## I. INTRODUCTION

A survey to determine the adequacy of the existing ventilation system and associated dust collection equipment to control airborne dust was performed in the production area of the Pittsburgh-Corning Tyler, Texas plant on May 7, 1969 by Dr. Morton Corn. Dr. Corn was accompanied and assisted by Mr. John L. Hyde, of the Engineering Section, Pittsburgh-Corning Research Center, 800 Presque Isle Drive, Pittsburgh, Pennsylvania 15239. The survey was performed at the request of Mr. Byrl M. Stout, Vice President of Manufacturing, Pittsburgh-Corning Corporation. The request was mad on April 28, 1969 at the Pittsburgh-Corning Research Center during a meeting called to discuss the enclosed citation of the Tyler plant by the Department of Labor (see Appendix A). The survey was concentrated exclusively on assessment of hygienic risk to airborne amosite asbestos dust and evaluation of plant facilities to reduce this risk.

During the period of the survey outdoor weather conditions were clear, sunny and warm, with temperatures in the 70-80°F rang . Humidity was high. (Relative humidity in plant approximately 75%).*

The author is unaware of any special precautions taken to ensure that the ventilation system was operating in anything but the "normal" mode during this survey. Therefore, results of measurements made in this survey must be considered representative of conditions in the plant during summer months when doors and windows are open. In general, winter conditions impose more

*Measured at 11:45 AM in plant.

stringent requirements on plant dust control systems because windows and doors are closed to preserve heat. There is no benefit of "dilution ventilation" from outdoor air. With the same facilities for dust removal by a ventilation system, in-plant dust in air concentrations during winter months will usually exceed those present during summer months.

## II. SUMMARY AND RECOMMENDATIONS

An industrial hygiene and ventilation survey of this plant performed on May 7, 1969 suggests that asbestos fiber concentrations are high in worker breathing zones (Builder and Feeder Operators) and at breathing level in certain other plant locations. There are no hygienic guidelines for concentration of Amosite fibers in air and the judgment of excessive dustiness in this plant is referred to guidelines for Chrysotile dust. Utilization of hygienic guidelines for Chrysotile asbestos concentration in air for Amosite asbestos fibers in air is an accepted procedur in the U. S. at this time. The finding of excessive dustiness at "spot" sampling locations in the plant is consistent with survey measurements which revealed inadequate quantities of air at local exhaust hoods. Insufficient air at local sites of dust emission was reflected in low air velocities at hood faces and low air conveying velocities in branch lines and ducts. The ventilation system was estimated for Builder and Feeder areas to move approximately one sixth of the air required to ventilate these processes.

In addition to the inadequacies of the ventilation system and the resultant excessive dustiness, it was found that general housekeeping is poor in the plant. Also, during the entire day of the survey not one employee in the production area was observed to wear a respirator.

In the opinion of the author, this short survey strongly suggests that employees at this plant are being exposed, on a

daily basis, to excessive concentrations of Amosite asbestos dust. It is recommended that efforts be immediately focussed on design of a complete ventilation and dust collection system at this plant. The system is rudimentary in concept and is underdesigned. Efforts to "doctor up" this system would probably lead to a less than satisfactory system and would involve expenditures in time and equipment equivalent to those associated with design of a new system.

## III. THRESHOLD LIMIT VALUE OF ASBESTOS DUST

"The threshold limit values refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect. Because of wide variation in individual susceptibility exposures of an occasional individual at or ven below the threshold limit may not prevent discomfort, aggravation of a pre-existing condition, or occupational illness.

"Threshold limits should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous conditions."*

The American Conference of Governmental Industrial Hygienists had, in 1967, a T.L.V. for asbestos of 5 million particles per cubic foot, as determined by impinger sampling and counting by light-field techniques. In a considered revision (1968), the Conference endorsed the retention of this T.L.V. for "most forms of asbestos". However, for crocidolite, because of the production of mesotheliomas, it was recommended that workers be equipped with air-supplied helmets because "no safe limit can be established for this form of asbestos at this time."

The British Occupational Hygiene society recently issued hygienic standards for chrysotile asbestos dust.** The standards are based on the objective that the risk of contracting asbestos

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* Extracted from the Preface, Threshold Limit Values for 1968. American Conference of Governmental Industrial Hygienists, 1014 Broadway, Cincinnati, Ohio 45202.

