Industrial Hygiene Study of the Johns-Manville Mineral Wool Fiber Facility, Alexandria, Indiana

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lengths averaged 15.5 and 17.0 micrometers, respectively. TWA free silica concentrations ranged from 0.60 to 1.02 and 0.09 to 260mg/cu m in the panel area and in the tile area, respectively. The highest carbon-monoxide concentration was 94 parts per million (ppm). The TWA concentration for the 21 hour sampling period was 35.4ppm. Trace metals were below detectable concentrations, except zinc (7440666) which ranged from 3 to 10 micrograms per cubic meter. Noise levels ranged from 75 decibels (dB) on the A scale to 96dB on the C scale. The authors conclude that concentrations of total airborne dust in the panel and tile areas and free silica in the clay and paint mix areas are excessive. They recommend further sampling for carbon-monoxide in the cupola changing areas and medical surveillance of workers exposed to mineral fiber.

ABSTRACT

An industrial hygiene study was conducted at the Johns-Manville, Alexandria, Indiana mineral wool fiber facility during April 11-15, 1975. Air samples were collected to evaluate time-weighted-average personnel exposures to respirable fibers, total airborne dust, free silica, trace metals and carbon monoxide. Spot noise measurements were also made. Results showed time-weighted-average fiber exposure to range from 0.10 to 1.95 fibers/cc whereas time-weighted-average total airborne dust concentrations ranged from 0.85 to 28.55 mg/m^3 with the free silica content of this dust ranging from 3.8 to 15.6 percent by weight. Twenty four of 45 calculated time-weighted-average free silica exposure values (total dust basis) were in excess of present OSHA standard for free silica. Exposure to carbon monoxide and trace metals were found to be low. Most trace metal levels were below detection by atomic absorption spectroscopy.

Airborne fiber diameter and length data were analyzed by fitting data to assumed log-normal size distribution functions. Count median airborne fiber diameters were found to range from 1.7 to 2.7 μm and count median fiber lengths were found to range from 6.8 to 24.8 μm. Airborne fiber diameter and length distributions determined by transmission electron microscopy were found to be in good agreement with the optical size data.

Fiber diameter distributions and typical energy dispersive x-ray spectra for present and past fibers are presented and discussed in relation to past exposure levels. Recommendations for engineering and work practice improvements to reduce exposure levels also are made.

INTRODUCTION

As part of studies being conducted by the National Institute for Occupational Safety and Health (NIOSH) of health effects due to exposures to respirable fibers other than asbestos, retrospective mortality and industrial hygiene studies are being conducted at the Johns-Manville mineral wool fiber production facility in Alexandria, Indiana. During April 11-15, 1975, the industrial hygiene portion of this study was conducted by John Dement, Ralph Zumwalde, Ken Wallingford, Chuck Murphy and Ronald D. Dobbin.

During the industrial hygiene study, air samples were taken to evaluate worker exposures to respirable mineral wool fibers, total airborne particulate matter, free silica, trace metals, arsenic, and carbon monoxide. In addition, a limited number of sound level measurements were made. This report includes a description of the Alexandria, Indiana facility, plant medical, industrial hygiene and safety programs, air sampling and analysis methods, sample results and conclusions and recommendations for improvements.

DESCRIPTION OF THE FACILITY

First commercial production of mineral wool at this Alexandria, Indiana facility was begun by C.C. Hall in or about 1897[1] thus forming the Banner Rockwool Corporation. Banner Rockwool was bought by the Johns-Manville Corporation in 1929 and, at the time of the present study, this plant employed approximately 330 hourly and 58 salaried workers. These workers were organized by the United International Papermakers Union in 1941.

Acoustical ceiling boards and tiles are the only products presently produced at this facility with production being maintained on a four shift basis, 7 days per week. Production of acoustical products began in approximately 1967. All panel production is under one roof.

MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

Only first aid medical facilities are available within the Plant with supervisors administering the first aid. Pre-employment examinations including a chest x-ray, urinalysis and blood tests are given. Periodic examinations are offered to employees on a bi-annual basis; however, these are not required. Dr. Owen, a local physician, is retained as the Plant's medical consultant. Facilities at the Alexandria Clinic are also used.

All indsutrial hygiene at this plant is handled at the Corporate level. Since 1972, four dust surveys have been conducted by Johns-Manville. Results of these surveys are shown in Appendix III. These surveys were made using a variety of sampling methods including fiber counts, impinger counts and respirable mass sampling.

A full time safety director (Mr. Tolbert) is used at this facility. The safety program consists of monthly inspections made by a committee comprised of Company and Union personnel. During these inspections, appropriate pictures and records are made and Department heads are required to make corrections and report actions taken back to the committee. Monthly Departmental safety meetings, conducted by the foremen, are also held. Personal protective equipment presently used includes safety glasses in most production areas and hearing protection in the fiber forming and board planer areas. Dust respirators are furnished for those employees who desire them; however, during the present study only paint mixers were observed using respirators.

DESCRIPTION OF PLANT PROCESSES

Present Operations

Acoustical boards and panels are produced in this facility using slagwool, expanded perlite, newsprint, starch and clay binders as raw materials. A process flow diagram is shown in Figure 1.

Slagwool is produced by layer charging blast furnace and phosphate slags with metallurgical coke into cupolas. As might be expected, slag composition may vary. Typical analyses of the slag charge, as provided by the slag suppliers, are shown in Table 1. Fibers are formed by directing the molten slag onto rapidly revolving steel drums whereby centrifugal force causes the slag to be thrown from the drum forming primary fibers. These fibers are then met by rapidly moving air and blown into a fiber collection chamber. The fibers are next chopped to shorter lengths and shot (unfiberized slag) removed. The shot is conveyed to a settling pond on the Plant site. The fibers are conveyed to the "wool" storage bin for use in panel production.

Clay binders for the boards and panels are produced by hand batching. To the batch, clay and small amounts anti microbacteriasides (sodium pentachlorophenate and copper sulfate) are added and the binder pumped to a binder storage tank. Perlite, starch and newsprint used to make tiles are each held in separate storage tanks.

Acoustical panels are formed by first blending the various raw materials together to form a slurry. Panels are formed on a 12 ft. wide "fourdrinier" similar to those used to make paper. The slurry is spread uniformly onto a screen to a thickness of approximately one inch and water removed. After a substantial portion of the water has been removed by compressing the board, the board is cut to length using a water saw. The panels are then dried in a continuous flow dryer for a period of 4 to 4½ hours.

Following drying, the boards are cut to proper length and width automatically using multiple circular saws. Surfaces of the boards are then planed to smoothness and coated with a clay "smooth" coat in liquid suspension. This clay coat is hand mixed in a separate area of the plant using several types of clays and a surfactant. After coating with clay, the panels are again dried.

Following the clay coating operations, perforations are made in the boards using a punch press and fissure roller. Joining groves are then cut in the board using a rip saw and the boards spray painted in automated spray booths. This spray paint is hand mixed in the same area as the clay coat material. Raw materials used to make the spray paint are shown in Table 2. Some higher quality panels also may receive a clear plastic (polyethylene emulsion) overspray.

Following the paint spray operation, the paint is dried using a radiant heat dryer and the boards inspected and packaged.

Production of smaller tiles is done in a separate area of the plant. As shown in Figure 1, these tiles are produced from large panels which have completed the process through the rip saw operation. These panels are removed from the conveyor and taken to the tile area. Production methods are essentially the same as previously described above for large panels.

Past Operations

Mineral wool fibers presently being produced and used to make acoustical products are made from blast furnace and phosphate slags which are shipped to the plant. However, until the mid-1930's, limestone rock from the area was used as the fiber raw material. Also, in approximately 1950, fiber forming methods were changed from steam blowing to spinning. According to company personnel, fibers formed by the steam blowing process were of shorter length and of more variable diameter than those presently produced. Company personnel indicated that nominal fiber diameters presently range from 4.5 to 5.5 μm.

Prior to 1967, a number of mineral wool and other insulation products were produced at this plant. Unitl the mid-1950's, there were three main products these being mineral wool insulation blankets, granulated blowing wool insulation and an insulation material known as "rock cork." Granulated wool was simply shredded mineral blanket from which shot (unfiberized slag) was removed. This material was bagged by hand using shovels. According to company personnel, some general ventilation was provided in the bagging area. A small amount of water proofing material (wax, and zinc sterate) was applied to these products.

Rock cork was a wet cast, low temperature insulation formed by blending mineral wool with asphalt and newsprint. After casting, these blocks were dried in a tunnel dryer. Some bentonite clay was periodically used in this formulation although the quantity is unknown. After drying, these blocks were trimmed to proper size with the trimmings being blown into a room and used as a minor component in blowing wool.

During approximately 1946 to 1954, a cold storage insulation known as "zeolite block" was produced. This material was wet cast and contained a phenol-formaldehyde binder similar to binders which are presently used to make most fibrous glass blanket insulations.

During the early 1950's and until approximately 1966, a naturally fissured ceiling tile known as "Permacoustic" was produced at this Plant.

These tiles were made by mixing chopped mineral wool fibers with a cooked starch binder and clay followed by pan casting. The casts were then dried in a tunnel drier.

INSPECTION OF THE PLANT

Potential Exposures

The following are potential exposures which were noted during this study:

1) Respiratory and skin exposures to mineral wool fibers, free silica, metals and clay minerals in panel and board production areas

2) Exposures to carbon monoxide, metals and arsenic in cupola charge area

3) High noise exposures in selected areas of the plant

Housekeeping

Housekeeping in this facility appeared to be acceptable during this visit. Floors and machines are kept clean by frequently using both hand and brooms and vacuum sweeping.

One unacceptable procedure observed during this survey was hand shoveling broken panels into waste carts. This operation was visibly dusty. Respirators were only ocassionally noted being used.

Engineering Controls

Cupola emissions into the charge area are controlled by maintaining face velocities at the charge door in excess of 200 ft./min. as measured with an Alnor Velometer. Cupola emissions are controlled by a bag collector.

In the panel and tile production areas, all dust generation sources such as saws, planers, punch presses and fissure rollers are provided with local exhaust ventilation. Collected dust is vented to bag collectors. These controls were installed at the time acoustical tile production began. Capture velocities at several of these sources were measured using an Alnor Velometer and were found to range from 200 to 3500 ft./min. Hood designs are generally good.

At the binder and paint mix stations, local exhaust ventilation is provided at the hand mix stations by maintaining air flow through the tank entrance. This ventilation appeared to be unacceptable, as velocities at both mix tanks were barely measurable (< 20 ft./min.).

The major source of dust exposure in this facility is airborne dust caused by handling boards and tiles to which loose material, from sawing

etc., adheres. Although some board "dusting boxes" (where some of the dust is removed by high air velocities) are provided, their effectiveness appeared minimal.

SURVEY PROCEDURES

During this study, air samples were taken to evaluate worker exposures to mineral wool fibers, total airborne dust, free silica, trace metals (Cd, Cr, Co, Mn, Ni, Pb, Zn), arsenic and carbon monoxide. Bulk samples of the mineral fibers and associated raw materials were also collected to determine fiber diameter and free silica content. Sound level measurements were also made at selected Plant locations.

Trace Metals and Arsenic in Cupola Areas

Samples to determine trace metals and arsenic concentrations in the cupola charged area and fiber forming area were collected using a stationary sequential sampler. Millipore Type AA (0.8 μm average pore size) membrane filters were used at a calibrated flow rate of 2.0 lpm. All samples were collected over a period of two hours.

Trace metals (Cd, Cr, Co, Mn, Ni, Pb, Zn) and arsenic determinations were made by atomic absorption spectroscopy following digestion with nitric acid. In some cases, samples were combined for analysis to provide sufficient material for analysis.

Carbon Monoxide in Cupola Area

Samples for carbon monoxide exposures were taken in the cupola charge area using an "Ecolyzer" carbon monoxide sampler (0-100 ppm range) which had been calibrated immediately prior to use. Concentration measurements were continuously recorded over 21 hour periods using a strip chart recorder at a chart speed of 4.75 inches/min.

Mineral Wool Fibers, Total Airborne Dust, Free Silica and Trace Metals in Panel and Tile Production Area

Personal and general area samples were collected in the panel and tile production departments to evaluate exposures to respirable mineral wool fibers, total airborne dust, free silica and trace metals. Two samplers were placed on each worker or in each stationary sample location. One sample was used to evaluate exposures to total airborne dust, free silica and trace metals and the other used to evaluate respirable fiber exposures.

Total airborne dust was collected on MSA, polyvinyl chloride filters (5.0 μm pore size) mounted in 37 mm diameter, 3 piece Millipore sample holders. Samples were collected over periods ranging from 5 to 7 hours at a calibrated flow of 2.0 liters per minute. Filters were tared and re-weighed on a Cahn electrobalance and total airborne dust concentrations expressed as milligrams per cubic meter of air (mg/m^3).

For free silica and trace metals analyses, the samples for dust were grouped according to dust weight on the filters. Due to expected low metal concentrations, those samples with heaviest dust loadings were used for trace metals analyses with the remaining samples used for free silica determinations. Trace metals were determined by atomic absorption spectroscopy after digestion with nitric acid. Free silica determinations were made by the colorimetric method of Talvitie.

In addition to determinations of airborne free silica concentrations, samples of the major raw materials used to make panels and tiles also were collected for free silica determinations. These analyses were performed by the colorimetric method of Talvitie.

Personal and stationary samples were collected to evaluate exposures to respirable mineral wool fibers were collected on open faced, 37 mm diameter, Millipore Type AA (0.8 μm pore size) membrane filters at a calibrated flow rate of 2.0 liters per minute. Sample periods ranged for 30 minutes to apporximately 2 hours with filters being periodically changed such that representative portions of the work shift (5-7 hours) were sampled. These samples were analyzed by simultaneously counting fibers and determining their diameter and length using phase contrast optical microscopy at a magnification of 430X. At least 100 fibers of 100 microscopic fields were counted for each sample and fiber concentrations reported as fibers/cc. Samples were prepared for analysis using the direct clearing method used for asbestos.[2]

In addition to optical microscopic analyses, selected samples were also analyzed by transmission electron microscopy to determine airborne fiber diameter and length and chemical composition. These samples were prepared by the direct mounting technique as described by Fraser[3] using 200 mesh Formvar/carbon coated copper grids. Fiber diameter and length were determined at a magnification of 2000X by comparison with calibration marks engraved on the microscope viewing screen. Fiber chemical composition (semi-quantitative) was determined for selected fibers using energy dispersive x-ray analysis. Electron micrographs were made of typical fibers along with photographs of typical x-ray spectra. Scanning electron micrographs were also taken of selected fibers.

Bulk samples of the mineral fibers being produced during this study and fibers produced prior to 1940 (steam blow fibers) were also collected. Fiber diameter distributions were determined for these samples by sizing at least 300 randomly selected fibers using phase contrast microscopy. Trace metal levels were also determined for these samples using atomic absorption spectroscopy following a nitric acid digestion.

Free Silica Exposures in Binder and Paint Mix Areas

Exposures to respirable free silica in the binder and paint mixing areas were determined using 10 mm nylon cyclone pre-samplers followed by 37 mm diameter MSA polyvinyl chloride filters (5.0 μm pore size) operated at

1.7 liters per minute. Free silica determinations were made by the colorimetric method of Talvitie.

Sound Level Measurements

Sound level measurements were made in selected Plant areas using a General Radio 1565-A sound level meter calibrated with a Type 1562-A calibrator. Measurements were made using the "A", "B", and "C" weighting networks in order to obtain an indication of noise frequency.

SURVEY RESULTS AND DATA ANALYSIS

Raw Materials

The results of the optical microscopic fiber diameter analyses of the mineral wool fibers being produced during this survey and the old steam blown fibers are shown in Figure 2 and summary statistics shown in Table 3. The count median fiber diameters were determined to be 5.1 μm for fibers presently being produced and 3.6 μm for the old steam blown fiber. In addition to a smaller median diameter, the steam blown fiber also has much more variability in diameter as demonstrated by the larger geometric standard deviation.

Results of the free silica determinations for the mineral wool fibers and the clays used to make the panels and tiles are shown in Table 4. Both fibers and the koalin clay are seen to contain insignificant amounts of free silica. However, the clays used in the panel formations were found to contain 9.9 and 8.4% free silica, respectively.

The results of the trace metal determinations for the mineral wool fiber sample are shown in Table 5. All trace metals analyzed were extremely low with lead and chromium showing highest values of 44 and 30 ppm, respectively.

Trace Metals and Arsenic in Cupola Areas

Results of sequential samples for trace metals and arsenic in the cupola charge and fiber forming areas are shown in Table 6. All metals, except manganese and zinc, were below detectable levels by atomic absorption spectroscopy. Both manganese and zinc were present at levels of 3.3 $\mu g/m^3$ in the cupola charge area. Approximate lower detectable limits ($\mu g/m^3$) were calculated for each metal according to air volume sampled and are shown in Table 6.

Table 6 also shows arsenic levels in the cupola area to be below detectable levels by atomic absorption spectroscopy. Exposures to arsenic are below limits presently being recommended by NIOSH for this material.[4]

Carbon Monoxide in Cupola Area

Results of continuous carbon monoxide measurements in the cupola charge area are shown in Table 7. The strip chart output was used to determine approximate hourly average exposures along with hourly peak concentrations. Hourly average exposures were estimated by visually dividing areas on the strip chart. An example of the strip chart output demonstrating this estimation procedure is shown in Figure 3.

As was expected, carbon monoxide levels were highly variable with a peak level of approximately 94 ppm. The time weighted average concentration for the 21 hour sample period was 35.4 ppm with the single highest hourly average being 58 ppm.

