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REPORT OF PRELIMINARY DUST INVESTIGATION FOR ASBESTOS TEXTILE INSTITUTE JUNE, 1947

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REPORT

of

PRELIMINARY DUST SURVEY

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OBJECT OF INVESTIGATION

This project was a preliminary investigation of the asbestosis problem in textile plants of members of the Asbestos Textile Institute, with the immediate object of defining the specific nature and the magnitude of the problem in all its phases. From such a definition, the character of a long-term project could be outlined. An original objective of most immediate importance was to facilitate the exchange of information between member companies on successful methods of dust control and otherwise to promote a general improvement in that field.

SUMMARY

The facts upon which this report is based were obtained on visits during the past three months, to all plants of Institute members (except one, who wished the visit postponed to a later date). Complete cooperation was extended at all plants. Dr. C. Richard Walmer, Medical Director of Industrial Hygiene Foundation, participated in visits to three plants and in development of the medical concepts of this report.

The problem is seen to be composed of three aspects which are discussed in three sections of the report and summarized herewith, as ENGINEERING, MEDICAL, and PHYSICAL TESTING.

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Engineering. -- Mechanical methods were seen in use in one or more plants which effected practical dust control in all operations, bringing dust concentrations down to five million or lower with one or two exceptions. It is proposed to prepare formal detailed descriptions of these methods for general distribution to members of Asbestos Textile Institute.

Medical Supervision of Workers. -- Only five plants have had any medical x-ray surveys of employees. In the others, therefore, there is a serious lack of information as to the incidence of asbestosis. The lack is more serious, in a sense, because in most of these plants no compensable cases of asbestosis have occurred to draw attention of top management to the problem. While the medical survey conducted by one plant recently shows only about three per cent of the employees with asbestosis, two other plants appear to have about 20 per cent of their employees affected.

Medical supervision of workers in this industry is of utmost importance for the protection of both employee and employer, not to mention other considerations. Therefore, it is strongly recommended that each plant institute a program of medical and x-ray examinations of all exposed workers as early as practical.

Physical Testing (Dust Counts, etc.) -- The "maximum permissible dustiness" for asbestos is commonly taken to be five million particles per cubic foot. This represents good attainment in the dust control program. It is emphasized, however, that dust elimination to this extent does not positively insure that no asbestosis will develop in some workers after a long working life (greater than 20-25 years). Scientific evidence is obscure on this point. It is recommended, therefore, that studies be initiated aimed to develop another

yardstick, because it is suggested that when control below five million is attained, present dust count methods may not properly measure the remaining hazard.

A detailed summary of recommendations for a long-term investigation is given at the end of this report.

I - E N G I N E E R I N G

PRESENT STATUS OF DUST CONTROL

Practically all plants visited have had one or more dust count surveys made of their operations and these data were available for the present study. In addition, a few samples were taken by the investigator in most plants.

These records were studied and a range of concentrations judged to be most representative selected for the summary given in Table I. Where relatively extreme values appear it is an indication of too few data to permit a closer estimate.

Figures in the last column are selected to indicate the magnitude of readily attainable dust concentrations with dust control measures now in common use; or judged to be most typical of an operation where no special dust control measures are employed, e.g., ring spinning.

Discussion of Concentrations

The available dust count data for operations in the preparation room are highly variable and reflect the poorer accuracy in sampling inherent in operations that are intermittent and miscellaneous in character. These figures are, therefore, considered much less reliable than those for other departments.

The figures for carding room dustiness indicate that with reasonably good enclosure and exhaust of the machines, concentrations well below three million are obtainable. Four of the plants visited exceed the five million limit materially.

