0213	004	000.927-000.129	0.367	0.206	0.370	0.377	0.188	STATIONARY GENERAL AREA SAMPLES
AREA 02	004	000.927-000.129	0.367	0.206		0.377	0.188	
PLANT TOTAL	004	000.927-000.129	0.367	0.206		0.377	0.188	

END OF REPORT

TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
ZINC	TOTAL MASS	ATOMIC ABSORP.	TOTAL MASS SAMPLES ARE COLLECTED ON AA MILLIPORE FILTERS (0.8UM PORE SIZE) 37MM DIAMETER WITH A FLOW RATE OF 1.7 LITERS PER MINUTE. FILTERS ARE PRE AND POST-DESICATED AND WEIGHED TO THE NEAREST 0.1MG USING A CAHN GRAM ELECTROBALANCE. TRACE METAL DETERMINATIONS ARE MADE BY ATOMIC ABSORPTION WITH CONCENTRATIONS REPORTED AS UG/M3.

TABLE 3. INDIVIDUAL SAMPLE RESULTS

AGENT: ZINC
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP.

JOB CODE	SHIFT MAN NO.	SAMPLE NO.	DATE	TIME ON	TIME OFF	VOLUME M3	CONC.	UNITS
0213	12	AA5	06/16/76	852	1500	0.6255	1.119	UG/M3
TIME WEIGHTED AVE.= 1.119								
0213	13	AA6	06/16/76	906	1510	0.6187	1.131	UG/M3
TIME WEIGHTED AVE.= 1.131								
0213	14	AA1	06/16/76	910	1510	0.6119	1.307	UG/M3
TIME WEIGHTED AVE.= 1.307								
0213	15	AA2	06/16/76	916	1510	0.6017	0.665	UG/M3
TIME WEIGHTED AVE.= 0.665								

TABLE 4, STATISTICS

AGENT: ZINC
SAMPLE METHOD/ANALYTICAL TECHNIQUE: TOTAL MASS /ATOMIC ABSORP,

JOB CODE	NO. OF SAMPLES	RANGE UG/M3 (HI-LOW)	MEAN UG/M3	MEDIAN UG/M3	T.W. AVE.	STANDARD DEVIATION	STANDARD ERROR	JOB TITLE
0213	004	001,307-000,665	1,056	1,125	1,058	0,274	0,137	STATIONARY GENERAL AREA SAMPLES
AREA 02	004	001,307-000,665	1,056	1,125		0,274	0,137	
PLANT TOTAL	004	001,307-000,665	1,056	1,125		0,274	0,137	

END OF REPORT

INTERPACE CORPORATION

HILLSBORO NEW YORK

DATE OF STUDY: 06/14/76 - 06/16/76

AGENT STUDIED: CADMIUM

SIC CODE: COUNTY: ESSEX

SETTLED DUST SAMPLES ANALYZED FOR CADMIUM, NO. I-1 COLLECTED NEAR CRUSH
ER, NO. I-2 COLLECTED NEAR DRYER, NO.S I-3 AND I-4 COLLECTED NEAR F-1 BA
GGING OPERATION, NO. I-5 COLLECTED NEAR P-4 AND C-1 BAGGING OPERATION,
NO. I-6 COLLECTED ON TRUCK LOADING DOCK ALL HAD LESS THAN 3.0 PPM.