Airborne Fiber and Total Airborne Dust Exposures in Panel and Tile Lines

Tables 8 and 9 show results of the airborne fiber and total airborne dust samples in the main panel and small panel (tile) areas, respectively. These tables show both individual sample results and calculated time-weighted-average (TWA) exposures for each area or worker sampled. A summary of these data is presented in Table 10.

In the main panel line, the highest fiber concentration observed in a single sample was 1.9 fibers/cc. This sample was collected on a feeder working on the special panel line. The highest time-weighted-average fiber concentration observed was 0.88 fibers/cc for a panel feeder. In the tile area, the highest fiber concentration observed in a single sample was 2.04 fibers/cc for a tile take-off operator with the highest time-weighted-average fiber exposure of 1.95 fibers/cc for this same operator. Mean time-weighted-average fiber exposures were 0.50 and 0.66 fibers/cc in the panel and tile production areas, respectively.

Time-weighted-average total airborne dust concentrations ranged from 0.85 to 14.72 mg/m^3 in main panel area and 1.03 to 28.55 mg/m^3 in the tile area. Twelve of 46 samples (24%) time-weighted-average exposures in these areas are in excess of 10 mg/m^3. In both areas, line feeders and panel take-off operators are seen to experience highest dust concentrations. Mean time-weighted-average total airborne dust concentrations were 4.58 and 8.18 mg/m^3 in the panel and tile production areas, respectively.

A correlation between total mass and fiber concentrations was attempted using linear regression. The results are shown in Figure 4. Although a considerable amount of scatter was noted, a correlation coefficient of 0.73 was obtained demonstrating a fair degree of association between the two methods of exposure measurement for this facility.

The airborne fiber diameter and length data were analyzed by fitting the data for diamter and length to log-normal size distributions by linear regression. The cumulative probability values were converted to probit values and the fiber size intervals converted to a linear scale by a logarithmic transformation.[5] Samples at the same location or worn by the same person were combined for these analyses. Linear regression correlation coefficients greater than 0.9 were obtained for all analyses indicating good fit to the assumed log-normal

distribution. Count median fiber size (diameter and length), geometric standard deviations and 95% confidence intervals for these values were calculated for each person or area sampled. These results are shown in Appendix II and summarized in Tables 11, 12 and 13.

In the main panel area, count median airborne fiber diameters were found to range from 1.7 to 2.4 µm with an average of 2.1 µm. Count median fiber lengths were found to range from 6.8 to 22.7 µm with an average of 15.5 µm. In the small tile area, count median fiber diameters were found to range from 1.7 to 2.7 µm and averaged 2.2 µm. Count median fiber lengths were found to range from 11.0 to 24.8 µm with an average of 17.0 µm.

The results electron microscopic determinations of airborne fiber diameters on selected samples are shown in Table 14 and compared with the results obtained by optical phase contrast microscopy. A count median fiber diameter of 1.91 µm was determined by electron microscopy compared to 2.15 µm by optical microscopy. The close agreement between these values indicates that essentially all airborne fibers are being counted by the phase contrast counting technique. By electron microscopy, less than 2% of the airborne fibers were smaller than 0.5 µm in diameter with the smallest fiber observed being approximately 0.3 µm in diameter. By electron microscopy, approximately 15% of the airborne fibers were less than 10 µm in length.

Figures 5 and 6 show electron micrographs and semi-quantitative x-ray spectra for typical airborne fibers. The major chemical components of these fibers are calcium and silicon with smaller amounts of potassium, magnesium and aluminum. A trace of sulfur was also noted in the small fiber indicated in Figure 3. Typical scanning electron microscopy of the airborne dusts are shown in Figure 7 demonstrating the presence of large quantities of non-fibrous material. Using energy dispersive x-ray analysis, most of the non-fibrous material was indentified as clay.

The relationship between airborne fiber size and fiber respirability is not well defined. Dement[6] has reviewed the available literature on this subject and has suggested that fibers less than 3.5 µm in diameter and less than 50 µm in length should be considered "potentially" respirable. The proportion of the airbonre fibers in this facility which satisfied these criteria were calculated for each area or person sampled and are shown in Tables 8 and 9 and summarized in Table 14. In the panel department 60.2 to 90.9% of the airborne fibers could be considered "potentially" respirable and in the tile department 59.8 to 92.6% of the fibers satisfied this criteria. The average percent of airborne fibers which were "potentially" respirable was 75.6 and 74.3% for the panel and tile areas, respectively.

Free Silica Exposures in Panel and Tile Areas

Samples for free silica analyses were chosen randomly from samples in the panel and tile areas. The results of the samples analyzed for these areas are shown in Table 15 and 16. The average percent free silica in the panel areas was 6.9% and in the tile area 9.1%. These average free silica values were used to calculate free silica concentrations for all total airborne

dust samples in these areas. Free silica concentrations for the panel and tile lines are shown in Tables 17 and 18, respectively and summarized in Table 19.

In the panel area, calculated time-weighted average (TWA) free silica exposures ranged from 0.60 to 1.02 mg/m^3 whereas exposures ranged from 0.09 to 2.60 mg/m^3 in the tile area. Mean TWAs were 0.30 and 0.74 mg/m^3 for the panel and tile areas, respectively. In the panel area, 38.9% of the TWA exposures were in excess of 0.30 mg/m^3 and in the tile area 66.7 percent of the TWA exposures exceeded this value.

Trace Metal Exposures in Panel and Tile Areas

Due to the observed low trace metal levels in the mineral wool fibers themselves, trace metal exposures in the panel and tile production areas were expected to be extremely low and possibly below detection by atomic absorption spectroscopy. Due to these considerations, only samples from the tile area were analyzed for trace metals as dust concentrations were higher in this area. Results of these analyses are shown in Table 16.

All trace metals except for zinc were below detectable levels. Lower detectable levels were calculated for each metal according to the volume of air sampled and are shown in Table 16. Zinc levels were found to range from 3 to 10 µg/m^3.

Free Silica Exposures in Binder and Paint Mixer Areas

Respirable free silica concentrations determined for paint mixing and spraying operations and binder mixing operations are shown in Table 21. Respirable free silica concentrations for paint mixing operators ranged from 0.07 to 0.33 mg/m^3 whereas stationary samples at the paint spray booths showed < 0.002 and 0.08 mg/m^3. The personal sample collected on a binder mixer showed a concentration of 0.23 mg/m^3.

Results of Sound Level Measurements

Results of sound level measurements in selected plant are shown in Table 22. Three plant areas were shown to have dBA levels in excess of 90; these being the fiber forming area, cupola rest area and the painting area in the tile department. Observation of the dBC values indicates the majority of the noise to be of low frequency. These sound level measurements, while indicative of possible high noise exposures, do not represent 8 hour exposure values.

DISCUSSION

Results of the present survey show time-weighted-average fiber exposures to range from 0.10 to 1.95 fibers/cc with an overall plant average of 0.59 fibers/cc. Approximately 75% of these fibers are potentially respirable. Time-weighted-average total airborne dust exposures ranged from 0.85 to 28.55 mg/m^3 with an overall plant average of 6.71 mg/m^3. Twelve of 46 (approximately 24%) time-weighted-average total dust exposures were in excess of 10 mg/m^3.[7]

In addition to excessive total dust exposures, free silica exposures (total airborne dusts) were also found to be excessive ranging from 0.06 to 2.60 mg/m^3 with an overall plant average of 0.56 mg/m^3. Twenty-five of 46 (approximately 55%) free silica exposures were in excess of allowable OSHA 8-hour-time-weighted-average value for free silica.[8] The major source for the excessive dust exposures observed in the tile and panel areas is dust adhering to the panel surfaces as a result of sawing and surface treatment operations. Exposures result from handling and treatment of these tiles and panels.

Analyses of the raw materials for free silica content indicates that the majority of the free silica exposure is due to high silica content of the clay minerals which are used as binders for the ceiling panels and tiles. Trace metal exposures in all areas sampled were extremely low and below present OSHA standards for each metal analyzed.

Respirable free silica exposures in the paint and binder mixing areas also were observed to exceed both the NIOSH proposed standard of .050 mg/m^3[9] and the present OSHA standard of 0.1 mg/m^3.[8]

Carbon monoxide concentrations in the cupola charge area averaged approximately 35 ppm for a 21 hour sample period; however, hourly average concentrations as high as 58 ppm were noted. As workers are not in the cupola charge area continuously, 8-hour-time-weighted-average carbon monoxide exposures are probably not in excess of the NIOSH recommended standard of 35 ppm.[10]

The extent to which dust and fiber exposures measured during this study are representative of past exposures is difficult to assess as only limited historic dust measurements are available. Analyses of the raw materials used to make the ceiling panels and tiles indicates that the clays used contain significant amounts of free silica (8-10%) and accounts for the excessive free silica exposures observed during the present study. As production of ceiling panels was started in 1967, significant free silica exposures would not be anticipated prior to that time.

Changes in fiber composition have also been made over the years and could conceivably effect exposures to trace metals and fiber physical properties such as solubility. A change in fiber composition probably occurred in the mid-1930's when the major fiber raw material was changed from limestone rock to metal slags. Carpenter and Spolyar[1] reported compositions of the various cupola charges at this plant during their medical study published in 1945. These data are shown in Table 23 and compared with recent slag analyses provide by the slag suppliers. With the

exception of higher iron content of lead slag reported in 1945, major components are essentially the same. A typical x-ray spectrum for the old steam blown fiber obtained using the present study is shown in Figure 8. This spectrum, although only semi-quantitative, is essentially the same as the spectra for fibers presently produced (Figures 5 and 6) except that silica content may be slightly higher.

Prior to 1972, the only dust concentrations available for this plant were reported by Carpenter and Spolyar[1] in 1945. These investigators reported that Greenburg-Smith impinger counts taken in 1934 showed concentrations ranging from 12 to 26 mppcf. Following this study, various control meausures reduced the dust concentrations to 5 to 10 mppcf.

A direct conversion from impinger concentrations to airborne fiber concentrations is not possible thus no direct relationship between present fiber levels and past levels is available. In addition to changes in control methods, several process changes have been made which could have affected fiber exposures. These are:

1. The method of fiber formation was changed from the steam blowing method to the rotary process in the mid-1930's. Fiber formed by the steam blowing method were more varied in diameter and probably shorter than fibers produced after that time possibly resulting in higher fiber exposures.

2. Various oils have been applied to the fibers in the past. Oils probably tended to reduce fiber exposures.

Available data would tend to support the conclusion that past fiber exposure may have been higher than those measured during the present study. NIOSH has conducted preliminary studies in a similar rock wool plant producing blowing wool and not using local exhaust ventilation for dust control. These results are summarized in Table 24. Fiber concentrations as high as 2.60 fibers/cc were observed with an average of 1.65 fibers/cc. These concentrations are 2-3 times the concentrations observed in the present study and may be indicative of potential past exposure levels in this plant.

Health effects of respiratory exposures to rock wool and slag wool have not been extensively studied. Most studies of mineral wool have been concerned with exposures to fibrous glass.[6] Carpenter and Spolyar reported the results of a chest x-ray study of employees of this plant in 1945.[1] Chest films of 84 production workers whose duration of employment varied from 7 to 36 years were read and these results compared with 90 office workers at the same plant. Although 43 of the 84 production workers showed exagerated linear markings, the authors concluded that the prevalance of these markings was not different from the non-exposed office workers.

Fairhall et.al.[11] reported the results of animal exposures to rock wool dusts. Eight cats were exposed to rock wool dust for 1 hour each day, 5 to 6 days per week for three months. Impinger counts taken in the dusting chamber showed concentrations up to 850 mppcf although the mean concentration was approximately 200 mppcf. The authors found fibers

in the small bronchi, bronchioles and alveolar ducts with much of the material contained in phagocytic cells. The authors concluded that only a foreign body reaction was observed. The lack of extended exposures and short period from exposure until sacrifice precludes any conclusions as to the carcinogenesis potential of these fibers.

Recently conducted experiments have shown that a number of fibrous minerals including fibrous glass produce mesotheliomas upon intrapleural and intropertoneal implantation or injection.[12,13,14,15,16] These authors have generally concluded that the carcinogenic effects of fibrous materials are related to physical rather than chemical properties.

CONCLUSIONS AND RECOMMENDATIONS

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

1. Exposures to total airborne dust are excessive in the panel and tile production areas. Although only total dust samples were taken, free silica exposures also appear excessive. The major source for this airborne dust appears to be material adhering to panel surfaces from sawing and surface treatment operations. "Dusting box" design should be examined and possibly redesigned for higher air velocities.

2. Free silica exposures appear to be excessive in the clay and paint mix area. The exhaust hood at the mix station should be redesigned such that a minimum velocity of 100 fpm is maintained at the tank entrance.

3. Further sampling for carbon monoxide exposures should be conducted in the cupola charging area and control velocities at the cupola charge port increased if exposures approach 35 ppm on an 8 hour basis.

4. Although no conclusive data exist to implicate slagwool as a health hazard, animal data suggest that hazards may be associated with such exposures; therefore, close medical surveillance of those involved in operations with fiber exposures appears warranted. It is recommended that a medical surveillance program be initiated in this facility similar to that outlined in the NIOSH Asbestos Criteria Document.[2]

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APPENDIX I

Tables and Figures

Tables

APPENDIX I

(Continued)

Figures

Table 1

Composition of Slag Used to Make
Mineral Wool Fibers, Johns-Manville
Alexandria, Indiana

Component	Composition, % By Weight	
	Blast Furnace 8/74	Phosphate 4/74
Silica (SiO_2) *	36.8	41.90
Aluminum Oxide (Al_2O_3)	9.5	7.00
Calcium Oxide (CaO)	39.0	46.45
Magnesium Oxide (MgO)	12.2	---
Manganese Oxide (MnO)	0.77	---
Sulfur (S)	1.49	0.20
Iron Oxide ($FeO\&Fe_2O_3$)	0.56	---
Potassium (P_2O_5)	---	1.21
Titanium Oxide (TiO_2)	0.52	---

* Indicates silicates

TABLE 2

Raw Materials Used to Make
Panel and Tile Spray Paints,
Johns-Manville, Alexandria, Indiana

1. Hydroxyethyl Cellulose
2. Tamol 731
3. Igepal CTA-639
4. Troysam CMP Acetate
5. Troukyd 33 (Defoamer)
6. Diatomatous Earth
7. Titanium Dioxide Pigments (Major Ingredient)
8. Hydrated Aluminum
9. Calcium Carbonate (Major Ingredient)
10. Water

Table 3

Summary of Fiber Diameter Distributions
For Basic Fibers, Johns-Manville,
Alexandria, Indiana

Measure	Present Fibers	Steam Blown Fibers
Count Median Fiber Diameter, μm	5.1	3.6
95% Conf. Interval for Median Fiber Diameter	4.9-5.3	3.4-3.8
Geometric Standard Deviations, σ_g	1.35	1.62
95% Conf. Interval for σ_g	1.31-1.39	1.55-1.70

Table 4

Results of Free SiO_2 Determinations for Basic Raw Materials Used to Make Acoustical Panels, Alexandria, Indiana

Raw Material	% Free SiO_2 By Weight
Mineral Wool Fiber (4/75)	0.06
Old Mineral Wool Fiber (Steam Blown)	0.08
Clay (M & D)	9.9
Clay #1	8.4
Kaolin	0.16

Table 5

Results of Trace Metals Analyses of Mineral Wool Fibers, Johns-Manville Alexandria, Indiana

Trace Metal	Concentration In Fiber, ppm
Be	<1
Cd	4
Co	23
Cr	30
Mn	2
Ni	28
Pb	44
Zn	<1

Table 6

Results of Airborne Trace Metals and Arsenic
Samples in Cupola Areas,
Johns-Manville, Alexandria, Indiana

Area Sampled	Total Hours Sampled	Concentration, (1) $\mu g/m^3$							
		Cd	Cr	Co	Mn	Ni	Pb	Zn	As
Cupola Charge Floor	10	<2	<1	<2	<1	<3	<2	2.5	<2
Cupola Charge Floor	10	<2	<1	<2	3.3	<3	<2	3.3	<2
Fiber Forming Area	12	<2	<1	<2	<1	<3	<2	0.1	<2

(1) Present OSHA 8 hour time-weighted exposure standards for these materials are:

Cd 0.2 mg/m^3, Cr 1 mg/m^3, Mn 5 mg/m^3, Ni 1 mg/m^3, Pb 0.2 mg/m^3, Zn 5 mg/m^3 and As 0.5 mg/m^3.

The NIOSH recommended standard for As is 2 $\mu g/m^3$.