All the data for mule spinners exposure indicate a wide variation in dustiness, ranging from two to eight million, but the volume of data are not

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TABLE 1

PRESENT STATUS OF DUST CONTROL IN DIFFERENT PLANTS: DESCRIBED IN TERMS OF AVERAGE DUST COUNTS

	A	B	C	D	E	F	G	H	I	J	Most Typical with Control
Preparation	-	1-3	5-7	3-9	-	1-8	2-7	-	20	7-11	Below 7
Carding	2-3	1-2	10-25	4-12	1½-3	2-4½	2-3	2-3	30-50	4-17	2-3
Mule Spinning	-	1-3	6	-	3-7	2	-	-	-	8	-
Ring Spinning	2-4	1-5	-	1-4	3-5	1-2	2-8	8	13-18	5-6	3-5
Twisting	2-6	1-5	5-7	2	5-8	2-4	2-10	-	13-18	4-9	4-7
Weaving	1-2	1-5	11-15	2-5	-	1-5	2-10	4-7	-	2-4	1-3
Spooling, Winding	2-4	-	-	2	2-7	-	2	5-7	3	5	-

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great enough to yield a good average. Concentrations for ring spinning vary from one to five million although there is no strong indication in the available data of marked differences between this operation and mule spinning.

There is a similar wide variation in data for twisting (two to eight million), but there is some justification in these data for the opinion widely held that this is one of the dustier operations in the finishing end of the mill. It is believed that occasional high values in both ring spinning and twisting reflect in some cases the sampling procedure. If the large impinger is maintained in one location and there is a strand breakage in that immediate vicinity the resulting whipping dust will be reflected in that single sample and would not, therefore, be representative of the worker's exposure.

Dustiness in weaving operations reflects the use of water for dust control in some plants and exhaust systems in others. The lowest concentrations of one to two million obtained in Plant A reflect highly efficient wet weaving methods there employed. Concentrations less than four to five million are readily attainable by local exhaust methods as indicated by the results in several plants.

The data for spooling and winding operations are included for completeness, but reflect miscellaneous operations and conditions. The dust reported is often due to the effect of other machinery in the same room. These considerations therefore affect the reliability of these data, as in the case of operations in the preparation room.

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EXISTING DUST CONTROL PRACTICES

The following discussion of dust control practices in the industry is merely an outline. To be useful to those who are responsible for the engineering in each plant, they will need to be set forth in the form of detailed specifications describing details of construction, specifications for sheet metal contractors, for purchase of fans of proper capacity and for design and operation of dust collectors.

Preparation

Highly variable practices prevail in different plants and the miscellaneous character of operations within a single plant makes it impractical to formulate many general statements. However, it may be said that such control as is realized results from the use of modern equipment that is well enclosed and which usually incorporates pneumatic conveyors with ceiling condensers. The large movement of air involved in pneumatic transport serves the useful additional purpose of preventing the escape of dust from the primary equipment. Discharge of stock from ceiling condensers into bins, stock boxes, or feed hoppers is a dust usually not under control. The blending operation is another source which is often not satisfactorily controlled. With the exception of these two common operations, most of the dust control procedures required will be more or less specific for each plant.

Carding

As has been noted, reduction of dustiness in carding to concentrations of three million or less is easily attained by good enclosure of the machine and carefully designed exhaust. Moreover, experience of several

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companies proves that it does not interfere seriously with manufacturing operations nor with quality of roving produced.

Our investigations indicate the superior advantages of having sidewalls of the enclosure of wood to facilitate small clearance by rubbing contact at the edge of the main cylinder, thus avoiding excessive air infiltration at that point. Wood covers have the advantage of resistance to crushing, which was evident in installations with sheet metal covers.

Connection of the enclosure to the exhaust system by means of chambers of ample dimensions, i.e., large cross-sectional area is of major importance to avoid localized high air velocities close to the webbing in the main cylinder. This detail was not always observed.

In view of similar degrees of success, judged by dust counts, between various installations, the best criterion of superior design as to details of exhaust from the machine was in the relative economy respecting volume of air exhausted per machine. Our observations indicated rather extreme variations as indicated in the following table of exhaust rates per carding set in five representative plants:

Plant	Air Exhausted Per Set
A	1500 cfm
B	2200 cfm
E	3800 cfm
G	5400 cfm
H	2000 cfm

It is apparent from this investigation that 2000-2500 cfm per set of breaker and finisher cards is ample exhaust capacity if the system is properly designed.