** Ann. Occup. Hyg. 11, 47-69 (1968).

be reduced to 1 per cent of those who have a lifetime's exposure to the dust. By "asbestosis" the committee meant the earliest demonstrable effects on the lung due to asbestos. These standards are cited here because they are more stringent than the U. S. guideline referred to above. The exposure guidelines are:



TABLE 1

BRITISH HYGIENIC GUIDELINES FOR ASBESTOS DUST

| DUST CATEGORY | CONCENTRATION AVERAGED OVER 3 MONTHS | |
|---|---|---|
| | Fibers/cm$^3$ | MPPCF* |
| Negligible | 0 - 0.4 | 0.011 |
| Low | 0.5 - 1.9 | 0.014 - 0.054 |
| Medium | 2.0 - 10 | 0.054 - 0.28 |
| High | Over 10 | Over 0.28 |

The concentrations refer to fibers greater than 5 microns in length as determined by the membrane filter method.

The problem faced today with respect to Amosite asbestos is that there simply is insufficient data for dosage-response prediction of exposed populations.** The guidelines for Chrysotile will undoubtedly continue to be the threshold limit value guideline for exposure to other forms of asbestos dust for years to come.

In a survey of dust concentrations in the Unibestos facility, Port Allegheny Plant of Pittsburgh-Corning, simultaneous impinger

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*Million particles per cubic foot (as fibers).

**Stokinger, H. E."Development of TLV's for Fibrous Materials." Paper presented at Special Session on Fibers, Annual Meeting of American Industrial Hygiene Association, Denver, Colorado. May, 1969.

and membrane filter sampling was performed. The conversion of values obtained by one method to those of the other method was not possible. At each location, the numbers of the fibers and particles varied. The impinger method is based on particles while the membrane filter method assesses only fibers. For the purposes of this preliminary survey, either method would yield data suggesting that airborne dust concentrations were acceptable or unacceptable. Therefore, the membrane filter technique was used and the British guideline is applicable (Table I).

## IV. DESCRIPTION OF SAMPLING AND ANALYTICAL METHODS



### A. Assessment of Airborne Dust

Samples were obtained at either worker breathing zones as they performed their routine tasks, or at breathing level to represent "background air". Samples were obtained during a five or ten minute period at a flow rate of 21 lpm by utilizing a vacuum pump in conjunction with a filter holder and sample filter. The system was precalibrated in terms of pump inlet pressure and air flow with all sampling line components, including filter, in plac

A membrane filter (Type HA Millipore) was used to obtain samples for microscopic evaluation of fiber and dust particle concentrations. This paper is composed of pores 0.45 microns in size and has been shown to retain, with 100% efficiency, particles down to 0.05 micron diameter.[1]

The filter was first visually examined to detect any loose dust or uneven dust deposition. In the few cases where the filter deposit did not pass this examination, it was necessary to resuspend the collected dust in distilled water and refilter this suspension on VF grade Millipore filter to assure an even dust distribution over the entire filter area. A pie shaped segment of the filter was then placed on a microscope slide and rendered completely transparent with Cargille certified index of refraction liquids. Cargille liquid of index of refraction 1.500 was usually most suitable. The counting of the dust particles and the counting and sizing of asbestos fibers was performed with the aid of a



[1] Megaw, W. J. and Wiffen, R. D.: Int. J. Air Water Poll. 1, 501 (1963).

Zeiss Photomicroscope using Phase Contrast Illumination. The objective lens was a Zeiss Neofluor Ph 63x with a numerical aperture of 0.90. The eyepiece had a magnification of 20x and contained a calibrated Porton graticule. The optovar feature of the Zeiss scope contributed to the total magnification of 2016x. Resolution was approximately 0.35 microns. Particles and fibers of size 0.30 microns could be detected.



In the evaluation procedure, all particles and fibers in the Porton field of view were counted and the fibers were grouped by fiber length into three categories (less than five microns, five to ten microns, and larger than ten microns). This procedure was repeated for a number of randomly selected fields on the face of the filter. Because only a portion of the total filter area was evaluated by this method, it was necessary to correct the count by the ratio of the total filter area to the evaluated area. The resultant particle or fiber number was divided by the volume of the air sample to obtain dust or fiber concentration expressed as millions of particles per cubic foot (MPPCF).