Table 7

Summary of Carbon Monoxide Concentrations
In Cupola Charging Area, Johns-Manville,
Alexandria, Indiana

Sampling Period	Peak Exposure ppm	Hourly Average ppm
	April 11, 1975	
4:00 - 5:00 pm	40	27
5:00 - 6:00 pm	50	30
6:00 - 7:00 pm	68	38
7:00 - 8:00 pm	80	38
8:00 - 9:00 pm	52	24
9:00 - 10:00 pm	60	40
10:00 - 11:00 pm	84	50
11:00 - 12:00 pm	72	46
	April 12, 1976	
12:00 - 1:00 am	68	42
1:00 - 2:00 am	40	30
2:00 - 3:00 am	30	24
3:00 - 4:00 am	46	30
4:00 - 5:00 am	50	36
5:00 - 6:00 am	42	30
6:00 - 7:00 am	40	28
7:00 - 8:00 am	51	32
8:00 - 9:00 am	94	58
9:00 - 10:00 am	68	42
10:00 - 11:00 am	40	32
11:00 - 12:00 N	48	24
12:00 - 1:15 pm	90	42

Time Weighted Average = 35.4 ppm

Table 8

Airborne Fiber and Total Dust Exposures in Main and Special Panel Lines, Johns-Manville, Alexandria, Indiana

Job or Sample Location	Fiber Count Samples				Total Dust Samples			
	Sample Number	Air Vol. Liters	Conc. Fibers/cc	% Resp.*	Sample Number	Dust Weight mg	Air Vol. m^3	Conc. mg/m^3
Stationary at Fiber Bailer	JM 2	230	0.19		MSA 1491	0.69	.76	0.90
	JM 47	336	0.17					
	JM 54	190	0.24					
(TWA)			0.19	75.8				0.90
Stationary at Water Saw (TWA)	JM 4	740	0.10		MSA 1501	0.72	0.74	0.96
			0.10	82.9				0.96
Stationary at Saw Area Entrance	JM 3	134	0.54		MSA 1562	1.12	0.72	1.56
	JM 46	120	0.52					
	JM 22	120	0.54					
	JM 52	150	0.98					
	JM 55	190	0.36					
(TWA)			0.58	82.2				1.56
Line Feeder	JM 76	222	0.82		MSA 1711	6.19	0.42	14.72
	JM 80	200	0.28					
(TWA)			0.56	67.5				14.72
Line Feeder	JM 62	224	0.50		MSA 1520	1.38	0.46	3.00
	JM 75	122	0.60					
(TWA)			0.54	69.9				3.00

Table 8 Continued

Job or Sample Location	Fiber Count Samples				Total Dust Samples			
	Sample Number	Air Vol. Liters	Conc. Fibers/cc	% Resp.*	Sample Number	Dust Weight mg	Air Vol. m^3	Conc. mg/m^3
Punch Press Operator	JM 12	190	0.19		MSA 1530	1.09	0.68	1.60
	JM 50	300	0.18					
	JM 41	182	0.52					
(TWA)			0.27	90.9				1.60
Feeder for Surface Punch	JM 8	214	0.19		MSA 1511	3.36	0.68	4.94
	JM 30	288	0.43					
	JM 37	182	0.38					
(TWA)			0.34	80.4				4.94
Feeder for Park Saw	JM 17	294	0.33		MSA 1547	5.19	0.66	7.86
	JM 45	145	0.64					
	JM 26	190	1.09					
(TWA)			0.63	83.1				7.86
Feeder for Park Saw	JM 14	172	0.47		MSA 1750	4.42	0.58	7.62
	JM 25	245	0.83					
	JM 31	188	0.80					
(TWA)			0.72	78.1				7.62
Panel Feeder	JM 6	130	0.95		MSA 1518	9.21	0.76	12.12
	JM 44	120	1.60					
	JM 38	120	1.74					
	JM 56	150	0.92					
	JM 51	190	1.41					
(TWA)			0.80	65.9				12.12
Panel Feeder	JM 7	132	.72		MSA 1496	4.13	0.52	7.94
	JM 39	120	1.22					
	JM 23	116	1.38					
	JM 58	150	0.37					
(TWA)			0.88	60.2				7.94

Table 8 Continued

Job or Sample Location	Fiber Count Samples				Total Dust Samples			
	Sample Number	Air Vol. Liters	Conc. Fibers/cc	% Resp.*	Sample Number	Dust Weight mg	Air Vol. m^3	Conc. mg/m^3
Inspector	JM 13	186	0.55		MSA 1546	2.50	0.66	3.79
	JM 24	282	0.23					
	JM 32	200	0.40					
(TWA)			0.37	84.6				3.79
Inspector	JM 11	192	0.32		MSA 1549	4.43	0.67	6.61
	JM 29	280	0.35					
	JM 36	200	0.68					
(TWA)			0.44	68.3				6.61
Wool Line Utility Man	JM 10	176	0.37		MSA 1782	1.24	0.67	1.85
	JM 48	304	0.39					
	JM 43	198	0.23					
(TWA)			0.33	74.5				1.85
Wool Line Utility Man	JM 5	236	1.35		MSA 1746	0.97	0.80	1.21
	JM 49	160	0.26					
	JM 59	200	0.25					
(TWA)			0.69	72.3				1.21
Wool Line Utility Man	JM 1	117	0.61		MSA 1505	Sample voided due to pump failure		
	JM 33	328	0.18					
	JM 53	210	0.53					
(TWA)			0.37	73.4				
Special Line Take-Off, Hand Boxing	JM 19	170	0.37		MSA 1767	0.53	0.62	0.8
	JM 28	135	0.33					
	JM 42	176	0.57					
(TWA)			0.43	77.6				0.8

Table 8 Continued

Job or Sample Location	Fiber Count Samples				Total Dust Samples			
	Sample Number	Air Vol. Liters	Conc. Fibers/cc	% Resp.	Sample Number	Dust Weight mg	Air Vol. m^3	Conc. mg/m^3
Special Line Feeder	JM 20	184	0.41		MSA 1754	2.86	0.62	4.61
	JM 35	284	0.37					
	JM 21	158	1.9					
(TWA)			0.77	6.92				4.61
Special Line Feeder	JM 18	158	0.57		MSA 1537	1.64	0.62	2.65
	JM 27	152	0.60					
	JM 34	318	0.29					
(TWA)			0.44	78.1				2.65
Clay Coater	JM 9	198	0.24		MSA 1752	1.56	0.68	2.29
	JM 16	290	0.38					
	JM 15	214	0.93					
(TWA)			0.52	74.9				2.29

Respirable fibers are defined as those airborne fibers both less than 3.5 μm in diameter and less than 50 μm in length.

Table 9

Airborne Fiber and Total Dust Exposures in Small Panel (Tile) Line, Johns-Manville, Alexandria, Indiana

Job or Sample Location	Fiber Count Samples				Total Dust Samples			
	Sample Number	Air Vol. Liters	Conc. Fibers/cc	% Resp.*	Sample Number	Dust Weight mg	Air Vol. m^3	Conc. mg/m^3
Line Feeder	JM 124	90	0.74		MSA 1727	0.75	0.24	3.13
	JM 111	110	0.54		MSA 1808	0.84	0.23	3.65
	JM 109	130	0.57		MSA 1817	1.36	0.22	6.18
(TWA)			0.61	79.7				4.40
Saw Feeder	JM 96	94	1.17		MSA 1710	0.63	0.22	2.86
	JM 108	106	1.17		MSA 1831	0.81	0.28	2.89
	JM 131	80	1.01		MSA 1802	1.52	0.18	8.44
(TWA)			1.12	70.1				4.35
Saw Take Off Operator	JM 98	100	0.91					
	JM 100	102	0.83		MSA 1816	2.43	0.26	9.35
	JM 112	86	1.3		MSA 1516	2.44	0.19	12.84
(TWA)			0.99	85.7				10.82
Feeder, M & J	JM 61	228	0.72		MSA 1594	2.7	0.27	10.00
	JM 89	202	0.40					
(TWA)			0.57	62.9				10.00
Feeder M & J	JM 71	256	0.60		MSA 1752		Void	
	JM 85	260	0.44					
(TWA)			0.52	71.6				
M & J Operator	JM 67	123	1.03		MSA 1552		Void	
	JM 86	260	0.28					
(TWA)			0.52	79.4				

Table 9 Continued

Job or Sample Location	Fiber Count Samples				Total Dust Samples			
	Sample Number	Air Vol. Liters	Conc. Fibers/cc	% Resp.*	Sample Number	Dust Weight mg	Air Vol. m^3	Conc. mg/m^3
Greenlee Feeder	JM 70	353	0.42		MSA 1725	3.77	0.34	11.09
	JM 82	86	0.59					
(TWA)			0.45	74.1				11.09
Greenlee Feeder	JM 94	120	1.75		MSA 1708	3.06	.26	11.77
	JM 101	114	1.07		MSA 1526	1.86	.26	7.15
	JM 122	82	1.74		MSA 1805	1.02	.19	5.37
(TWA)			1.50	61.5				8.37
Take Off Greenlee	JM 92	1440	0.43		MSA 1558	7.86	0.27	29.11
					MSA 1497	8.54	0.26	32.85
	JM 124	90	0.74		MSA 1832	1.59	0.10	15.90
(TWA)			0.44	70.2				28.55
Take Off Greenlee	Samples Void				MSA 1545	6.44	0.51	12.63
(TWA)								12.63
Greenlee Feeder	JM 99	240	0.93		MSA 1624	3.90	0.26	15.00
	JM 105	130	1.90		MSA 1536	2.19	0.27	8.11
	JM 123	90	1.01					
(TWA)			0.99	80.3				11.51
Greenlee Operator	JM 66	127	1.35		MSA 1739	4.41	0.52	8.48
	JM 83	133	0.91					
(TWA)			1.12	73.9				8.48

Table 9 Continued

Job or Sample Location	Fiber Count Samples				Total Dust Samples			
	Sample Number	Air Vol. Liters	Conc. Fibers/cc	% Resp.*	Sample Number	Dust Weight mg	Air Vol. m^3	Conc. mg/m^3
Punch Press Feeder	JM 91	98	0.35		MSA 1731	0.27	0.22	1.23
	JM 106	106	0.32		MSA 1806	0.43	0.28	1.54
	JM 115	80	0.48		MSA 1529	0.51	0.19	2.68
(TWA)			0.37	87.0				1.76
Asst. Tanner Operator	JM 117	125	0.33		MSA 1531	3.70	0.23	16.09
	JM 119	110	0.53		MSA 1827	0.33	0.25	1.32
	JM 125	130	0.52		MSA 1830	3.85	0.22	17.50
(TWA)			0.46	86.2				11.26
Relief Operator Feeder, Etc.	JM 132	132	0.19		MSA 1834	0.22	0.24	0.92
	JM 110	112	0.25		MSA 1813	0.36	0.23	1.57
					MSA 1810	0.14	0.21	0.67
(TWA)			0.22	69.0				1.03
Relief Operator	JM 77	212	0.52		MSA 1595	3.91	0.45	8.69
	JM 79	238	0.41					
(TWA)			0.46	78.5				8.69
Relief Operator	JM 65	224	1.10		MSA 1567	5.74	0.43	13.35
	JM 78	164	0.81					
(TWA)			0.98	71.7				13.35
Relief Feeder	JM 95	104	0.49		MSA 1495	0.60	0.51	1.18
	JM 104	108	0.19		MSA 1840	1.78	0.27	6.59
	JM 127	84	0.14		MSA 1792	0.19	0.19	1.00
(TWA)			0.28	86.4				2.65

Table 9 Continued

Job or Sample Location	Fiber Count Samples				Total Dust Samples			
	Sample Number	Air Vol. Liters	Conc. Fibers/cc	% Resp.*	Sample Number	Dust Weight mg	Air Vol. m^3	Conc. mg/m^3
Hand Trucker	JM 60	244	1.29		MSA 1503	6.17	0.49	12.59
	JM 87	123	0.85					
(TWA)			1.15	67.9				12.59
Take Off Operator	JM 114	120	0.53		MSA 1819	1.00	0.23	4.35
	JM 118	114	0.34		MSA 1838	0.56	0.23	2.43
					MSA 1715	0.44	0.21	2.10
(TWA)			0.44	72.3				2.99
Take Off Operator	JM 113	116	0.24		MSA 1807	0.42	0.22	1.91
	JM 121	116	0.35		MSA 1821	0.35	0.23	1.52
	JM 120	120	0.15		MSA 1795	0.35	0.21	1.67
(TWA)			0.25	92.6				1.70
Take Off Operator	JM 63	226	2.04		MSA 1763	11.11	0.43	25.84
	JM 88	186	1.85					
(TWA)			1.95	59.8				25.84
Take Off Operator	JM 69	516	0.40		MSA 1759	0.87	0.52	1.67
(TWA)			0.40	67.7				1.67
Take Off Operator	JM 64	230	0.96		MSA 1532	4.19	0.44	9.52
	JM 81	210	0.96					
(TWA)			0.96	66.7				9.52
Take Off Operator	JM 90	240	0.11		MSA 1694	0.11	0.26	0.42
	JM 103	120	0.30		MSA 1833	0.92	0.29	3.17
	JM 128	78	0.97		MSA 1839	1.03	0.19	5.42
(TWA)			0.31	71.8				2.64

Table 9 Continued

Job or Sample Location	Fiber Count Samples				Total Dust Samples			
	Sample Number	Air Vol. Liters	Conc. Fibers/cc	% Resp.*	Sample Number	Dust Weight mg	Air Vol. m^3	Conc. mg/m^3
Inspector	JM 74	510	0.34		MSA 1502	1.15	0.51	2.25
(TWA)			0.34	90.4				2.25
Inspector	JM 68	500	0.18		MSA 1526	1.86	0.52	3.58
(TWA)			0.18	73.3				3.58
Inspector	JM 97	120	0.76		MSA 1777	0.68	0.23	2.96
	JM 116	112	0.13		MSA 1804	0.96	0.27	3.56
	JM 129	86	0.53		MSA 1563	0.64	0.19	3.37
(TWA)			0.32	72.3				3.30
Inspector	JM 93	118	0.78		MSA 1759	0.87	0.23	3.78
	JM 107	116	0.36		MSA 1835	2.33	0.29	8.04
	JM 130	90	0.20		MSA 1504	0.93	0.20	4.65
(TWA)			0.47	58.5				5.74

* Respirable fibers are defined as those airborne fibers which are both less than 3.5 μm in diameter and less than 50 μm in length.

Table 10

Summary of Airborne Fiber And Total Airborne Dust Samples in Panel And Tile Production Areas, Johns-Manville, Alexandria, Indiana

Exposure Measure	Panel Production	Tile Production
Airborne Fiber Exposures		
Average TWA*, fibers/cc ± SE	0.50 ± 0.05	0.66 ± 0.08
Range of TWA Exposures, fibers/cc	0.10 - 0.88	0.18 - 1.95
Total Airborne Dust		
Average TWA, mg/m^3 ± SE	4.58 ± 0.91	8.18 ± 1.31
Range of TWA Exposures, mg/m^3	0.85 - 14.72	1.03 - 28.55

*TWA = Time Weighted-Average.

Table 11

Frequency Distributions for Count
Median Airborne Fiber Diameters
Johns-Manville, Alexandria, Indiana

Size Interval for Count Median Airborne Diameter, µm	Number of Count Median Diameter Within Each Category	
	Main Panel	Main Panel
1.70-1.89	5	3
1.90-2.09	5	7
2.10-2.29	5	9
2.30-2.49	5	6
2.50-2.69	0	3
$\geq$ 2.70	0	0

Table 12

Frequency Distributions for Count
Median Airborne Fiber Lengths,
Johns-Manville, Alexandria, Indiana

Size Interval for Count Median Airborne Diameter, μm	Number of Count Median Diameter Within Each Category	
	Main Panel	Main Panel
6.00-7.99	1	0
8.00-9.99	2	0
10.00-11.99	1	3
12.00-13.99	2	4
14.00-15.99	4	5
16.00-17.99	5	5
18.00-19.99	3	4
20.00-21.99	1	3
$\geq$ 22.00	1	3

Table 13

Summary of Composite Airborne
Fiber Size Distributions by Major
Operations, Johns-Manville,
Alexandria, Indiana

Operation and Parameter Measured	Fiber Diameter	Fiber Length
Main and Special Panel Line		
Average Count Median Size, µm	2.1	15.5
Range for Count Median Size, µm	1.7-2.4	6.8-22.7
Average % Respirable*	75.6	
Small Panel (Tile) Line		
Average Count Median Size, µm	2.2	17.0
Range for Count Median Size, µm	1.7-2.7	11.0-24.8
Average % Respirable*	74.3	

* Respirable fibers are defined as those which are both less than 3.5 µm in diameter and less than 50 µm in length

Table 14

Comparison of Airborne Fiber Diameter Distributions Obtained By Optical And Electron Microscopy (All Samples Combined), Johns-Manville, Alexandria, Inidana

Diameter Measure	Optical	Electron
Count Median Fiber Diameter (μm)	2.15	1.91
Geometric Standard Deviation, $\sqrt{g}$	1.74	2.00

Table 15

Free Silica Exposures (Total Dust) in Main and Special Panel Lines, Johns-Manville, Alexandria, Indiana

Job or Sample Location	Sample Number	Total Dust Weight mg	Free SiO_2 mg	Air Vol. m^3	Free SiO_2 mg/m^3	% Free SiO_2
Stationary At Boiler	MSA 1491	0.69	0.08	0.76	0.10	11.5
Stationary At Water Saw	MSA 1501	0.72	0.05	0.74	0.07	7.0
Line Feeder	MSA 1520	1.38	0.09	0.46	0.20	6.5
Punch Press Operator	MSA 1530	1.09	0.06	0.68	0.09	5.5
Feeder For Surface Punch	MSA 1511	3.36	0.21	0.68	0.31	6.3
Feeder For Park Saw	MSA 1547	5.19	0.04	0.66	0.61	7.7
Inspector	MSA 1546	2.46	0.25	0.66	0.38	10.1
Inspector	MSA 1549	4.43	0.41	0.67	0.61	9.3
Wool Line Utility Man	MSA 1782	1.24	0.08	0.67	0.12	6.5
Wool Line Utility Man	MSA 1746	0.97	0.05	0.80	0.06	5.2
Special Line Feeder	MSA 1754	2.86	0.11	0.62	0.18	3.8
Special Line Feeder	MSA 1537	1.64	0.10	0.62	0.16	6.1
Clay Coater	MSA 1752	1.55	0.06	0.68	0.08	3.8

Average % Free SiO_2 = 6.9

Table 16

Free Silica Exposures (Total Dust) in Tile Area

John-Manville, Alexandria, Indiana

Job or Sample Location	Sample Number	Total Dust Weight mg	Free SiO_2 mg	Air Vol. m^3	Free SiO_2 mg/m^3	% Free SiO_2
Feeder M & J	MSA 1594	2.70	0.12	0.24	0.44	4.4
Greenlee Feeder	MSA 1725	3.77	0.26	0.34	0.76	6.9
Greenlee Feeder	MSA 1526	1.86	0.21	0.52	0.40	11.3
Greenlee Operator	MSA 1739	4.41	0.39	0.52	0.75	8.8
Relief Operator	MSA 1595	1.45	0.07	0.45	0.16	4.8
Hand Trucker	MSA 1503	6.17	0.64	0.49	1.30	10.3
Take Off Operator	MSA 1532	4.19	0.35	0.44	0.80	8.3
Inspector	MSA 1502	1.15	0.18	0.51	0.35	15.6
Inspector	MSA 1526	1.86	0.21	0.52	0.40	11.3

Average % Free SiO_2 = 9.1

Table 17

Calculated Time-Weight-Average Free Silica Exposures in Panel Area, Johns-Manville, Alexandria, Indiana

Job or Sample Location	Sample Number	Dust Wt. mg	Air Vol. m^3	Free Silica Conc.*, mg/m^3
Stationary At Fiber Bailer	MSA 1491	0.69	0.76	0.06
Stationary At Water Saw	MSA 1501	0.72	0.74	0.07
Stationary At Saw Area Entrance	MSA 1562	1.12	0.72	0.11
Line Feeder	MSA 1711	6.19	0.42	1.02
Line Feeder	MSA 1520	1.38	0.46	0.21
Punch Press Operator	MSA 1530	1.09	0.68	0.11
Feeder for Surface Punch	MSA 1511	3.36	0.68	0.34
Feeder for Park Saw	MSA 1547	5.19	0.66	0.54
Feeder for Park Saw	MSA 1750	4.42	0.58	0.53
Panel Feeder	MSA 1518	9.21	0.76	0.84
Inspector	MSA 1546	2.50	0.66	0.26
Inspector	MSA 1549	4.43	0.67	0.46
Wool Line Utility Man	MSA 1782	1.24	0.67	0.13
Wool Line Utility Man	MSA 1746	0.97	0.80	0.08
Special Line Take Off	MSA 1767	0.53	0.62	0.06
Special Line Feeder	MSA 1754	2.86	0.62	0.32
Special Line Feeder	MSA 1537	1.64	0.62	0.18
Clay Coater	MSA 1752	1.56	0.68	0.16

* Average free silica = 6.9% used for all calculations.