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All five of the systems described in the table serve their purpose satisfactorily from the viewpoint of operation, but it does not mean that they would be equally satisfactory to others. Thus the plant with high exhaust capacity (G) has a unique interplant tunnel connection, so that excess heat from another plant supplies replacement air without added cost, for heat, or winter discomfort.

Plant H controls dust by completely housing each pair of cards in a spacious room, exhausted at a rate of 2000 cfm. Sidewalls are easily removed for repairs. Most plants would not prefer this arrangement.

As far as the dust count data can show, the card room of Plant B with 2200 cfm is equal if not superior to that of Plant E with 3800 cfm, a recently installed system.

The fundamental features of best card dust control systems observed are as follows:

1. Wood enclosure with hingeing arrangement.
2. Liberal clearance between worker rolls and curve of cover permitting air passage at low velocity.
3. Large chamber connection on cover, to duct.
4. Duct branch not over 5", preferably 4".
5. No blast gate dampers in branch line.
6. Exhaust influence over comb, either by extension of main cover or by separate hoods.
7. Exhaust space under machine, not over 4" duct.
8. Enclosure and exhaust of feed hopper, not over 4" duct.

Two installations include an exhaust branch to prevent the escape of dust originating in the space between the ring doffers and the main cylinder.

Spinning

One plant has installed ventilation for their ring spinning frames which management believes has reduced dust in this operation. It consists in a series of exhaust openings under the frame, near the floor, running the length of each frame. Time did not permit demonstrating to our own satisfaction whether a measurable improvement had been effected or not. This should be done by a series of dust measurements with exhaust on and off. The volume of air exhaust is insufficient to effect a true local exhaust action, and if it is effective it must, therefore, be an effect of simple dilution.

Twisting

Interest in control of dust from twisters is widespread in the industry and Plants A and B have installed an exhaust system like the one described for the spinning frames in Plant A. Here again the operators believe a marked improvement has resulted. Dust count data is needed that will measure the degree of improvement.

Winders

Cop winders have been exhausted in Plants A and B with reports of beneficial reduction in dustiness. We do not have quantitative data on this point. The exhaust arrangement for Foster winders was developed many years ago and is well known. The tendency to elimination of this machine makes the problem one of little practical interest now.

In most plants, dust from other equipment, such as spinning and twisting which are commonly in the same room, is of greater importance than that from winding operations.

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Weaving

One plant has a superior method of suppressing dust in weaving by wet methods and dust count records indicate a complete suppression of dust. It involves a water spray head mounted above the warp at the rear of the harness with a mechanical screw arrangement for constant movement of the spray head transversely to the warp. They believe it to be more effective than the system common in several plants wherein the warp is passed over wetted rolls.

It is apparently not practical to recommend 100 per cent wet weaving throughout the industry. Moreover, we are satisfied that it is practical to control dust in this operation by local exhaust, where dry weaving is considered imperativefor special properties of the cloth. One of the best exhaust arrangements includes an exhaust opening directly under the warp at the rear of the harness frame with a slot exhaust opening carried by the lay beam, the latter connected to the stationary part of the exhaust system, either by flexible hose arrangement or by an all metal swivel joint.

Duct Work

The actual arrangement of duct work and exhaust fan present no unusual problems where good practice in sheet metal fabrication is followed. Two points are of sufficient importance to require emphasis. Special care should be exercised in the fabrication to avoid sharp projections on the inside that create points of lodgement for fibers. Secondly, it must be designed to provide adequate transporting velocities. Velocities below 2000 fpm, in the experience of the industry, may permit settlement of material and gradual clogging. Therefore, allowing a margin of safety, the design should provide for velocities of 3000 fpm.

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The problem of distribution of planned air flows to the different branches of the system is of importance in the design of all dust exhaust systems. The use of dampers in branches to adjust air flows is avoided in the best systems. Their function in effecting balance between branches is best attained in the original design. Design procedures to effect this objective are available but will not be elaborated at this point.