The statistical reliability of the evaluation was expressed as the standard deviation, calculated as $N^{1/2}$, where N is the particle or fiber count.

The procedure outlined follows, in its essential points, that recommended by J. R. Lynch and H. E. Ayer in their article "Measurement of Asbestos Exposure" which appeared in the Journal of Occupational Medicine, Volume 10, January, 1968.

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B. Measurement of Air Velocities at Hoods

A calibrated velometer was used to measure face velocities of hoods and room air velocities.*

C. Air Velocities in Ventilation Ducts

A standard 1/4" diameter pitot tube was used in conjunction with a Dwyer 1:10 inclined manometer to determine velocity pressures in ducts. Ten point traverses were taken in larger ducts (>6" diameter); centerline readings only were obtained in smaller ducts. All measurements are considered to be approximate (estimated reliability ± 10%) because of the conditions imposed by the system. For example, there were few locations where measurements could be made 10 diameters from entries or elbows. Also, the standard pitot tube should not be used in lines smaller than 8" diameter. .However, the reliability of measurements achieved is perfectly adequate for a preliminary survey of the type undertaken here.







*Alnor Velometer, Illinois Testing Laboratory, Chicago, Illinois.

## V. RESULTS AND DISCUSSION

### A. Airborne Dust Concentrations

Measured concentrations of dust particles and asbestos fibers are summarized in Table 2. In order to facilitate comparison with the guidelines from Table 1, the last two columns (5 and 6) of Table 2 for fiber concentrations have been add d to yield Column 7, which should be compared with Column 3 of Table 1. On this basis, operators at the feeders are receiving High exposures. Builder operators are also receiving High xposures. Although much dust is present at the cutting operation the single sample obtained suggests that particles and not fibers ar the major contributors to the dispersion. Table 2 suggests that outdoor air is Negligible in terms of fiber content, as is the dust collector effluent. However, the aisle of the warehouse opposite the Feeders is High, suggesting the large zone of influence of the dust sources in the Feeder areas. It cannot be too strongly stressed that these are "spot" samples and must be viewed as suggestive results only. However, they do convey a picture of high dust exposures in Feeder and Builder areas, as well as in adjacent zones. The author must state, based on previous experience, that dust concentrations in plant air would almost certainly increase during winter months.



### B. Local Exhaust Hood Face Velocities

There are design guidelines for face velocities of air at local exhaust hoods* In general, a face velocity of 100 fpm is



*See Chapter 5, Industrial Ventilation, 10th Ed. American Conference of Governmental Industrial Hygienists, 1014 Broadway, Cincinnati, Ohio.

TABLE 2

ASBESTOS FIBER CONCENTRATIONS AT SELECTED PLANT LOCATIONS

| Date and Time of Sample | Description of Sampling Site | Dust Particle or Fiber Counts, Expressed as Millions of Particles Per Cubic Foot + Standard Deviation | | | | |
|---|---|---|---|---|---|---|
| | | Particles | Fibers | | | Total (Cols. 5 + 6) |
| | | | <5 μ | 5-10 μ | >10 μ | |
| 5/7 2:30 PM-2:35 PM | Breathing zone of Feeder Operator, Lines 1 and 2 during sweeping, feeding. (Note: cooling fan at dust collector on.) | 12.3±0.6 | 3.60±0.28 | 0.64±0.12 | 0.14±0.04 | 0.92 |
| 5/7 2:36 PM-2:46 PM | Breathing level in Walkway adjacent to Feeder No. 3. | 10.5±0.5 | 3.40±0.19 | 0.34±0.06 | 0.14±0.04 | 0.48 |
| 5/7 2:50 PM- | Effluent from Dust Collector Bags approx. 1" from Bag. Dust collector for Lines 1 and 2. | 2.9±0.2 | 0.71±0.09 | 0.06±0.03 | 0.02±0.02 | 0.08 |
| 5/7 3:05 PM-3:15 PM | Outdoor air sample at breathing level on loading dock near Oil House. | 1.5±0.2 | 0.16±0.04 | 0.03±0.02 | 0.05±0.02 | 0.08 |
| 5/7 3:15 PM-3:25 PM | Breathing level in aisle, Unibestos Warehouse opposite Feeder Lines 1 and 2. | 35.0±1.7 | 1.26±0.12 | 0.18±0.03 | 0.10±0.02 | 0.28 |
| 5/7 3:30 PM-3:40 PM | Breathing zone of Builder Operator, Line No. 3 (3/4 x 1 Unibestos). Cycle of loading, building, spraying, etc. Note: Fans on over Lines 2 and 3. | 3.2±0.2 | 1.48±0.09 | 0.18±0.03 | 0.10±0.02 | 0.28 |
| 5/ 3:45 PM-3:56 PM | Breathing zone of Builder Operator, Line No. 3. Cycle of loading, building, spraying, etc. | 12.5±0.6 | 4.02±0.20 | 0.20±0.04 | 0.21±0.05 | 0.41 |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |

TABLE 2 (continued)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5/7 | 4:05 pm-<br>4:15 pm | Breathing zone of Operator, Large Cutting Saw.<br>Note: Door adjacent to cutting operation open to outdoor air. | 37.4±1.8 | 1.11±0.11 | 0.07±0.03 | 0.05±0.024 | 0.12 |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |

recommended for control of fume and vapors, while higher velocities are not uncommon for control of materials emitted with great force. At the Port Allegheny Plant, Mr. John Hyde, of Pittsburgh-Corning, and the author are designing for 200 fpm face velocity at hoods which interface with plant air: internal process hoods are designed for 100 fpm.



Table 3 is a summary of measured air velocities at selected hoods in the Tyler Plant. With the exceptions of the Builder hoods and the Scrap Grinder hood, face velocities at hoods are inadequate. Smoke tube tests performed at each hood offered visual confirmation of this conclusion based on velocity measurements. Although the hood on the Intermediate Saw was satisfactory, it would not be so if two or more saws were used simultaneously.

C. Air Flow Associated with Local Exhaust Hoods and Dust Collectors

Figure 1 is a line diagram of the ventilation ducts in the Feeder and Builder Areas. The duct locations for Pitot tube traverses are denoted by numbers. Table 4 is a summary of volum of air flowing at these points as determined on the day of this survey. The values listed in Table 4 are probably overestimates because certain of the ducts were partially clogged with settled fibers. All data and calculations for the Table 4 summary are included in Appendix B.

Table 4 and data in Appendix B indicate the following:

1. Air is very poorly distributed in the ventilation system. As an example, hoods 2, 3 and 4 for similar operations were allocated 63, 391 and 202 cfm respectively.

TABLE 3

UNIBESTOS LINES: SUMMARY OF HOOD AIR VELOCITIES

| Location | | Site of Measurement* and Average Air Velocity, fpm** | | |
|---|---|---|---|---|
| Line No. 1 | 40" Fiber Feeder+ | Left Side | Top | 0 |
| | | | Middle | 0 |
| | | | Bottom | 0 |
| | | Center | Top | 50 |
| | | | Bottom | 50 |
| | | Right Side | Top | 0 |
| | | | Bottom | 0 |
| | | Note: Smoke tube test revealed poor control. | | |
| Line No. 1 | 30" Fiber Feeder+ | Left Side | Top | 20 |
| | | | Bottom | 20-30 |
| | | Center | Top | 60 |
| | | | Bottom | 60 |
| | | Right Side | Top | 60 |
| | | | Bottom | 50 |
| Line No. 1 | 30" Fiber Feeder+ | Left Side | Top | 20 |
| | | | Middle | 0 |
| | | | Bottom | 0 |
| | | Center | Top | 20 |
| | | | Middle | 0-10 |
| | | | Bottom | 0-10 |
| | | Right Side | Top | 20-30 |
| | | | Middle | 30 |
| Line No. 1 | 40" Fiber Feeder | Left Side | Top | 0 |
| | | | Middle | 0 |
| | | | Bottom | 0 |
| | | Center | Top | 10 |
| | | | Middle | 10-30 |
| | | | Bottom | 10-30 |
| | | Right Side | Top | 0 |
| | | | Middle | 20 |
| | | | Bottom | 20 |
| Line No. 2 (Note: Approx. 75% of hood face blocked by fiber) | 40" Fiber Feeder | Left Side | Top | 50-100 |
| | | | Middle | 75-100 |
| | | | Bottom | 75-100 |
| | | Center | Top | 30-40 |
| | | Right Side | Top | 30 |
| | | | Bottom | 50 |

+Room air in vicinity of feeders measured to be 30-40 fpm, South to North (fans off). Room air in vicinity of feeders measured to be 300 fpm, South to North (fans on).