INTERPACE CORPORATION

HILLSBORO NEW YORK

DATE OF STUDY: 06/14/76 - 06/16/76

AGENT STUDIED: CHROMIUM

SIC CODE: COUNTY:ESSEX

SETTLED DUST SAMPLES ANALYZED FOR CHROMIUM. NO. I-1 COLLECTED NEAR CRUSHER 24.0 PPM, NO. I-2 COLLECTED NEAR DRYER 24.0 PPM, NO. I-3 COLLECTED NEAR F-1 BAGGING OPERATION 13.0 PPM, NO. I-4 COLLECTED NEAR F-1 BAGGING OPERATION 10.0 PPM, NO. I-5 COLLECTED NEAR P-4 AND C-1 BAGGING OPERATION 7.0 PPM, NO. I-6 COLLECTED ON TRUCK LOADING DOCK 15.0 PPM

INTERPACE CORPORATION

HILLSBORO NEW YORK

DATE OF STUDY: 06/14/76 - 06/16/76

AGENT STUDIED: COBALT

SIC CODE: COUNTY:ESSEX

SETTLED DUST SAMPLES ANALYZED FOR COBALT. NO. I-1 COLLECTED NEAR CRUSHE
R, NO. I-2 COLLECTED NEAR DRYER, NO.S I-3 AND I-4 COLLECTED NEAR F-1 BAG
GING OPERATION, NO. I-5 COLLECTED NEAR P-4 AND C-1 BAGGING OPERATION, NO
. I-6 COLLECTED ON TRUCK LOADING DOCK ALL HAD LESS THAN 10.0 PPM.

INTERPACE CORPORATION

WILLSBORO NEW YORK

DATE OF STUDY: 06/14/76 - 06/16/76

AGENT STUDIED: IRON

SIC CODE: COUNTY: ESSEX

SETTLED DUST SAMPLES ANALYZED FOR IRON. NO. I-1 COLLECTED NEAR CRUSHER 42500.0 PPM, NO. I-2 COLLECTED NEAR DRYER 54600.0 PPM, NO. I-3 COLLECTED NEAR F-1 BAGGING OPERATION 16200.0 PPM, NO. I-4 COLLECTED NEAR F-1 BAGGING 5070.0 PPM, NO. I-5 COLLECTED NEAR P-4 AND C-1 BAGGING OPERATION 5750.0 PPM, NO. I-6 COLLECTED ON TRUCK LOADING DOCK 7060.0 PPM.

INTERPACE CORPORATION

WILLSBORO NEW YORK

DATE OF STUDY: 06/14/76 - 06/16/76

AGENT STUDIED: MANGANESE

SIC CODE: COUNTY:ESSEX

SETTLED DUST SAMPLES ANALYZED FOR MANGANESE, NO. I-1 COLLECTED NEAR CRUSHER 1050.0 PPM, NO. I-2 COLLECTED NEAR DRYER 1070.0 PPM, NO. I-3 COLLECTED NEAR F-1 BAGGING OPERATION 983.0 PPM, NO. I-4 COLLECTED NEAR F-1 BAGGING OPERATION 932.0 PPM, NO. I-5 COLLECTED NEAR P-4 AND C-1 BAGGING OPERATION 930.0 PPM, NO. I-6 COLLECTED ON TRUCK LOADING DOCK 972.0 PPM

INTERPACE CORPORATION

WILLSBORO NEW YORK

DATE OF STUDY: 06/14/76 - 06/16/76

AGENT STUDIED: NICKEL

SIC CODE: COUNTY:ESSEX

SETTLED DUST SAMPLES ANALYZED FOR NICKEL. NO. I-1 COLLECTED NEAR CRUSHE
R, NO. I-2 COLLECTED NEAR DRYER, NO. I-3 AND I-4 COLLECTED NEAR F-1 BAG-
GING, NO. I-5 COLLECTED NEAR P-4 AND C-1 BAGGING OPERATION NO. I-6 COLL-
ECTED ON TRUCK LOADING DOCK. ALL SAMPLES LESS THAN 20.0 PPM.