Dust Collectors

Five plants in the survey employ the well-known burlap dust house for filtering air from various exhaust systems. The favored filtering area is determined on the basis of one square foot for each air flow of 2 cfm. Most arrangements are such as to permit cleaning by whipping with a bamboo pole or a buggy whip by men who remain on the clean air side of the filter cloth. In one system, the men are required to enter the dust side for cleaning purposes, and final cleaning is carried out once weekly with the use of a central station vacuum cleaner. Practices in different plants are variable as to frequency with which the burlap filter is freed of its dust load by whipping

While these dust collectors work well, we are not prepared to recommend them to the exclusion of some commercial types of filters having automatic shakers. Several engineering elements enter into the design of a dust collector system, involving principally a proper estimate of pressure drop in all elements of the system and especially that through the filter proper (back pressure). If the pressure drop estimate in the filter is incorrect, the system will not operate properly. If the basic resistance of the filter, i.e., that immediately after shaking the cloth, is subject to a constant increase over a period

of weeks, the system operation will suffer. Apparently, some of the older commercial flat bag type of collectors did exhibit that difficulty. Modifications in the design of such units have, however, been incorporated in more recent models and those difficulties may have been eliminated.

Two plants employ commercial collectors of the flat bag or envelope type. Another plant uses a cloth tube commercial collector and also one whose filtering element is of paper, which is replaced at intervals of several weeks. A study of operating details of these commercial collectors is indicated in this study, including considerations of original cost and operating cost.

Recirculation

Several plants return air from the dust collectors to the workroom to conserve heat in the cold weather. We are not prepared at this point either to condone or to condemn this practice except in cases where there is obviously leakage of dust through the filter and consequent recontamination of the air inside the plant. The practice is generally frowned upon where dusts that are hazardous to health are being handled. We believe there are certain circumstances where the practice might be permissible provided adequate safeguards are incorporated in operating procedures. The large volumes of air involved in dust control represent a tremendous problem as to heat loss and boiler capacity which cannot be passed over lightly.

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II - M E D I C A L

PRESENT MEDICAL FACILITIES AND PRACTICES

Every plant has connections with a local specialist in radiology who is employed for diagnostic work on an irregular basis. Three have their own x-ray machines used by the local specialist, but only one has a well-established schedule of periodic medical examinations.

Half of the plants have no positive information as to the incidence of asbestosis among their workers. The situation is these respects is indicated in Table II.

TABLE II.

PRESENT PRACTICES AND FACILITIES AS TO MEDICAL X-RAY EXAMINATIONS IN VARIOUS PLANTS

Plant	Recent X-ray[1] Survey Made	Periodic X-ray Examinations Made	Have Own X-ray Machine
A	Yes	No	Yes
B	No	No	No
C	Yes	No	No
D	Yes	No	No
E	No	No	No
F	No	No	No
G	No	No	No
H	Yes	Yes	Yes
I	No	No	No
J	Yes	No	Yes

[1]Within last few years, and results available to plant or its physician

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ESTIMATED INCIDENCE OF ASBESTOSIS

The incidence of asbestosis among employees of those plants where employees were examined in recent years, shows a marked variation as indicated by the following:

Plant A has recorded cases diagnosed as asbestosis to the extent of about 20 per cent, and in the past nine years has compensated, on the average, two cases per annum. Total textile employment about 400.

Plant C on the basis of a recent systematic survey, estimates asbestosis incidence to be about three to four per cent.

Plant D has results from an incomplete survey in which four cases were found among those volunteering for examination with a total textile employment of around 150. They have compensated one case in about 10 years. Three more are pending.

Plant H with a textile employment of 300 finds five or six cases annually that the physician believes show early changes due to asbestos.

Plant J has counted potential cases of asbestosis amounting in number to about 20 per cent, comparable with Plant A.

The other plants have conducted no systematic x-ray surveys of their own and have no information as to incidence among their employees. None of these has had cases requiring compensation.