TABLE 3 (continued)

| | | | | |
|---|---|---|---|---|
| Line No. 2 | 30" Fiber Feeder | Stand by (not in use) | | |
| Line No. 2 | 30" Scrap Feeder | Left Side | Top | 10-50 |
| | | | Middle | 30 |
| | | | Bottom | 20 |
| | | Center | Top | 20 |
| | | | Middle | 40 |
| | | | Bottom | 30 |
| | | Right Side | Top | 0 |
| | | | Middle | 40 |
| | | | Bottom | 20 |
| | | Left Side | Top | 75-100 |
| | | | Bottom | 100 |
| | | Center | Top | 100 |
| | | | Middle | 100 |
| | | | Bottom | 75-100 |
| | | Right Side | Top | 125 |
| | | | Bottom | 75-100 |
| Line No. 3 | 20" Scrap Feeder | Left Side | Top | 0 |
| | | | Bottom | 20-30 |
| | | Right Side | Top | 0 |
| | | | Bottom | 30-40 |
| Builder Hoods | | Line No. 2 | | 125-150 |
| | | Line No. 3 | | 150 |
| | | Line No. 1 | Invalid measurements because instrument could not be properly placed. Smoke tube revealed good control. | |
| Scrap Grinder Hood | | Left Side | Top | 75-100 |
| | | | Middle | 100-150 |
| | | | Bottom | 150 |
| | | Center | Top | 75 |
| | | | Middle | 75-100 |
| | | | Bottom | 100 |
| | | Right Side | Top | 50-75 |
| | | | Middle | 50-75 |
| | | | Bottom | 50-75 |
| Saw Area: | Intermediate Saw+ | | | 200-300 |

+Large Rip Saw Off.

*All measurements in vertical plane at hood face, unless otherwise specified.