Table 18

Calculated Time-Weighted-Average Free Silica Exposures in Tile Area, Johns-Manville, Alexandria, Indiana

Job or Sample Location	Sample Number	Dust Wt. mg	Air Vol. m^3	Free Silica Conc.*, mg/m^3
Line Feeder	MSA 1727, 1808, 1817	2.95	0.69	0.40
Saw Feeder	MSA 1710, 1831, 1802	2.96	0.68	0.40
Saw Take Off Operator	MSA 1816, 1516	4.87	0.45	0.98
Feeder, M & J	MSA 1594	2.70	0.27	0.91
M & J Operator	MSA 1725	3.77	0.34	1.01
Greenlee Operator	MSA 1708, 1526, 1805	5.94	0.71	0.76
Take Off Greenlee	MSA 1558, 1497, 1832	17.99	0.63	2.60
Take Off Greenlee	MSA 1545	6.44	0.51	1.15
Greenlee Operator	MSA 1624, 1536	6.09	0.53	1.05
Greenlee Operator	MSA 1739	4.41	0.52	0.77

Table 18 (Continued)

Job or Sample Location	Sample Number	Dust Wt. mg	Air Vol. m^3	Free Silica Conc.*, mg/m^3
Punch Press Feeder	MSA 1731, 1806, 1529	1.21	0.69	0.16
Asst. Tanner Operator	MSA 1531 1827, 1830	7.88	0.70	1.02
Relief Operator	MSA 1834, 1813, 1810	0.72	0.68	0.09
Relief Operator	MSA 1595	3.91	0.45	0.79
Relief Operator	MSA 1567	5.74	0.43	1.21
Relief Operator	MSA 1495, 1840, 1792	2.57	0.97	0.24
Hand Trucker	MSA 1503	6.17	0.49	1.15
Take Off Operator	MSA 1819, 1838, 1715	2.00	0.67	0.27
Take Off Operator	MSA 1807 1821, 1795	1.12	0.66	0.15
Take Off Operator	MSA 1763	11.11	0.43	2.35
Take Off Operator	MSA 1759	0.87	0.52	0.15

Table 18 (Continued)

Job or Sample Location	Sample Number	Dust Wt. mg	Air Vol. m^3	Free Silica Conc.,* mg/m^3
Take Off Operator	MSA 1532	4.19	0.44	0.87
Take Off Operator	MSA 1694 1833, 1839	2.06	0.74	0.24
Inspector	MSA 1502	1.15	0.51	0.20
Inspector	MSA 1526	1.86	0.52	0.33
Inspector	MSA 1777, 1804, 1563	2.28	0.69	0.30
Inspector	MSA 1759, 1835, 1504	4.13	0.72	0.52

* Average free silica = 9.1% used for all calculations.

Table 19

Summary of Calculated Free Silica
Exposures in Panel and Tile Areas
Johns-Manville, Alexandria, Indiana

Exposure Measure	Panel Production	Tile Production
Average Conc., $mg/m^3 \pm SE$	0.30 ± 0.07	0.74 ± 0.12
% TWA's > 1.0 mg/m^3	5.5	29.6
% TWA's > 0.30 mg/m^3	38.9	66.7
% TWA's > 0.10 mg/m^3	77.8	96.3

Table 20

Trace Metal Concentrations in Tile Area Operations,

Johns-Manville, Alexandria, Indiana

Job or Sample Location	Sample Number	Air Vol. m^3	Trace Metals Conc. $\mu g/m^3$						
			Cd*	Cr*	Co*	Mn*	Ni*	Pb*	Zn
Line Feeder	MSA 1817	0.22	9	5	9	5	14	9	5
Saw Feeder	MSA 1802	0.18	11	6	11	6	17	11	6
Saw Take Off	MSA 1816	0.26	8	4	8	4	12	8	4
Greenlee Feeder	MSA 1708	0.26	8	4	8	4	12	8	4
Take Off Greenlee	MSA 1832	0.10	20	10	20	10	30	20	10
Greenlee Operator	MSA 1624	0.26	8	4	8	8	12	8	4
Punch Press Feeder	MSA 1529	0.19	11	6	11	5	16	11	5
Asst. Trucker Operator	MSA 1830	0.22	9	5	9	5	14	9	5
Relief Operator, Feeder, etc.	MSA 1813	0.23	9	4	9	4	13	9	4
Relief Feeder	MSA 1840	0.27	7	4	7	4	11	7	4
Take Off Operator	MSA 1819	0.23	9	4	9	4	13	9	4
Take Off Operator	MSA 1807	0.22	9	5	9	5	14	9	5
Inspector	MSA 1804	0.27	7	4	7	4	11	7	4
Inspector	MSA 1835	0.29	7	3	7	3	10	7	3

* All samples below detectable levels. Values shown are lowest detectable concentrations according to air volumes sampled.

Table 21

Respirable Free Silica Exposures in Paint and Binder Operations,
Johns-Manville, Alexandria, Indiana

Job or Sample Location	Sample Number	Total Dust Wt. mg	Free SiO_2 Wt. mg	Air Vol. m^3	Free SiO_2 mg/m^3	% Free SiO_2
	Paint Mixing and Spraying Operations					
Paint Mixer*	MSA 1828	0.91	0.06	0.53	0.07	6.6
Paint Mixer*	MSA 1823	2.44	0.17	0.51	0.33	7.0
Paint Mixer	MSA 1798	0.28	0.13	0.53	0.25	46.4
Stationary at Paint Mixing	MSA 1696	0.29	0.04	0.53	0.08	13.8
Stationary at Mainline Spray Booth	MSA 1533	0.22	< 0.01	0.45	< 0.02	--
	Binder Mixing					
Binder Mixer	MSA 1506	1.10	0.10	0.44	0.23	9.1
Stationary at Binder Tank Platform	MSA 1534	0.73	0.02	0.43	0.05	2.7
Stationary at Binder Control Panel	MSA 1745	0.38	< 0.01	0.43	< 0.02	

* Operators wearing respirators during sample period.

Table 22

Summary of Area Sound Level Measurements,
Johns-Manville, Alexandria, Indiana

Operation of Area	Sound Level, dB "A" Scale	"B" Scale	"C" Scale
Main Line and Special Line			
Binder Mixing(1)	82	86	91
Cupola Charge Floor	88	92	94
Cupola Discharge (Fiber Forming)	92	95	97
At Cupola Rest Station (First Floor)	94	96	97
In Bulk Fiber Baling Area	77	85	91
In Fourdrinier Area	81	84	87
At Large Panel Saws	86	89	91
At Clay Coater	84	86	88
At Large Panel Punch Press	82-91	86-93	88-96
Large Panel Painting	85	86	88
At Paint Dryer	86	87	89
At Inspection Station	85	85	87
Small Panel (Tile) Operations			
At Tenoner	86	87	88
At Tile Painting	90-94	90-93	89-93
In Inspection Area	75	80	82
Take Off	76	78	83

(1) Sound levels as high as 98 dBA were observed when the alarm buzzer was in operation.

Table 23

COMPARISON OF PRESENT AND PAST CUPOLA RAW MATERIALS
JOHNS-MANVILLE, ALEXANDRIA, INDIANA

Component	Composition, % By Weight					
	Reported by Carpenter and Spolyar, 1945				Recent Analyses	
	Rock	Lead Slag	Blast Furnace Slag	Blast Furnace Slag	Blast Furnace Slag (8/74)	Phosphate Slag (4/74)
Silica (SiO_2)	32.5	29.5	51.5	35.0	36.8	41.99
Aluminum Oxide (Al_2O_3)	8.5	16.5	16.0	12.0	9.5	7.00
Calcium Oxide (CaO)	17.0	11.0	21.5	43.0	39.0	46.45
Magnesium Oxide (MgO)	12.0	4.0	4.5	8.5	12.2	-----
Magnesium Oxide (MnO)	NR*	NR	NR	NR	0.77	-----
Sulfur (S)	NR	NR	NR	NR	1.49	0.20
Iron Oxide (fe) & Fe_2O_3)	2.0	30.0	6.5	1.0	0.56	-----
Potassium (P_2O_5)	NR	NR	NR	NR	-----	1.21
Titanium Oxide (TiO_2)	NR	NR	NR	NR	0.52	-----

* Not Reported

Table 24

SUMMARY OF A PRELIMINARY NIOSH STUDY IN A ROCK WOOL PLANT PRODUCING BLOWING WOOL, NO LOCAL EXHAUST VENTILATION

Measure	Values
Fiber Concentration, fibers/cc	
Mean ± SE	1.65 ± 0.32
Range	0.80 - 2.60
Median Airborne Fiber Size	
Diameter, μm	2.4
Length, μm	17.0

Figure 1

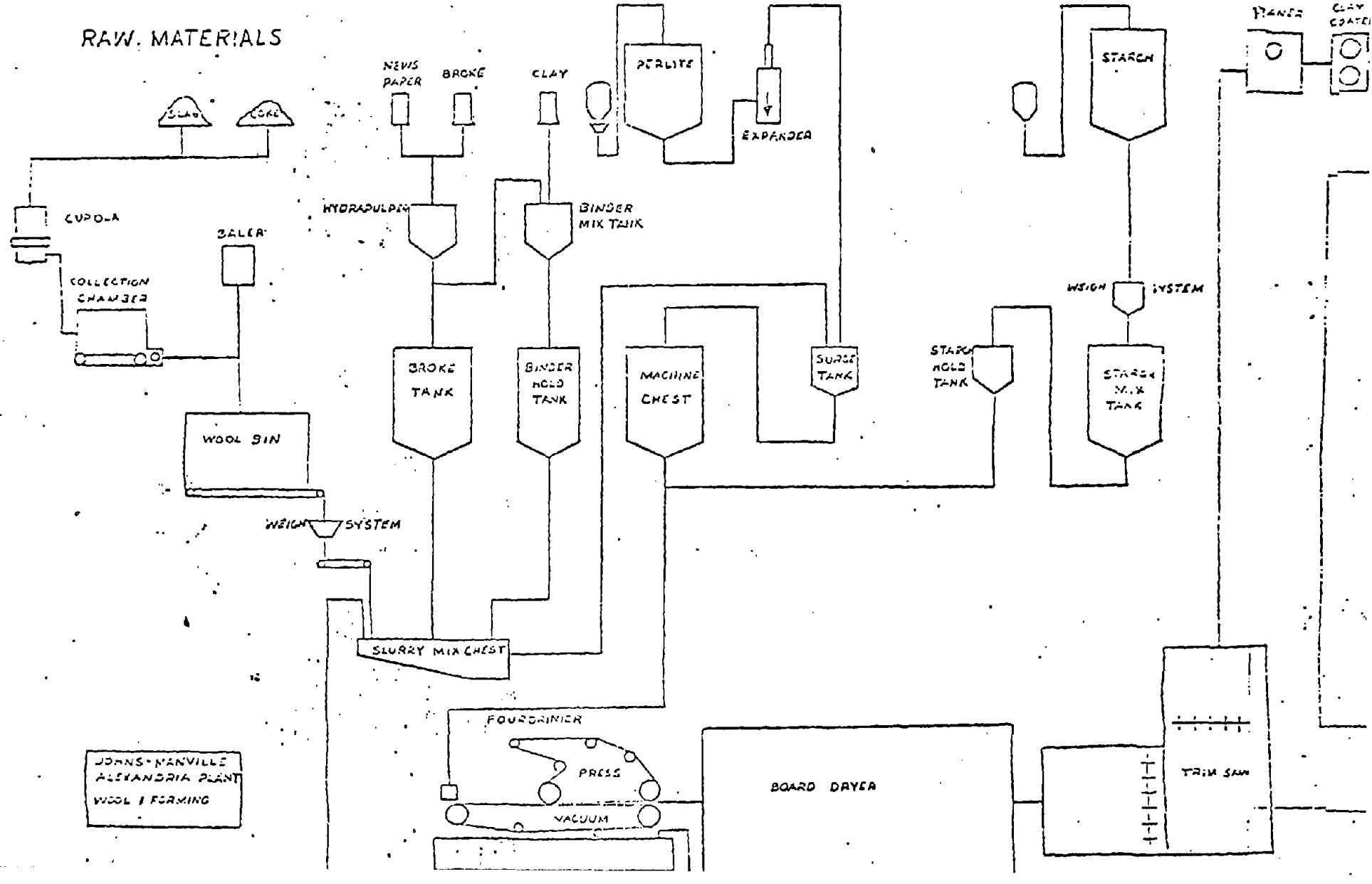
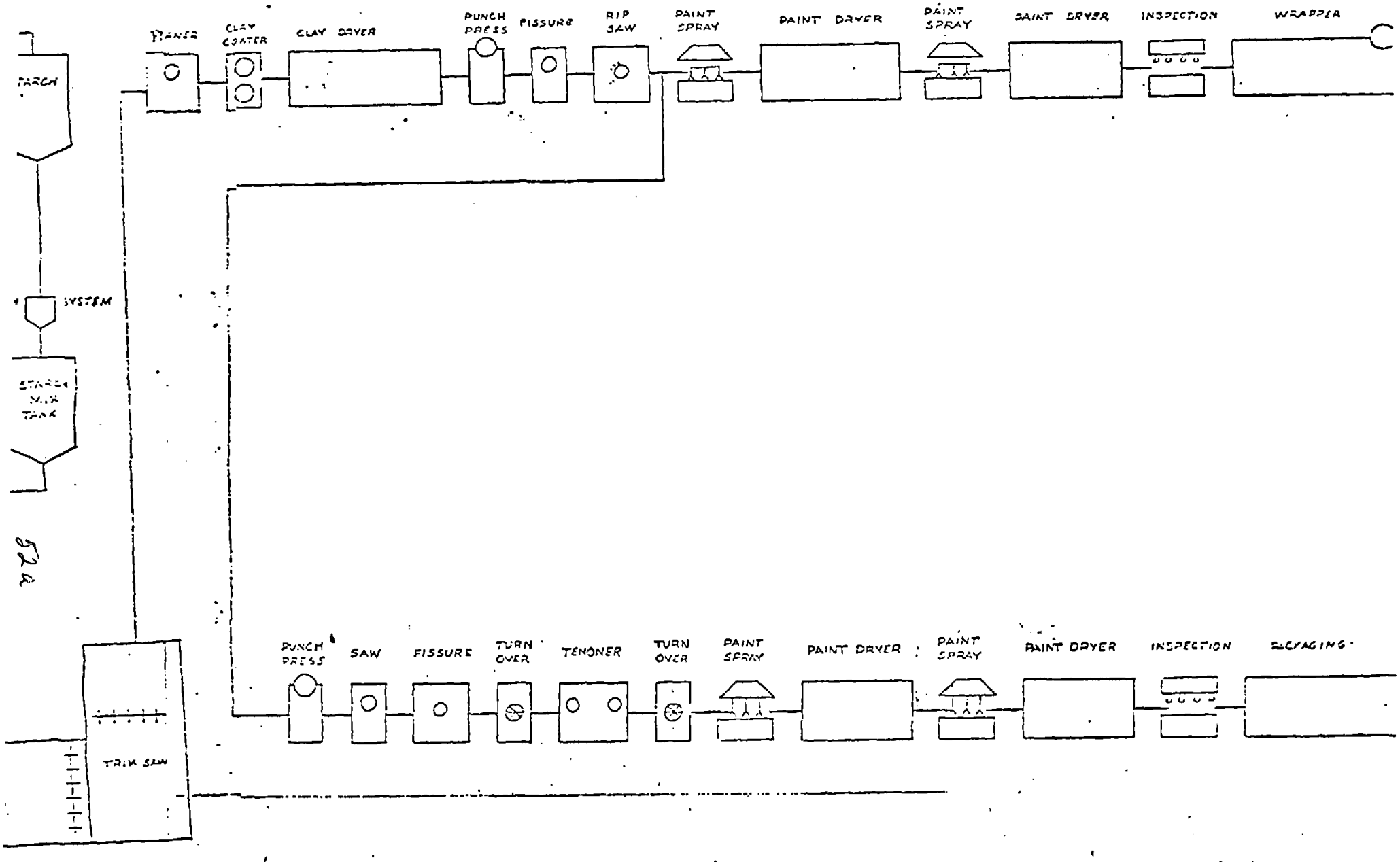