While we have no complete data on history of employment and labor turnover in the several plants, it is apparent that there is, at least superficially, a marked inconsistency in this picture. Also, it is clear that

a serious lack of information prevails generally on this aspect of the problem.

The story in North Carolina is worth special mention. This state instituted 10 years ago, a system of periodic medical examinations for all workers in dusty industries and, hence, all asbestos textile workers have been x-rayed and clinically examined for a longer period, on a periodic basis, than any other asbestos textile plant in this group. If the state examination finds that workers should discontinue their employment because of rapidly developing asbestosis they have the authority to effect this change. They also see to it that workers who should receive workman's compensation due to disabling asbestosis are processed. So far as we have been able to ascertain neither event has occurred to any employee of the two North Carolina asbestos plants in this group.

These observations suggest that there may well be a marked divergence in medical procedures, interpretations, and attitudes respecting the diagnosis of asbestosis.

There is a very urgent need for a concerted cooperative medical effort to develop improved diagnostic procedures and uniformity of interpretation.

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IMPORTANCE OF PERIODIC MEDICAL EXAMINATIONS

One of the most important elements of a program of protecting health of workers in dusty occupations is the periodic medical examination. The lack of scientific information regarding all aspects of asbestosis is serious. This cannot be over-emphasized. The obvious procedure to help overcome this deficiency is to employ every tool now available that will throw more light on the facts. The importance of the periodic medical x-ray examination can perhaps best be emphasized by stating that dust count investigations cannot, in the present state of knowledge, give us assurance as to the extent of our success in eliminating the hazard.

Regular examinations serve to protect the worker by giving early indication of health impairment due to dust, and permit intelligent action to be taken to avoid further serious health deterioration. This is particularly true if the detection is early enough and there is no progression to late stage asbestosis.

More important, for the long term, the accumulation of factual information regarding the health status of exposed workers, statistically interpreted in relation to dustiness studies and to mechanical developments in dust control equipment, will eventually indicate when the battle of asbestosis control is being won. This aspect of the problem is elaborated in the following section.

The inventory provided by such a medical program is just as important to intelligent action in this problem, as material inventories are to the proper conduct of business.

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The question as to whether a plant should purchase its own x-ray equipment is an economic one involving consideration of cost of local outside medical and x-ray facilities and of loss of employee time in travel, etc.

Diagnostic Panel

To further the objective of improvement and uniformity in diagnostic procedures, a medical section of the program is proposed in the form of a MEDICAL ASBESTOSIS PANEL to be composed of outstanding medical men in this field, and of the physician designated by each company as the one responsible for its medical and diagnostic work. The composition, as to outside medical personnel, of this panel would be determined by its objectives: the assembling of the best possible medical brains and the mutual education in diagnostic procedures that comes from exchanges of scientific experiences and information.

The panel would meet, perhaps semi-annually, and consider the significance of x-ray films and other clinical data brought to the group by each participating physician. Dr. C. Richard Walmer's services would be available for the organization and other details.

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STATISTICAL STUDIES OF MEDICAL RECORDS

There are two very important questions concerning the physiological nature of asbestos that have not yet been answered by any published investigation:

1. What is the expectation of asbestosis in workers exposed more than 15-20 years to low concentrations of asbestos dust? Among the 500-odd workers who composed the subjects in the U.S. Public Health Service study, there were abnormally few who had been exposed for more than 15 years and practically none over 20 years. These facts seriously affected the conclusions that could be drawn.

2. Is there a progression to advanced asbestosis after exposure of an individual has been discontinued or has been reduced to very low levels, due to action of dust deposits from earlier exposure? This question is of very great importance to intelligent medical supervision of workers in these plants.

It is virtually certain that statistical investigations of existing records would throw valuable light on these questions.

None of the plants visited during this inquiry have sufficiently extensive and systematic records to provide satisfactory answers to these questions, but the medical department of Metropolitan Life Insurance Company, under Dr. A. J. Lanza, have x-rays of a number of men obtained in the early 1930's which could provide the nucleus of some useful information, depending on how many of the original group are available for re-x-ray.