**Feet per minute.

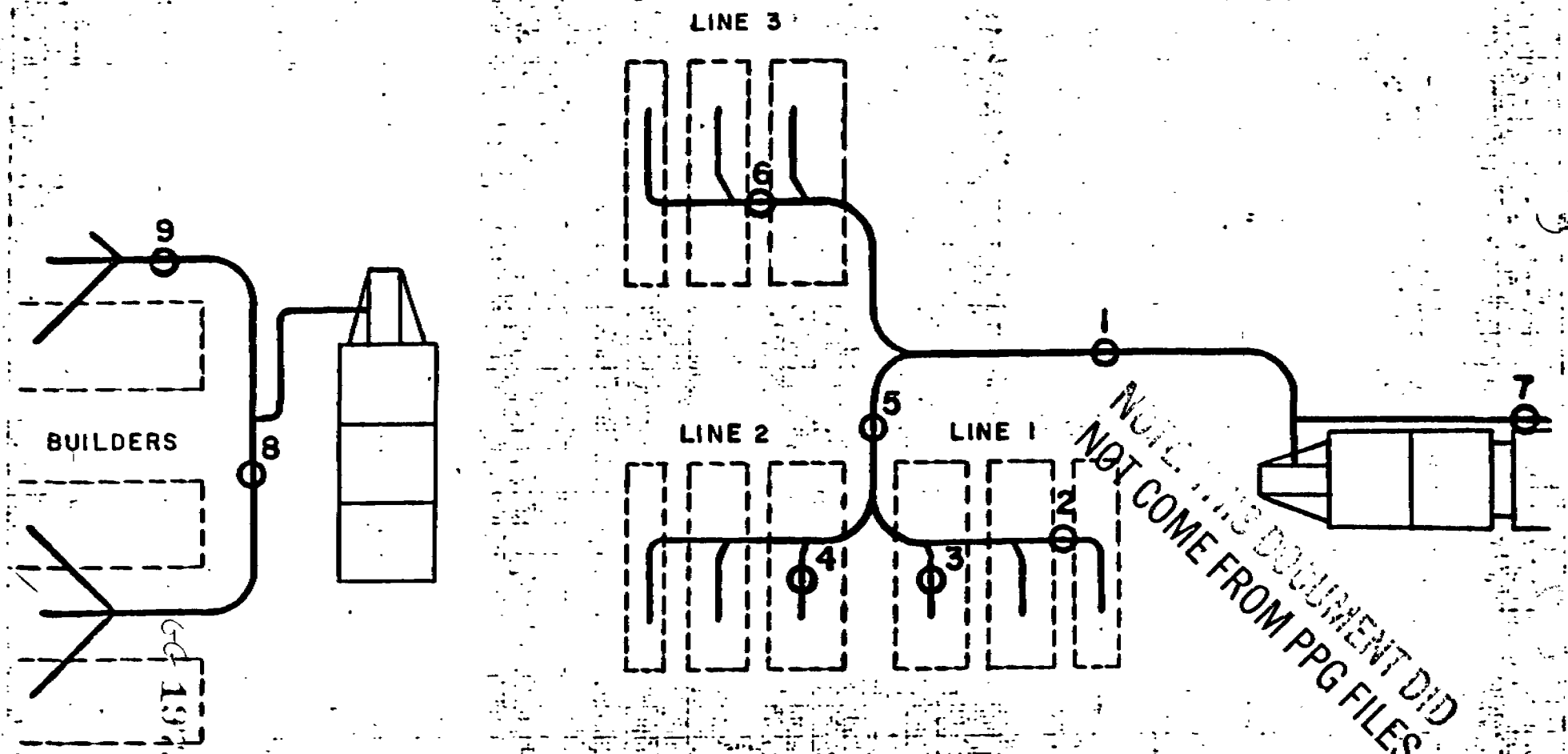


Figure 1. Schematic of Unibestos Lines Showing Ventilation System and Pitot Traverse Points. Tyler Plant, Pittsburgh-Corning Corporation

Scale: 1" = 8'-0"

Source: Dwg. No. 56-2002-0 (6-12-56).

TABLE 4

SUMMARY OF VOLUMETRIC AIR FLOWRATES IN DUCTS
IN FEEDER AND BUILDER AREAS

| Duct Number (Figure 4) | Air Flow, Cubic Feet Per Minute |
|---|---|
| Feeder Area: | |
| 1 | 2,769 |
| 2 | 63 |
| 3 | 391 |
| 4 | 202 |
| 5 | 1,940 |
| 6 | 183 |
| 7 | 877 |
| Builder Area: | |
| 8 | 1,724 |
| 9 | 810 |

2. Conveying velocities within ducts are generally very low for handling asbestos dust. A minimum design velocity of 4000 fpm is being used for the new ventilation system.* Duct 7 (Scrap Grinder Hood) and the 10" diameter duct into the Block Dust Collector were the only ducts with adequate air velocities for conveying asbestos dust.



3. Total air volume for the Builder and Feeder Grinders is very low (2769 + 1724 + 877 cfm). Estimates for Port Allegheny place the air requirements for adequate control for three lines at approximately 6.5x times this amount of air.

In summary, as judged by three different parameters, i.e. dust concentrations, face velocities at hoods, and duct air volumes, the ventilation system, and hence dust control at this plant, are unsatisfactory.

D. General Housekeeping

In general, housekeeping is judged to be poor at this plant. Appendix C is a selection of photographs taken during this survey. Asbestos dust is on all surfaces as well as in the air. It was noted that with the exception of Mr. Hyde and the author not a single person in the plant wore a respirator. It can only be concluded that Amosite fiber at this plant is not being handled with the care and respect that any substance with this toxic potential deserves.

The practice of exhausting bag dust collectors to plant air would not be permitted in the states of Pennsylvania and New York. Air cannot be recirculated when toxic substances are

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*Port Allegheny Plant.

involved. In the case of nuisance substances, recirculation is permitted if the recirculated air contains the toxic agent in concentrations less than 20% of the Threshold Limit Value.

## VI. ACKNOWLEDGEMENT

The author wishes to express his appreciation to Mr. John L. Hyde, of Pittsburgh Corning Corporation. Mr. Hyde provided invaluable assistance with survey measurements.

APPENDIX A

1. Letter from W.R. Blair, Regional Director, U. S. Departm nt of Labor, Dallas, Texas, to J. H. Bierer, President, Pitts-burgh-Corning.
2. Letter from B. M. Stout, Vice-President, Pi-tsburgh-Corning to W. R. Blair.
3. Letters from M. Corn to W. R. Blair.