RAW. MATERIALS
NEWS PAPER
BROKE
CLAY
PERLITE
EXPANDER
STARCH
PLANER
CUPOLA
BALER
COLLECTION CHAMBER
HYDRAPULPER
BINDER MIX TANK
WEIGH SYSTEM
BROKE TANK
BINDER HOLD TANK
MACHINE CHEST
SURGE TANK
STARCH HOLD TANK
STARCH MIX TANK
WOOL BIN
WEIGH SYSTEM
SLURRY MIX CHEST
FOURDRINIER
PRESS
VACUUM
BOARD DRYER
TRIM SAW
JOHNS-MANVILLE
ALEXANDRIA PLANT
WOOL I FORMING

Figure 1


PLANER
CLAY COATER
CLAY DRYER
PUNCH PRESS
FISSURE
RIP SAW
PAINT SPRAY
PAINT DRYER
PAINT SPRAY
PAINT DRYER
INSPECTION
WRAPPER
SYSTEM
PUNCH PRESS
SAW
FISSURE
TURN OVER
TENONER
TURN OVER
PAINT SPRAY
PAINT DRYER
PAINT SPRAY
PAINT DRYER
INSPECTION
PACKAGING
TRIM SAW

52a

FIGURE 2

BULK FIBER DIAMETER DISTRIBUTIONS

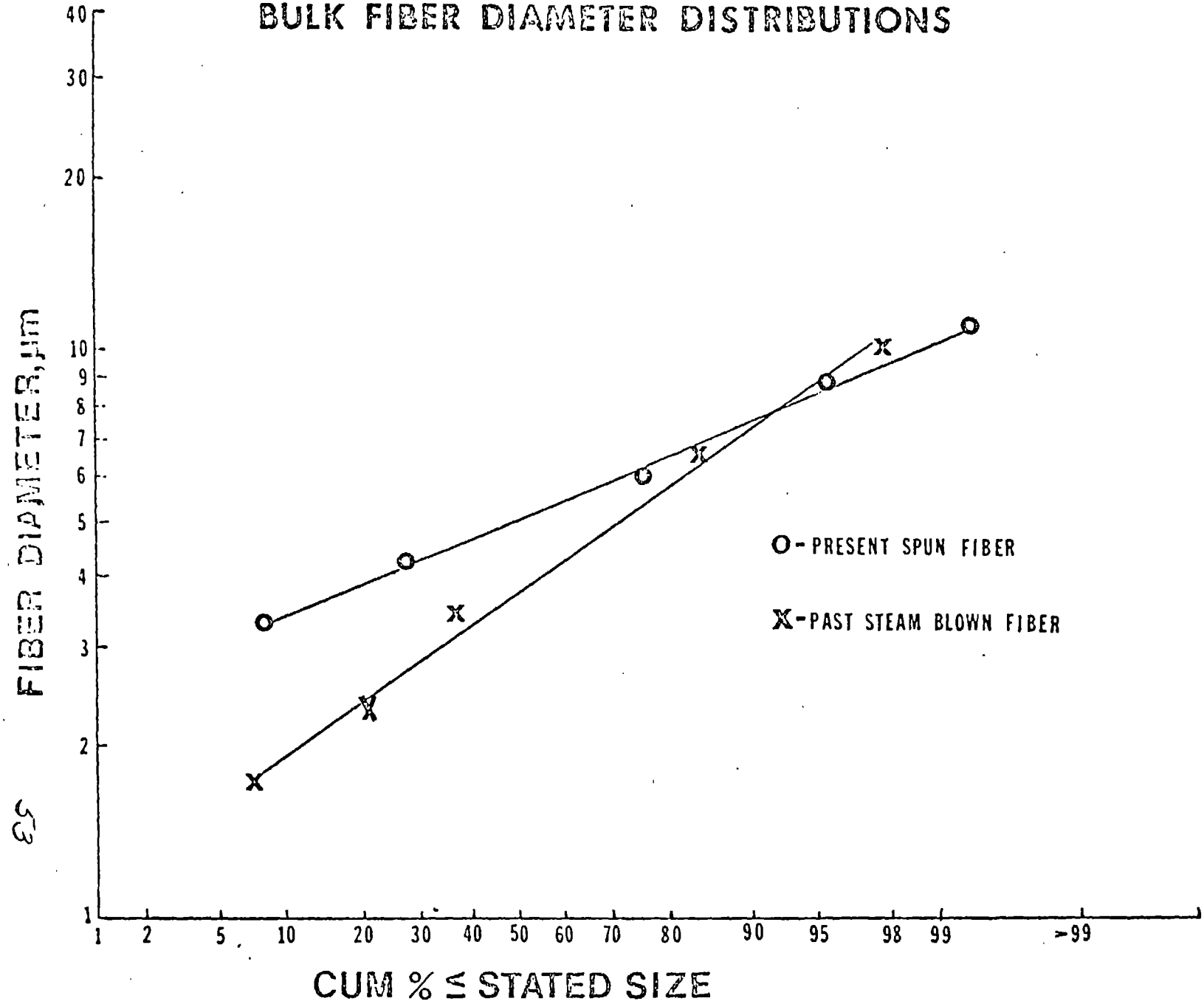


Figure 3

Example of Ecolizer Strip Chart
Output for Carbon Monoxide (0-100 ppm),
Johns-Manville, Alexandria, Indians

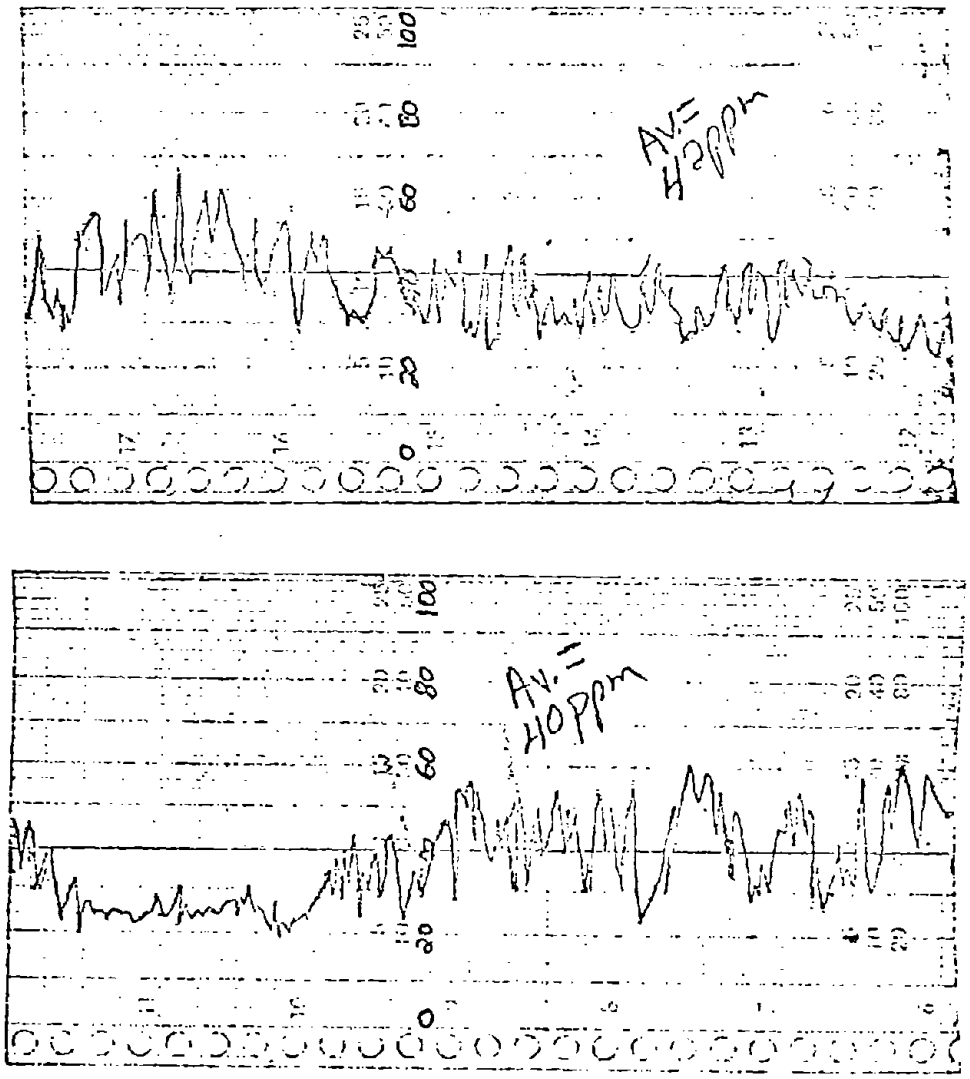


FIGURE 4

COMPARISON OF TIME-WEIGHTED-AVERAGE TOTAL DUST AND FIBER EXPOSURES, JOHNS-MANVILLE, ALEXANDRIA, INDIANA

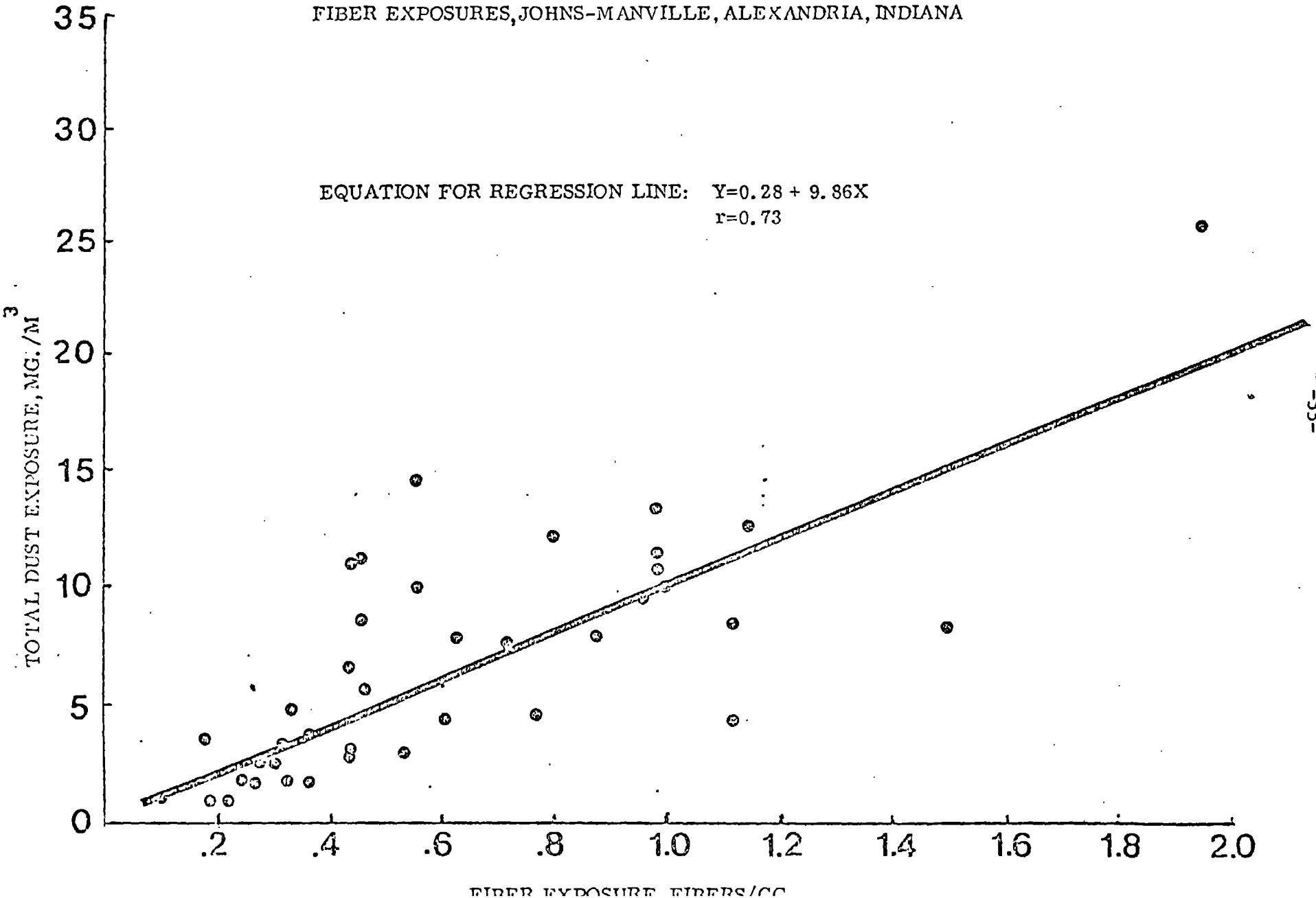
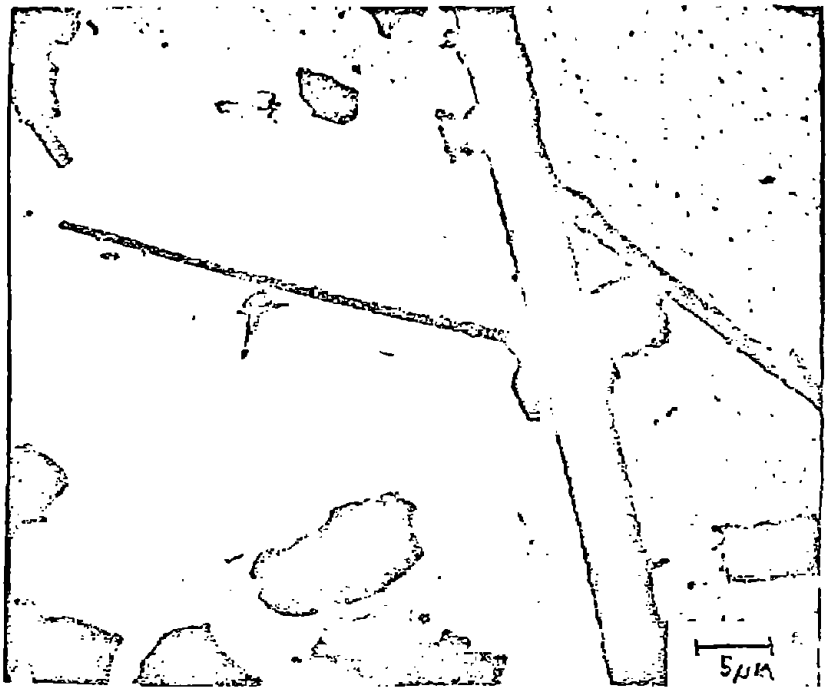


Figure 5

Electron Micrographs and X-ray Spectra
For Typical Airborne Fibers,
Johns-Manville, Alexandria, Indiana



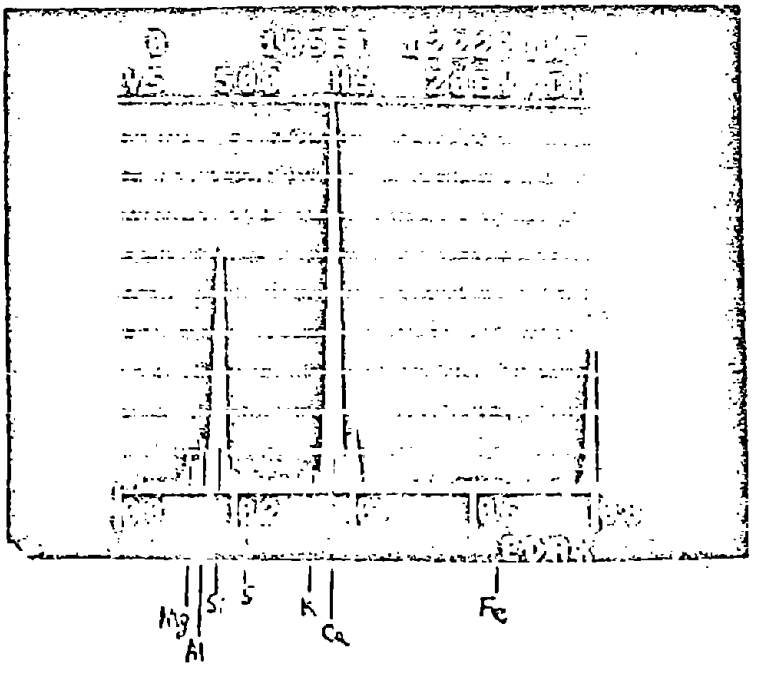
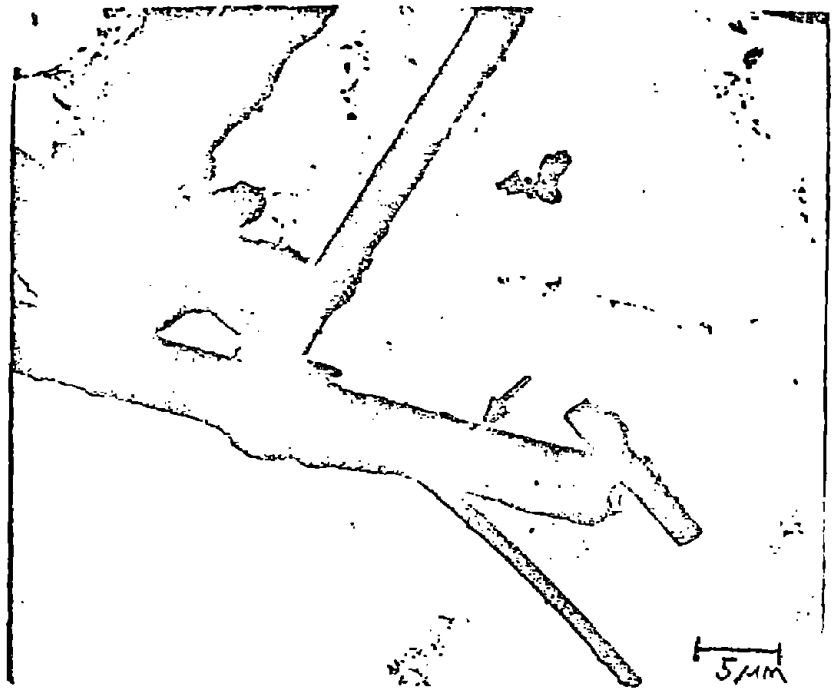