INTERPACE CORPORATION

HILLSBORO NEW YORK

DATE OF STUDY: 06/14/76 - 06/16/76

AGENT STUDIED: ZINC

SIC CODE: COUNTY:ESSEX

SETTLED DUST SAMPLES ANALYZED FOR ZINC. NO. I-1 COLLECTED NEAR CRUSHER 31.0 PPM, NO. I-2 COLLECTED NEAR DRYER 23.0 PPM, NO. I-3 COLLECTED NEAR F-1 BAGGING OPERATION 42.0 PPM, NO. I-4 COLLECTED NEAR F-1 BAGGING OPERATION 4.5 PPM, NO. 1-5 COLLECTED NEAR P-4 AND C-1 BAGGING OPERATION 11.0 PPM, NO. I-6 COLLECTED ON LOADING DOCK 9.2 PPM.

INTERPACE CORPORATION

WILLSBORO NEW YORK

DATE OF STUDY: 06/14/76 - 06/16/76

AGENT STUDIED: SILICA

SIC CODE: VV73300 COUNTY: ESSEX

SETTLED DUST SAMPLES ANALYZED FOR FREE SILICA,SECONDARY QUARTZ PEAK USED ...SAMPLE NO. I-1 COLLECTED NEAR CRUSHER, NO. I-2 COLLECTEC NEAR DRYER, NO.S I-3 AND I-4 COLLECTED NEAR F-1 BAGGING OPERATION, NO. --5 COLLECTED NEAR P-4 AND C-1 BAGGING OPERATION, NO. I-6 COLLECTED ON TRUCK LOADING DOCK----ALL SAMPLES HAD LESS THAN TWO PERCENT.

TABLE 2. SAMPLING PROCEDURES

AGENT	SAMPLING METHOD	ANALYTICAL TECH.	
NOISE	GENERAL AREA	SOUND LEVEL DBA	SOUND LEVEL MEASUREMENTS ARE MADE ON THE DBA WEIGHTED SCALE. MEASUREMENTS ARE MADE USING A GENERAL RADIO - 1565A SOUND LEVEL METER NEAR THE WORK AREAS.

TABLE 3, INDIVIDUAL SAMPLE RESULTS

AGENT: NOISE
SAMPLE METHOD/ANALYTICAL TECHNIQUE: GENERAL AREA /SOUND LEVEL DBA

CODE	MAN NO.	SAMPLE NO.	DATE	TIME OF MEASUREMENT	NOISE LEVEL		UNITS
0101	10	001	06/15/76	1000	104,0000	0,000	DBA
0101	10	001	06/15/76	1000	104,0000	0,000	DBA
0101	10	002	06/15/76	1015	112,0000	0,000	DBA
0101	10	002	06/15/76	1015	112,0000	0,000	DBA
0202	10	008	06/15/76	915	98,0000	0,000	DBA
0202	10	008	06/15/76	915	98,0000	0,000	DBA
0202	10	008	06/15/76	915	98,0000	0,000	DBA
0207	10	006	06/15/76	0845	93,0000	0,000	DBA
0207	10	006	06/15/76	0845	93,0000	0,000	DBA
0207	10	006	06/15/76	0845	93,0000	0,000	DBA
0207	10	007	06/15/76	0900	89,0000	0,000	DBA
0207	10	007	06/15/76	0900	89,0000	0,000	DBA
0213	10	003	06/15/76	0810	92,0000	0,000	DBA
0213	10	003	06/15/76	0810	92,0000	0,000	DBA
0213	10	004	06/15/76	815	93,0000	0,000	DBA
0213	10	004	06/15/76	815	93,0000	0,000	DBA
0213	10	005	06/15/76	838	92,0000	0,000	DBA
0213	10	005	06/15/76	838	92,0000	0,000	DBA
0213	10	009	06/15/76	0920	92,0000	0,000	DBA
0213	10	009	06/15/76	0920	92,0000	0,000	DBA
0213	10	010	06/15/76	0925	87,0000	0,000	DBA
0213	10	010	06/15/76	0925	87,0000	0,000	DBA
0213	10	011	06/15/76	0930	78,0000	0,000	DBA
0213	10	011	06/15/76	0930	78,0000	0,000	DBA

* SAMPLE IS NONSIGNIFICANT

END OF REPORT