Figure 6

Electron Micrographs and X-ray Spectra
For Typical Airborne Fibers,
Johns-Manville, Alexandria, Indiana



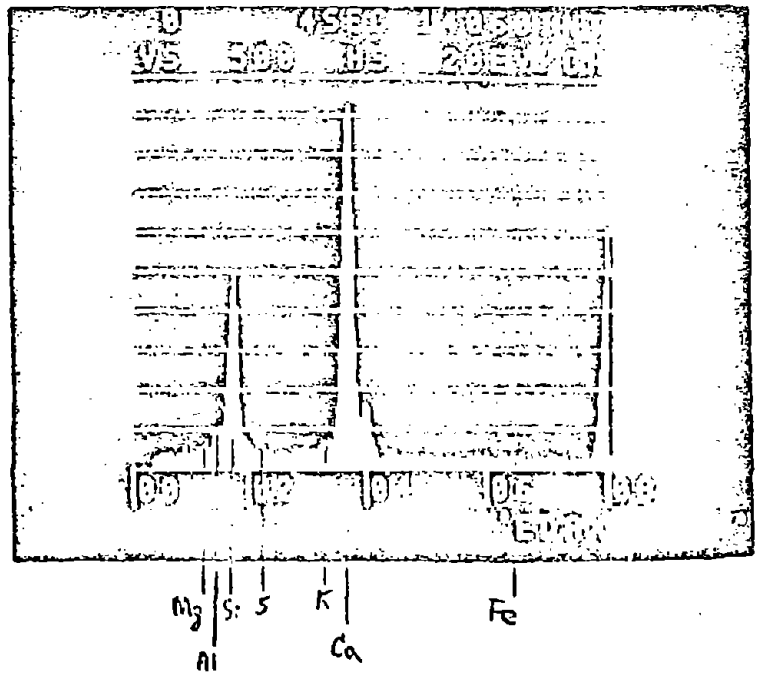
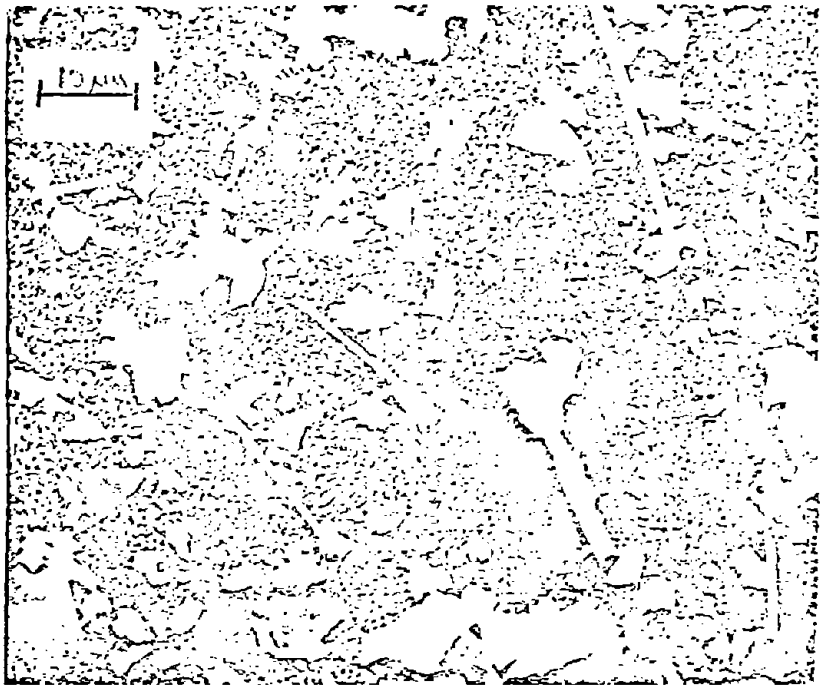


Figure 7

Scanning Electron Micrographs of
Typical Airborne Fibers,
Johns-Manville, Alexandria, Indiana



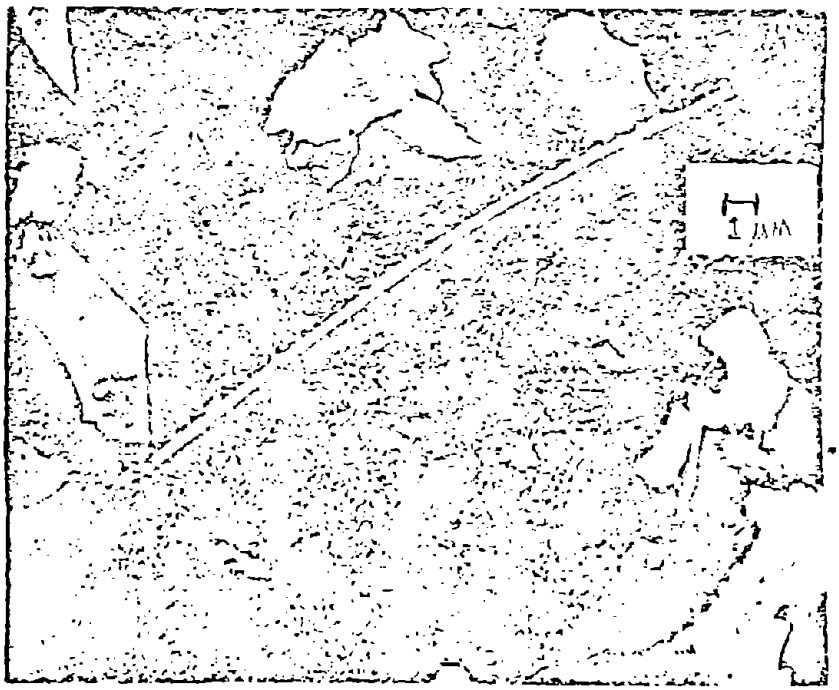
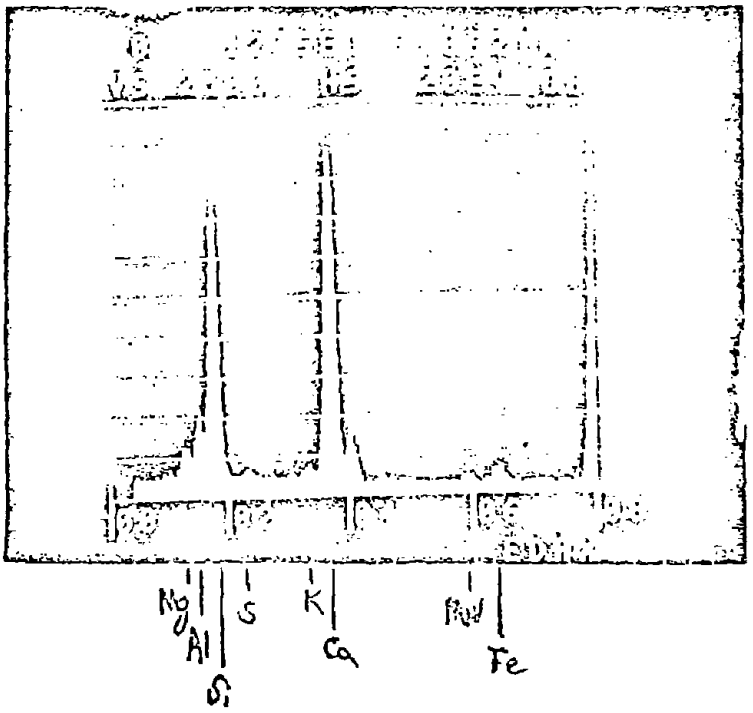


Figure 8

TYPICAL ENERGY DISPERSIVE X-RAY SPECTRUM
FOR THE STEAM BLOWN FIBER SAMPLE,
JOHNS-MANVILLE, ALEXANDRIA, INDIANA



Appendix II

Results of Airborne Fiber Diameter and Length Distribution Analyses

Johns-Manville
Alexandria, Indiana

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 2, JM 47, JM 54
Operation: Mainline and Special Line
Job or Sample Location: Stationary at Baler
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 124
Time Weighted Average Exposure (fibers/cc): 0.19

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.88	11.29
95% Confidence Interval for Count Median Size	1.68-2.11	8.57-14.74
Geometric Standard Deviation ($\sqrt{g}$)	1.89	4.54
95% Confidence Interval for $\sqrt{g}$	1.74-2.05	3.73-5.47
Approximate % of Fibers Considered Respirable*	75.8	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 4
Operation: Mainline and Special Line
Job or Sample Location: Stationary at Water Saw
Fields Counted (all Samples Combined): 100
No. Fibers Sized (all samples combined): 70
Time Weighted Average Exposure (fibers/cc): 0.10

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.23	17.76
95% Confidence Interval for Count Median Size	2.07-2.41	15.04-20.67
Geometric Standard Deviation ($\sqrt{g}$)	1.37	1.94
95% Confidence Interval for $\sqrt{g}$	1.30-1.45	1.74-2.17
Approximate % of Fibers Considered Respirable*	82.9	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 3, JM 46, JM 22, JM 52, JM 55
Operation: Mainline and Special Line
Job or Sample Location: Stationary at Saw Area Entrance
Fields Counted (all Samples Combined): 500
No. Fibers Sized (all samples combined): 281
Time Weighted Average Exposure (fibers/cc): 0.58

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.80	13.06
95% Confidence Interval for Count Median Size	1.69-1.91	11.34-14.75
Geometric Standard Deviation ($\sqrt{g}$)	1.66	2.99
95% Confidence Interval for $\sqrt{g}$	1.59-1.73	2.71-3.25
Approximate % of Fibers Considered Respirable*	82.2	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 76, JM 80
Operation: Mainline and Special Line
Job or Sample Location: Line Feeder
Fields Counted (all Samples Combined): 169
No. Fibers Sized (all samples combined): 160
Time Weighted Average Exposure (fibers/cc): 0.56

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.10	16.28
95% Confidence Interval for Count Median Size	1.90-2.33	13.94-19.01
Geometric Standard Deviation ($\sqrt{g}$)	1.88	2.58
95% Confidence Interval for $\sqrt{g}$	1.75-2.03	2.32-2.88
Approximate % of Fibers Considered Respirable*	67.5	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 62, JM 75
Operation: Mainline and Special Line
Job or Sample Location: Line Feeder
Fields Counted (all Samples Combined): 200
No. Fibers Sized (all samples combined): 153
Time Weighted Average Exposure (fibers/cc): 0.54

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.23	17.33
95% Confidence Interval for Count Median Size	1.99-2.49	14.76-20.24
Geometric Standard Deviation ($\sqrt{g}$)	2.01	2.66
95% Confidence Interval for $\sqrt{g}$	1.85-2.17	2.38-2.97
Approximate % of Fibers Considered Respirable*	69.9	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 12, JM 50, JM 41
Operation: Mainline and Special Line
Job or Sample Location: Punch Press Operator
Fields Counted (all Samples Combined): 301
No. Fibers Sized (all samples combined): 186
Time Weighted Average Exposure (fibers/cc): 0.27

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.69	6.81
95% Confidence Interval for Count Median Size	1.57-1.82	5.83-7.81
Geometric Standard Deviation ($\sqrt{g}$)	1.65	2.72
95% Confidence Interval for $\sqrt{g}$	1.57-1.74	2.45-3.01
Approximate % of Fibers Considered Respirable*	90.9	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 8, JM 30, JM 37
Operation: Mainline and Special Line
Job or Sample Location: Feeder for Surface Punch
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 204
Time Weighted Average Exposure (fibers/cc): 0.34

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.04	15.75
95% Confidence Interval for Count Median Size	1.92-2.16	14.01-17.72
Geometric Standard Deviation ($\sqrt{g}$)	1.53	2.29
95% Confidence Interval for $\sqrt{g}$	1.47-1.60	2.11-2.48
Approximate % of Fibers Considered Respirable*	80.4	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 17, JM 45, JM 26
Operation: Mainline and Special Line
Job or Sample Location: Feeder for Park Saw
Fields Counted (all Samples Combined): 256
No. Fibers Sized (all samples combined): 260
Time Weighted Average Exposure (fibers/cc): 0.63

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.94	16.76
95% Confidence Interval for Count Median Size	1.87-2.02	14.90-18.88
Geometric Standard Deviation ($\sqrt{g}$)	1.38	2.59
95% Confidence Interval for $\sqrt{g}$	1.34-1.42	2.38-2.81
Approximate % of Fibers Considered Respirable*	83.1	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 14, JM 25, JM 31
Operation: Mainline and Special Line
Job or Sample Location: Feeder for Park Saw
Fields Counted (all Samples Combined): 252
No. Fibers Sized (all samples combined): 315
Time Weighted Average Exposure (fibers/cc): 0.72

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.88	19.17
95% Confidence Interval for Count Median Size	1.78-1.98	17.55-20.81
Geometric Standard Deviation ($\sqrt{g}$)	1.61	2.12
95% Confidence Interval for $\sqrt{g}$	1.55-1.67	2.00-2.24
Approximate % of Fibers Considered Respirable*	78.1	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 6, JM 44, JM 38, JM 56, JM 51
Operation: Mainline and Special Line
Job or Sample Location: Feeder (Black Belt)
Fields Counted (all Samples Combined): 393
No. Fibers Sized (all samples combined): 499
Time Weighted Average Exposure (fibers/cc): 0.80

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.39	19.34
95% Confidence Interval for Count Median Size	2.26-2.52	17.76-20.97
Geometric Standard Deviation ($\sqrt{g}$)	1.82	2.53
95% Confidence Interval for $\sqrt{g}$	1.75-1.88	2.38-2.68
Approximate % of Fibers Considered Respirable*	65.9	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 6, JM 44, JM 38, JM 56, JM 51
Operation: Mainline and Special Line
Job or Sample Location: Feeder (Black Belt)
Fields Counted (all Samples Combined): 393
No. Fibers Sized (all samples combined): 499
Time Weighted Average Exposure (fibers/cc): 0.80

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.39	19.34
95% Confidence Interval for Count Median Size	2.26-2.52	17.76-20.97
Geometric Standard Deviation ($\sqrt{g}$)	1.82	2.53
95% Confidence Interval for $\sqrt{g}$	1.75-1.88	2.38-2.68
Approximate % of Fibers Considered Respirable*	65.9	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 7 JM 39, JM 23, JM 57, JM 58
Operation: Mainline and Special Line
Job or Sample Location: Feeder (Black Belt)
Fields Counted (all Samples Combined): 413
No. Fibers Sized (all samples combined): 450
Time Weighted Average Exposure (fibers/cc): 0.88

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.09	18.37
95% Confidence Interval for Count Median Size	1.98-2.21	16.88-19.97
Geometric Standard Deviation ($\sqrt{g}$)	1.82	2.44
95% Confidence Interval for $\sqrt{g}$	1.72-1.92	2.30-2.58
Approximate % of Fibers Considered Respirable*	60.2	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 13, JM 24, JM 32
Operation: Mainline and Special Line
Job or Sample Location: Inspector
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 214
Time Weighted Average Exposure (fibers/cc): 0.37

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.84	15.97
95% Confidence Interval for Count Median Size	1.72-1.96	14.38-17.70
Geometric Standard Deviation ($\sqrt{g}$)	1.59	2.14
95% Confidence Interval for $\sqrt{g}$	1.50-1.70	1.93-2.36
Approximate % of Fibers Considered Respirable*	84.6	

*Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 11, JM 29, JM 36
Operation: Mainline and Special Line
Job or Sample Location: Inspector
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 249
Time Weighted Average Exposure (fibers/cc): 0.44

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.39	22.68
95% Confidence Interval for Count Median Size	2.24-2.55	20.24-25.32
Geometric Standard Deviation ($\sqrt{g}$)	1.68	2.45
95% Confidence Interval for $\sqrt{g}$	1.61-1.76	2.27-2.66
Approximate % of Fibers Considered Respirable*	68.3	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 10, JM 48, JM 43
Operation: Mainline and Special Line
Job or Sample Location: Wool Line Utility Man
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 188
Time Weighted Average Exposure (fibers/cc): 0.33

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.10	14.95
95% Confidence Interval for Count Median Size	1.89-2.33	12.80-17.46
Geometric Standard Deviation ($\sqrt{g}$)	2.04	2.96
95% Confidence Interval for $\sqrt{g}$	1.90-2.20	2.35-2.62
Approximate % of Fibers Considered Respirable*	74.5	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 5 JM 49, JM 59
Operation: Mainline and Special Line
Job or Sample Location: Wool Line Utility Man
Fields Counted (all Samples Combined): 238
No. Fibers Sized (all samples combined): 119
Time Weighted Average Exposure (fibers/cc): 0.69

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.34	9.1
95% Confidence Interval for Count Median Size	2.21-2.48	7.64-10.84
Geometric Standard Deviation ($\sqrt{g}$)	1.57	3.77
95% Confidence Interval for $\sqrt{g}$	1.51-1.64	3.33-4.26
Approximate % of Fibers Considered Respirable*	72.3	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 1, JM 33, JM 53
Operation: Mainline and Special Line
Job or Sample Location: Wool Line Utility Man
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 214
Time Weighted Average Exposure (fibers/cc): 0.37

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.22	12.88
95% Confidence Interval for Count Median Size	2.06-2.38	11.13-15.04
Geometric Standard Deviation ($\sqrt{g}$)	1.70	3.01
95% Confidence Interval for $\sqrt{g}$	1.62-1.79	2.70-3.34
Approximate % of Fibers Considered Respirable*	73.4	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 19, JM 28, JM 42
Operation: Mainline and Special Line
Job or Sample Location: Special Line Take-off Hand Boxing
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 174
Time Weighted Average Exposure (fibers/cc): 0.43

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.05	15.67
95% Confidence Interval for Count Median Size	1.86-2.26	13.71-18.14
Geometric Standard Deviation ($\sqrt{g}$)	1.81	2.61
95% Confidence Interval for $\sqrt{g}$	1.70-1.93	2.35-2.89
Approximate % of Fibers Considered Respirable*	77.6	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 20, JM 35, JM 21
Operation: Mainline and Special Line
Job or Sample Location: Special Line Feeder
Fields Counted (all Samples Combined): 142
No. Fibers Sized (all samples combined): 198
Time Weighted Average Exposure (fibers/cc): 0.77

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.36	20.78
95% Confidence Interval for Count Median Size	2.18-2.55	18.20-23.53
Geometric Standard Deviation ($\sqrt{g}$)	1.73	2.47
95% Confidence Interval for $\sqrt{g}$	1.64-1.82	2.25-2.70
Approximate % of Fibers Considered Respirable*	69.2	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM-18, JM-27, JM-34
Operation: Mainline and Special Line
Job or Sample Location: Special Line Feeder
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 233
Time Weighted Average Exposure (fibers/cc): 0.44

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.02	16.03
95% Confidence Interval for Count Median Size	1.88-2.17	14.25-18.01
Geometric Standard Deviation ($\sqrt{g}$)	1.72	2.45
95% Confidence Interval for $\sqrt{g}$	1.64-1.81	2.25-2.66
Approximate % of Fibers Considered Respirable*	78.1	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 9, JM 16, JM 15
Operation: Mainline and Special Line
Job or Sample Location: Clay Coater
Fields Counted (all Samples Combined): 261
No. Fibers Sized (all samples combined): 231
Time Weighted Average Exposure (fibers/cc): 0.52

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.34	9.1
95% Confidence Interval for Count Median Size	2.21-2.48	7.64-10.84
Geometric Standard Deviation ($\sqrt{g}$)	1.57	3.77
95% Confidence Interval for $\sqrt{g}$	1.51-1.64	3.33-4.26
Approximate % of Fibers Considered Respirable*	74.9	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 124, JM 111, JM 109
Operation: Small Panel
Job or Sample Location: Line Feeder
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 172
Time Weighted Average Exposure (fibers/cc): 0.61

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.99	16.63
95% Confidence Interval for Count Median Size	1.82-2.17	14.57-18.93
Geometric Standard Deviation (σ_g)	1.79	2.36
95% Confidence Interval for σ_g	1.69-1.91	2.15-2.59
Approximate % of Fibers Considered Respirable*	79.7	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 96, JM 108, JM 131
Operation: Small Panel
Job or Sample Location: Saw feeder
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 271
Time Weighted Average Exposure (fibers/cc): 1.12

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.26	19.43
95% Confidence Interval for Count Median Size	2.12-2.40	17.46-21.32
Geometric Standard Deviation ($\sqrt{g}$)	1.67	2.28
95% Confidence Interval for $\sqrt{g}$	1.60-1.75	2.12-2.44
Approximate % of Fibers Considered Respirable*	70.1	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 98, JM 100, JM 112
Operation: Small Panel
Job or Sample Location: Saw take-off
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 245
Time Weighted Average Exposure (fibers/cc): 0.99

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.10	19.28
95% Confidence Interval for Count Median Size	1.97-2.24	17.39-20.98
Geometric Standard Deviation ($\sqrt{g}$)	1.66	2.09
95% Confidence Interval for $\sqrt{g}$	1.56-1.77	1.95-2.23
Approximate % of Fibers Considered Respirable*	85.7	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 61, JM 89
Operation: Small Panel
Job or Sample Location: Feeder M & J
Fields Counted (all Samples Combined): 174
No. Fibers Sized (all samples combined): 167
Time Weighted Average Exposure (fibers/cc): 0.57

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.45	20.86
95% Confidence Interval for Count Median Size	2.20-2.72	17.51-24.45
Geometric Standard Deviation ($\sqrt{g}$)	1.97	2.94
95% Confidence Interval for $\sqrt{g}$	1.82-2.12	2.61-3.31
Approximate % of Fibers Considered Respirable*	62.9	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 71, JM 85
Operation: Small Panel
Job or Sample Location: Feeder M & J
Fields Counted (all Samples Combined): 175
No. Fibers Sized (all samples combined): 197
Time Weighted Average Exposure (fibers/cc): 0.52

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.39	19.11
95% Confidence Interval for Count Median Size	2.20-2.59	16.49-21.47
Geometric Standard Deviation ($\sqrt{g}$)	1.77	2.28
95% Confidence Interval for $\sqrt{g}$	1.67-1.87	2.10-2.48
Approximate % of Fibers Considered Respirable*	71.6	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 67, JM 86
Operation: Panel
Job or Sample Location: M & J Operator
Fields Counted (all Samples Combined): 200
No. Fibers Sized (all samples combined): 165
Time Weighted Average Exposure (fibers/cc): 0.52

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.91	11.03
95% Confidence Interval for Count Median Size	1.72-2.14	9.13-13.30
Geometric Standard Deviation ($\sqrt{g}$)	2.11	3.36
95% Confidence Interval for $\sqrt{g}$	1.95-2.30	2.93-3.83
Approximate % of Fibers Considered Respirable*	79.4	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 70, JM 82
Operation: Small Panel
Job or Sample Location: Greenlee Feeder
Fields Counted (all Samples Combined): 183
No. Fibers Sized (all samples combined): 143
Time Weighted Average Exposure (fibers/cc): 0.45

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.24	17.19
95% Confidence Interval for Count Median Size	2.04-2.45	14.82-19.76
Geometric Standard Deviation ($\sqrt{g}$)	1.72	2.36
95% Confidence Interval for $\sqrt{g}$	1.61-1.83	2.13-2.61
Approximate % of Fibers Considered Respirable*	74.1	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 94, JM 101, JM 122
Operation: Small Panel
Job or Sample Location: Greenlee Feeder
Fields Counted (all Samples Combined): 317
No. Fibers Sized (all samples combined): 312
Time Weighted Average Exposure (fibers/cc): 1.50

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.42	24.40
95% Confidence Interval for Count Median Size	2.29-2.56	21.97-26.84
Geometric Standard Deviation ($\sqrt{g}$)	1.64	2.42
95% Confidence Interval for $\sqrt{g}$	1.58-1.71	2.25-2.59
Approximate % of Fibers Considered Respirable*	61.5	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 92, [illegible], JM 124
Operation: Small Panel
Job or Sample Location: Take-off Greenlee
Fields Counted (all Samples Combined): 20
No. Fibers Sized (all samples combined): 104
Time Weighted Average Exposure (fibers/cc): 0.44

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.53	21.21
95% Confidence Interval for Count Median Size	2.26-2.83	17.67-25.23
Geometric Standard Deviation ($\sqrt{g}$)	1.77	2.47
95% Confidence Interval for $\sqrt{g}$	1.64-1.92	2.18-2.80
Approximate % of Fibers Considered Respirable*	70.2	

Respirable fibers are defined as those which are both less than 3.5 μM In diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 99, JM 105, JM 123
Operation: Small Panel
Job or Sample Location: Greenlee Operator
Fields Counted (all Samples Combined): 257
No. Fibers Sized (all samples combined): 354
Time Weighted Average Exposure (fibers/cc): 0.99

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, µM	2.18	14.71
95% Confidence Interval for Count Median Size	2.08-2.28	13.49-15.76
Geometric Standard Deviation ($\sqrt{g}$)	1.52	2.09
95% Confidence Interval for $\sqrt{g}$	1.48-1.57	1.98-2.21
Approximate % of Fibers Considered Respirable*	80.3	

Respirable fibers are defined as those which are both less than 3.5 µM in diameter and less than 50 µM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 66, JM 83
Operation: Small Panel
Job or Sample Location: Greenlee Operator
Fields Counted (all Samples Combined): 163
No. Fibers Sized (all samples combined): 203
Time Weighted Average Exposure (fibers/cc): 1.12

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.38	14.38
95% Confidence Interval for Count Median Size	2.18-2.58	12.37-16.51
Geometric Standard Deviation ($\sqrt{g}$)	1.82	2.80
95% Confidence Interval for $\sqrt{g}$	1.71-1.93	2.52-3.16
Approximate % of Fibers Considered Respirable*	73.9	

*Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 91, JM 106, JM 115
Operation: Small Panel
Job or Sample Location: Punch Press Feeder
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 93
Time Weighted Average Exposure (fibers/cc): 0.37

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.82	12.23
95% Confidence Interval for Count Median Size	1.66-1.99	10.18-14.58
Geometric Standard Deviation ($\sqrt{g}$)	1.55	2.38
95% Confidence Interval for $\sqrt{g}$	1.45-1.65	2.10-2.70
Approximate % of Fibers Considered Respirable*	87.0	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 119, JM 125, JM 117
Operation: Small Panel
Job or Sample Location: Asst. Tenner Operator
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 138
Time Weighted Average Exposure (fibers/cc): 0.46

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.92	12.12
95% Confidence Interval for Count Median Size	1.77-2.07	10.29-14.12
Geometric Standard Deviation ($\sqrt{g}$)	1.57	2.54
95% Confidence Interval for $\sqrt{g}$	1.49-1.66	2.27-2.87
Approximate % of Fibers Considered Respirable*	86.2	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 132, JM 110
Operation: Small Panel
Job or Sample Location: Relief Operator Feeder
Fields Counted (all Samples Combined): 200
No. Fibers Sized (all samples combined): 42
Time Weighted Average Exposure (fibers/cc): 0.22

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.28	12.77
95% Confidence Interval for Count Median Size	1.78-2.91	9.14-15.58
Geometric Standard Deviation ($\sqrt{g}$)	2.20	2.88
95% Confidence Interval for $\sqrt{g}$	1.85-2.62	2.29-3.66
Approximate % of Fibers Considered Respirable*	69.0	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 77, JM 79
Operation: Small Panel
Job or Sample Location: Relief Operator
Fields Counted (all Samples Combined): 200
No. Fibers Sized (all samples combined): 186
Time Weighted Average Exposure (fibers/cc): 0.46

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, µM	2.08	15.16
95% Confidence Interval for Count Median Size	1.93-2.24	13.54-16.69
Geometric Standard Deviation ($\sqrt{g}$)	1.68	2.05
95% Confidence Interval for $\sqrt{g}$	1.59-1.77	1.90-2.21
Approximate % of Fibers Considered Respirable*	78.5	

Respirable fibers are defined as those which are both less than 3.5 µM in diameter and less than 50 µM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 65, JM 78
Operation: Small Panel
Job or Sample Location: Relief Operator
Fields Counted (all Samples Combined): 153
No. Fibers Sized (all samples combined): 233
Time Weighted Average Exposure (fibers/cc): 0.98

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.24	17.56
95% Confidence Interval for Count Median Size	2.09-2.41	15.72-19.39
Geometric Standard Deviation ($\sqrt{g}$)	1.73	2.24
95% Confidence Interval for $\sqrt{g}$	1.64-1.81	2.07-2.41
Approximate % of Fibers Considered Respirable*	71.7	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 95, JM 104, JM 127
Operation: Small Panel
Job or Sample Location: Relief Feeder
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 81
Time Weighted Average Exposure (fibers/cc): 0.28

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.92	11.45
95% Confidence Interval for Count Median Size	1.74-2.12	9.19-14.02
Geometric Standard Deviation ($\sqrt{g}$)	1.56	2.58
95% Confidence Interval for $\sqrt{g}$	1.45-1.67	2.38-2.80
Approximate % of Fibers Considered Respirable*	86.4	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 60, JM 87
Operation: Small Panel
Job or Sample Location: Hand Trucker
Fields Counted (all Samples Combined): 96
No. Fibers Sized (all samples combined): 212
Time Weighted Average Exposure (fibers/cc): 1.15

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.37	21.29
95% Confidence Interval for Count Median Size	2.21-2.54	18.84-23.66
Geometric Standard Deviation ($\sqrt{g}$)	1.65	2.29
95% Confidence Interval for $\sqrt{g}$	1.57-1.73	2.12-2.48
Approximate % of Fibers Considered Respirable*	67.9	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 114, JM 118
Operation: Small Panel
Job or Sample Location: Take-off Operator
Fields Counted (all Samples Combined): 200
No. Fibers Sized (all samples combined): 83
Time Weighted Average Exposure (fibers/cc): 0.44

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.21	15.52
95% Confidence Interval for Count Median Size	1.95-2.49	9.11-19.24
Geometric Standard Deviation ($\sqrt{g}$)	1.75	2.68
95% Confidence Interval for $\sqrt{g}$	1.62-1.91	2.30-3.60
Approximate % of Fibers Considered Respirable*	72.3	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 113, JM 121, JM 120
Operation: Small Panel
Job or Sample Location: Take-off Operator
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 122
Time Weighted Average Exposure (fibers/cc): 0.25

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.72	11.48
95% Confidence Interval for Count Median Size	1.60-1.85	9.74-13.52
Geometric Standard Deviation ($\sqrt{g}$)	1.49	2.45
95% Confidence Interval for $\sqrt{g}$	1.41-1.57	2.19-2.75
Approximate % of Fibers Considered Respirable*	92.6	

*Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 63, JM 88
Operation: Small Panel
Job or Sample Location: Take-off Operator
Fields Counted (all Samples Combined): 67
No. Fibers Sized (all samples combined): 219
Time Weighted Average Exposure (fibers/cc): 1.95

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.68	24.77
95% Confidence Interval for Count Median Size	2.45-2.92	24.75-28.36
Geometric Standard Deviation ($\sqrt{g}$)	1.90	2.74
95% Confidence Interval for $\sqrt{g}$	1.72-2.02	2.48-3.02
Approximate % of Fibers Considered Respirable*	59.8	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 69
Operation: Small Panel
Job or Sample Location: Take-off Operator
Fields Counted (all Samples Combined): 60
No. Fibers Sized (all samples combined): 102
Time Weighted Average Exposure (fibers/cc): 0.40

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.56	18.07
95% Confidence Interval for Count Median Size	2.26-2.89	15.29-21.35
Geometric Standard Deviation ($\sqrt{g}$)	1.85	2.32
95% Confidence Interval for $\sqrt{g}$	2.01-1.69	2.06-2.61
Approximate % of Fibers Considered Respirable*	67.7	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 64, JM 81
Operation: Small Panel
Job or Sample Location: Take-off Operator
Fields Counted (all Samples Combined): 116
No. Fibers Sized (all samples combined): 201
Time Weighted Average Exposure (fibers/cc): 0.96

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.16	20.90
95% Confidence Interval for Count Median Size	1.97-2.37	17.97-23.80
Geometric Standard Deviation ($\sqrt{g}$)	1.91	2.71
95% Confidence Interval for $\sqrt{g}$	2.03-1.79	2.45-2.99
Approximate % of Fibers Considered Respirable*	66.7	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 90, JM 103, JM 128
Operation: Small Panel
Job or Sample Location: Take-off Operator
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 78
Time Weighted Average Exposure (fibers/cc): 0.31

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.09	15.61
95% Confidence Interval for Count Median Size	1.79-2.44	12.35-19.41
Geometric Standard Deviation ($\sqrt{g}$)	1.99	2.72
95% Confidence Interval for $\sqrt{g}$	1.78-2.22	2.31-3.18
Approximate % of Fibers Considered Respirable*	71.8	

*Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 74
Operation: Small Panel
Job or Sample Location: Inspector
Fields Counted (all Samples Combined): 69
No. Fibers Sized (all samples combined): 104
Time Weighted Average Exposure (fibers/cc): 0.34

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	1.66	12.49
95% Confidence Interval for Count Median Size	1.51-1.82	10.55-14.62
Geometric Standard Deviation ($\sqrt{g}$)	1.62	2.29
95% Confidence Interval for $\sqrt{g}$	.659-1.73	2.04-2.57
Approximate % of Fibers Considered Respirable*	90.4	

*Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 68
Operation: Small Panel
Job or Sample Location: Inspector (line)
Fields Counted (all Samples Combined): 100
No. Fibers Sized (all samples combined): 75
Time Weighted Average Exposure (fibers/cc): 0.18

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.31	16.10
95% Confidence Interval for Count Median Size	1.99-2.67	12.67-20.08
Geometric Standard Deviation ($\sqrt{g}$)	1.87	2.74
95% Confidence Interval for $\sqrt{g}$	1.69-2.08	2.30-3.19
Approximate % of Fibers Considered Respirable*	73.3	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 97, JM 116, JM 129
Operation: Small Panel
Job or Sample Location: Inspector
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 137
Time Weighted Average Exposure (fibers/cc): 0.32

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, μM	2.06	17.60
95% Confidence Interval for Count Median Size	1.88-2.26	17.33-19.82
Geometric Standard Deviation ($\sqrt{g}$)	1.71	2.10
95% Confidence Interval for $\sqrt{g}$	1.60-1.82	1.92-2.30
Approximate % of Fibers Considered Respirable*	72.3	

Respirable fibers are defined as those which are both less than 3.5 μM in diameter and less than 50 μM in length.

AIRBORNE FIBER SIZE DATA
Johns - Manville
Alexandria, Indiana

Sample Numbers: JM 93, JM 107, JM 130
Operation: Small Panel
Job or Sample Location: Inspector
Fields Counted (all Samples Combined): 300
No. Fibers Sized (all samples combined): 130
Time Weighted Average Exposure (fibers/cc): 0.47

Summary Of Airborne Fiber Size Statistics for all Samples Combined

Summary Parameter	Fiber Diameter	Fiber Length
Probit Analysis Correlation Coef.	.9	.9
Fiber Count Median Size, µM	2.24	23.26
95% Confidence Interval for Count Median Size	2.02-2.48	19.47-27.41
Geometric Standard Deviation ($\sqrt{g}$)	1.78	2.66
95% Confidence Interval for $\sqrt{g}$	1.66-1.91	2.35-3.00
Approximate % of Fibers Considered Respirable*	58.5	

Respirable fibers are defined as those which are both less than 3.5 µM in diameter and less than 50 µM in length.

DATE March 19, 1975
INDUSTRIAL HYGIENE SURVEY
ALL STATIONS

DIVISION ARCHITECTURAL & ENGINEERED PRODS. PLANT ALEXANDRIA DATE FEB 11, 1975

OCCUPATIONAL DUST

Station No.	Station Description	Hazard	TLV	Current Survey Result
D-1FO	G.R.S. - Under Conveyors - First Floor	Mineral Wool	None None	0.68 F/cc 1.52 F/cc
D-2FO	Mineral Wool Baler - Operator	Mineral Wool	5.00 mg/M^3 5.00 mg/M^3	0.20 mg/M^3 0.28 mg/M^3
D-3FO	Operator - Working Cupola #7 - Second Floor	Nuisance Nuisance	5.00 mg/M^3 5.00 mg/M^3	0.71 mg/M^3 0.70 mg/M^3
D-4FO	Charge Bucket Filling Operator - Third Floor	Nuisance Nuisance	5.00 mg/M^3 5.00 mg/M^3	1.08 mg/M^3 1.20 mg/M^3
D-6FO	Binder Mixer - Operator	13% Quartz 13% Quartz	0.67 mg/M^3 0.67 mg/M^3	0.30 mg/M^3 0.41 mg/M^3
D-7FO	North End Fourdrinier Control Platform - Operator	7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3	0.13 mg/M^3 0.34 mg/M^3
D-9FO	Trim Saw Control Panel - Operator	5% Quartz 5% Quartz	1.43 mg/M^3 1.43 mg/M^3	0.27 mg/M^3 0.20 mg/M^3
(D-10FO)	Trim Saw Take-Off - East of Said Saw - manual Stacking Process - Operator Sample	3% Quartz 3% Quartz	2.00 mg/M^3 2.00 mg/M^3	2.09 mg/M^3 1.57 mg/M^3
D-11FO	Trim Saw Take-Off - East of Said Saw at Conveyor - Operator	3% Quartz 3% Quartz	2.00 mg/M^3 2.00 mg/M^3	1.09 mg/M^3 1.25 mg/M^3
D-1F	Paint Mixing Platform - Operator	9% Quartz 9% Quartz	0.91 mg/M^3 0.91 mg/M^3	0.00 mg/M^3 0.32 mg/M^3
D-2F	Number One Panel Line - Clay Coater - Operator	5% Quartz 5% Quartz	1.43 mg/M^3 1.43 mg/M^3	0.00 mg/M^3 0.34 mg/M^3
(D-3F)	Number One Panel Line - Punch Press - Operator	8% Quartz 8% Quartz	1.00 mg/M^3 1.00 mg/M^3	1.12 mg/M^3 0.42 mg/M^3

DNO - Did Not Operate
( ) - Above TLV
* - Personal Protective Equipment Not Worn & Required
( ) - Peak Exposure

DATE March 14, 1975

INDUSTRIAL HYGIENE SURVEY
ALL STATIONS

DIVISION ARCHITECTURAL & ENGINEERED FOODS. PLANT ALEXANDRIA DATE FEB 11, 1975

OCCUPATIONAL DUST

Station No.	Station Description	Hazard	TLV	Current Survey Result
D-6F	Number One Panel Line - Second Spray Booth - Operator	7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3	0.00 mg/M^3 0.40 mg/M^3
D-7F	Number One Panel Line - Inspection Area - Operator	7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3	0.00 mg/M^3 0.00 mg/M^3
D-8F	Number One Panel Line - Take-Off and Packaging Area - Operator	7% Quartz 7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3 1.11 mg/M^3	0.30 mg/M^3 0.00 mg/M^3 0.22 mg/M^3
D-9F	Number Two Panel Line - Punch Press - Feed Operator	8% Quartz 8% Quartz	1.00 mg/M^3 1.00 mg/M^3	0.27 mg/M^3 0.06 mg/M^3
D-10F	Number Two Panel Line - Take-Off Operator	8% Quartz 8% Quartz	1.00 mg/M^3 1.00 mg/M^3	0.00 mg/M^3 0.07 mg/M^3
D-11F	Number One Tile Line - Feed Multi-Saw - Operator	7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3	0.36 mg/M^3 0.64 mg/M^3
D-12F	Number One Tile Line - Feed Pierce Punch Press	7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3	D.N.O. D.N.O.
D-13F	Number One Tile Line - Take-Off Pierce Punch Press	7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3	D.N.O. D.N.O.
D-14F	Number One Tile Line - Tenonner	7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3	0.55 mg/M^3 0.01 mg/M^3
D-15F	Number One Tile Line - First Paint Spray Booth - Operator	7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3	0.11 mg/M^3 0.35 mg/M^3
D-16F	Number One Tile Line - Take-Off and Packaging Area - Operator	7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3	0.00 mg/M^3 0.00 mg/M^3
D-17F	Number One Tile Line - Vent Punch Press - Feed	7% Quartz 7% Quartz	1.11 mg/M^3 1.11 mg/M^3	D.N.O. D.N.O.

DNO - Did Not Operate
( ) - Above TLV
* - Personal Protective Equipment Not Worn & Required
() - Peak Exposure

DATE March 10, 1975

INDUSTRIAL HYGIENE SURVEY

ALL STATIONS

DIVISION ARCHITECTURAL & ENGINEERED PRODS. PLANT ALEXANDRIA DATE FEB 11, 1975

OCCUPATIONAL DUST

Station No.	Station Description	Hazard	TLV	Current Survey Result
D-18F	Number One Tile Line - Vent	7% Quartz	1.11 mg/M^3	D.N.O.
	Punch Press - Take-Off	7% Quartz	1.11 mg/M^3	D.N.O.
D-19F	Number Two Tile Line - Feed	7% Quartz	1.11 mg/M^3	0.32 mg/M^3
	Multi-Saw - Operator	7% Quartz	1.11 mg/M^3	0.20 mg/M^3
D-20F	Number Two Tile Line - IRP -	7% Quartz	1.11 mg/M^3	0.96 mg/M^3
	Operator	7% Quartz	1.11 mg/M^3	0.60 mg/M^3
D-21F	Number Two Tile Line - Feed -	7% Quartz	1.11 mg/M^3	D.N.O.
	Punch Press	7% Quartz	1.11 mg/M^3	D.N.O.
D-22F	Number Two Line - Manual Take-	7% Quartz	1.11 mg/M^3	0.24 mg/M^3
	Off - Operator	7% Quartz	1.11 mg/M^3	1.01 mg/M^3
D-23F	Operator - Number One Tile Line -	7% Quartz	1.11 mg/M^3	0.22 mg/M^3
	Inspection Area	7% Quartz	1.11 mg/M^3	0.00 mg/M^3
D-24F	Operator - Park Saw	8% Quartz	1.00 mg/M^3	0.31 mg/M^3
		8% Quartz	1.00 mg/M^3	0.06 mg/M^3
D-1S	Operator - Receiving Starch (bagged or bulk)	Starch	5.00 mg/M^3	0.00 mg/M^3
D-2S	Operator - Receiving Clay	Clay	5.00 mg/M^3	D.N.O.
D-3S	Operator - Forklift Truck -	7% Quartz	1.11 mg/M^3	0.00 mg/M^3
	Finishing End - Panel Line 1 or 2	7% Quartz	1.11 mg/M^3	0.10 mg/M^3
D-4S	Operator - Power Sweeper	8% Quartz	1.00 mg/M^3	0.35 mg/M^3

DNO - Did Not Operate

( ) - Above TLV

* - Personal Protective Equipment Not Worn & Required

() - Peak Exposure.

Johns-Manville

C. D. Gullekson - Alexandria January 25, 1974

D. R. Christensen - R&D Ctr.

F. J. Angelos - Waukegan

SPECIAL SILICA SAMPLINGS - ALEXANDRIA, A&EP DIVISION

During the recent annual Industrial Hygiene Survey conducted January 15, 1974, the Industrial Hygienist, at his own discretion, collected a number of airborne dust samples. The results follow:

Station	Description	Hazard	TLV	Results
D-9F0	Trim Saw Control Panel	5% Quartz	25.0 1.43	6.1 MPPCF 1.03 mg/M^3
D-11F0	Trim Saw Take-Off - East of Said Saw at Conveyor	5% Quartz	25.0 25.0 1.43	4.7 MPPCF 6.2 MPPCF 3.29 mg/M^3
D-17F	No. 1 Tile Line-Vent Punch Press Take-Off	5% Quartz	25.0 1.43	17.8 MPPCF 2.70 mg/M^3
D-18F	No. 1 Tile Line-Vent Punch Press Take-Off	5% Quartz	25.0 1.43	8.5 MPPCF 1.44 mg/M^3
D-1S	Unloading Bagged Starch	Starch	5.00	0.19 mg/M^3

Please refer any questions regarding this special survey work to F. J. Angelos, Industrial Hygienist, Waukegan.

Prepared by: K. J. Williams

D. R. Christensen

bjj

( ) - ABOVE TLV

Johns-Manville Internal Correspondence

To: Fiber Glass Environmental Committee Members

Date: December 10, 1973

From: D. R. Christensen - R&D Center

Copies: See Below

Subject: AIR BORNE ROCK WOOL ANALYSIS - ALEXANDRIA PLANT

As proposed at the September 24th meeting of the Fiber Glass Environmental Committee meeting, samples were taken to determine the number and size distribution of air borne rock wool fibers. The Waukegan field office and the Denver laboratory of the Environmental Control Department conducted the sampling and concentration analysis, respectively. The sampling was conducted on Millipore, cellulose ester, filter membranes, pore size, 0.8 μ, 37 mm diameter, sampling rate of 2.0 LPM, sample times ranged from 40 to 120 minutes as determined by the hygienist. Analysis was done at 400x magnification using phase contrast microscopy.

The results of the analysis are as follows:

Station Number	Description	FIB/cc >5u	FIB/cc Total
D-1FO	Nodulator Conveyors	0.8	1.0
D-2FO	Mineral Wool Baler	0.5	0.6
D-9FO	Trim Saw Control Panel	4.8	6.6
D-11FO	Trim Saw Take Off	5.3	6.0
D-12FO	Hydropulper	0.0	0.3
D-3F	No. 1 Panel Line--Punch Press	0.9	1.5
D-4F	No. 1 Panel Line--Fissure Roll	2.1	2.2
D-7F	No. 1 Panel Line--Inspection Area	0.5	0.6
D-11F	No. 1 Tile Line--Feed Multi-Saw	2.5	3.3
D-12F	No. 1 Tile Line--Feed Pierce Punch Press	3.5	6.2
D-14F	No. 1 Tile Line--Tenonner	2.9	3.6
D-16F	No. 1 Tile Line--T.O. Packaging	1.6	2.0
D-21F	No. 2 Tile Line--Feed Punch Press	1.7	2.3
D-X	No. 2 Panel Line--RIP. Saw	0.2	0.8

DATE December 22, 1972

ANNUAL INDUSTRIAL HYGIENE SURVEY
SURVEY RESULTS - ALL STATIONS

Architectural & EngineeredDIVISION Alexandria PLANT November 29, 1972 SURVEY DATE

STATION NUMBER	STATION DESCRIPTION	HAZARD	TLV	SURVEY RESULT
D-1FO	GRS Under Conveyors 1st Floor	Nuisance Nuisance	50.0 MPPCF 5.0 mg/m^3	1.5 MPPCF 0.0 mg/m^3
D-2FO	Mineral Wool Baler	Nuisance	50.0 MPPCF	2.3 MPPCF
D-3FO	GRS Cupola Pouring Floor In Front of #7 Cupola 2nd Floor	Nuisance	50.0 MPPCF	1.7 MPPCF
D-4FO	Charge Bucket Filling Operator - 3rd Floor	Nuisance	50.0 MPPCF	4.4 MPPCF
D-5FO	GRS in Front of #7 Copula Feed - 3rd Floor	Nuisance	50.0 MPPCF	6.9 MPPCF
D-6FO	Binder Mixer	22% Quartz 13% Respirable Quartz	9.3 MPPCF 0.67 mg/m^3	23.4 MPPCF 1.26 mg/m^3
D-7FO	North End Fourdrinier Control Platform	7% Quartz	20.8 MPPCF	2.1 MPPCF
D-8FO	GRS 10' East of Oven (450') Door No. 50	7% Quartz	20.8 MPPCF	10.5 MPPCF
D-9FO	Trim Saw Control Panel	5% Quartz 5% Respirable Quartz	25.0 MPPCF 1.43 mg/m^3	11.8 MPPCF 1.54 mg/m^3
D-10FO	Trim Saw Take-Off East of Said Saw Manual Stacking Process	5% Quartz	25.0 MPPCF	14.6 MPPCF
D-11FO	Trim Saw Take-Off East of Said Saw at Conveyor	Did not operate		
D-12FO	(Hog) Scrap Grinder	Did not operate		

SURVEY RESULTS - ALL STATIONS

Architectural & Engineered DIVISION Alexandria PLANT November 29, 1972 SURVEY PERIOD

NUMBER	STATION DESCRIPTION	HAZARD	TLV	SURVEY RESULTS
D-1F	Paint Mixing Platform	9% Quartz	17.9 MPPCF	6.5 MPPCF
D-2F	No. 1 Panel Line - Clay Coater	5% Quartz	25.0 MPPCF 1.43 mg/m^3	8.7 MPPCF 0.64 mg/m^3
D-3F	No. 1 Panel Line - Punch Press	8% Quartz	19.2 MPPCF 1.0 mg/m^3	7.5 MPPCF 0.76 mg/m^3
D-4F	No. 1 Panel Line - Fissure Roll	7% Quartz	20.8 MPPCF	4.0 MPPCF
D-5F	No. 1 Panel Line - Rip Saw	7% Quartz	20.8 MPPCF	4.1 MPPCF
D-6F	No. 1 Panel Line - 2nd Spray Booth (CFO)	7% Quartz	20.8 MPPCF	6.1 MPPCF
D-7F	No. 1 Panel Line - Inspection Area	7% Quartz	20.8 MPPCF	20.0 MPPCF
D-8F	No. 1 Panel Line - Take-Off and Packaging Area	7% Quartz	20.8 MPPCF 1.0 mg/m^3	3.4 MPPCF 0.29 mg/m^3
D-9F	No. 2 Panel Line - Punch Press	8% Quartz	19.2 MPPCF	4.4 MPPCF
D-10F	No. 2 Panel Line - Sample Taken at Rip Saw	8% Quartz	19.2 MPPCF	1.8 MPPCF
D-11F	No. 1 Tile-Feed Multi-Saw	7% Quartz	20.8 MPPCF	2.1 MPPCF
D-12F	No. 1 Tile Line-Feed Pierce Punch Press	7% Quartz	20.8 MPPCF 1.11 mg/m^3	12.3 MPPCF 0.0 mg/m^3
D-13F	No. 1 Tile Line - Take-Off Pierce Punch Press	7% Quartz	20.8 MPPCF 1.11 mg/m^3	4.3 MPPCF 0.0 mg/m^3
D-14F	No. 1 Tile Line - Tenonner	7% Quartz	20.8 MPPCF 1.11 mg/m^3	12.2 MPPCF 0.0 mg/m^3
D-15F	No. 1 Tile Line - First Paint Spray Booth	7% Quartz	20.8 MPPCF 1.11 mg/m^3	10.0 MPPCF 0.0 mg/m^3
D-16F	No. 1 Tile Line - Take-Off and Packaging Area	5% Quartz	25.0 MPPCF 1.43 mg/m^3	17.0 MPPCF 0.0 mg/m^3
D-17F	No. 1 Tile Line - Vent Punch Press - Feed	% Quartz	Did not operate	
D-18F	No. 1 Tile Line - Vent Punch Press - Take-Off	% Quartz	Did not operate	

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SURVEY RESULTS - ALL STATIONS

Architectural & Engineered DIVISION Alexandria PLANT November 29, 1972 SURVEY PERIOD

NUMBER	STATION DESCRIPTION	HAZARD	TLV	SURVEY RESULTS
D-19F	No. 2 Tile Line - Feed Multi Saw	% Quartz	Did not operate	
D-20F	No. 2 Tile Line - IRP	% Quartz	Did not operate	
D-21F	No. 2 Tile Line - Feed Punch Press	% Quartz	Did not operate	
D-22F	No. 2 Tile Line - Manual Take Off	% Quartz	Did not operate	
D-23F	GRS No. 1 Tile Line Inspection Area	5% Quartz	25.0 MPPCF 1.43 mg/m^3	3.9 MPPCF 0.0 mg/m^3

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