The most outstanding store of information is in the records of the Division of Industrial Hygiene of the North Carolina Department of Health who, in accordance with state law have x-rayed workers in this, and other dusty industries, almost annually for the past 10 years. A study of these records would undoubtedly cast much light on the question of progression. Through officials of the company members in North Carolina, we already have assurances of their full cooperation in any investigations, and although we have not discussed the matter with them directly as to details, there is every reason to suppose that the desired information would be made available to us for the purposes described.

In addition, a general x-ray and medical survey of workers in one or two plants with a long history of high order of dust control would be of great value for this purpose.

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III - PHYSICAL

SIGNIFICANCE OF DUST COUNTS

Correlation between development of asbestosis and some pertinent measure of dustiness, e.g., dust counts, can be developed by periodically observing and recording data on both aspects -- periodic medical examinations of exposed workers together with the periodically measured dust exposure of each. However, to be useful for preventive purposes, theseprocedures have to be extended into the past wherever data is available. This was the procedure employed in the studies of the U.S.Public Health Service in North Carolina plants (Public Health Bulletin No. 241, 1938).

The main value of dust counts in asbestos plants is to obtain data on dust concentrations that can be compared with that study, and thus lead to conclusions as to probability of development of asbestosis in the particular plant being studied.

In that study, dustiness of different occupations was measured in the usual manner, and also the incidence of asbestosis by medical and x-ray examinations of the men employed. A statistical comparison of the two sets of data led the investigators to the conclusion that new cases of asbestosis would probably not occur if dust control measures were undertaken to ensure that no dust exposures exceeded five million particles per cubic foot (measured in the same manner).

APPRAISAL OF REDUCED DUST HAZARD

Having reached a degree of dust control represented by the dust count limit of five million, it is then proper to ask: "What degree of assurance is afforded by existing knowledge that asbestosis will not, in fact, develop in the future if dustiness is kept below that level?"

If there are factors, at present unknown, that will indicate a need for still better dust control, what will that limit be?

The information available does not permit complete assurance that five million is thoroughly safe nor has information been developed permitting a better estimate of safe dustiness.

It is nevertheless of the greatest importance either that such assurances be sought or a new yardstick of accomplishment be found for accurately measuring any remaining hazard in the dust zone below five million for the elimination of future asbestosis depends upon the degree of control effected now.

Measurement of Dustiness

One basis of uncertainty as to applying present conventional dust counting techniques to the measurement of asbestos dust hazards below the five million level is summarized in the question -- are the fibers of asbestos the causative agent or the non-fibrous "cubical" particles that look like those of other industrial dusts? The non-fibrous particles in most textile operations comprise 80-95 per cent of the total dust seen in dust counting.

While it is proven that asbestos dust is the cause of asbestosis, there is no certain information as to what shape or size of dust is the causative factor. The correlation studies of the U.S.Public Health Service

employed conventional dust count techniques which, in effect, related incidence of asbestosis to the number of non-fibrous particles of a size ranging from one to five or 10 microns.

For illustration, suppose the causative dust element is something different, e.g., fibers that are less than 50-60 microns long, and less than 1-2 microns in diameter. The conventional dust count method would be satisfactory only if there were a fairly constant ratio between the two types of dust; it would, in that case, provide an adequate index.

Preliminary Studies on Qualities of Asbestos Dust

With a view to eventual development of supplementary methods for measuring asbestos dust concentrations on a weight basis, we have conducted some preliminary studies directed to the colorimetric determination of total silica in the minute quantities of asbestos dust obtained in a typical atmospheric sample. This requires development since it could provide a valuable tool for further investigation.

Sub-microscopic particles and fibers.

Another aspect of the dust examination problem on which preliminary work has been done involved studies with the electron microscope. We posed the two following questions:

1. Ordinary dust particles, one to three microns in diameter, comprise most of the particles in the dust count. They look like ordinary industrial dust and we refer to them as "cubical" as distinguished from "fibrous" particles. The question is: are these particles in fact non-fibrous or are they bundles of fibers?

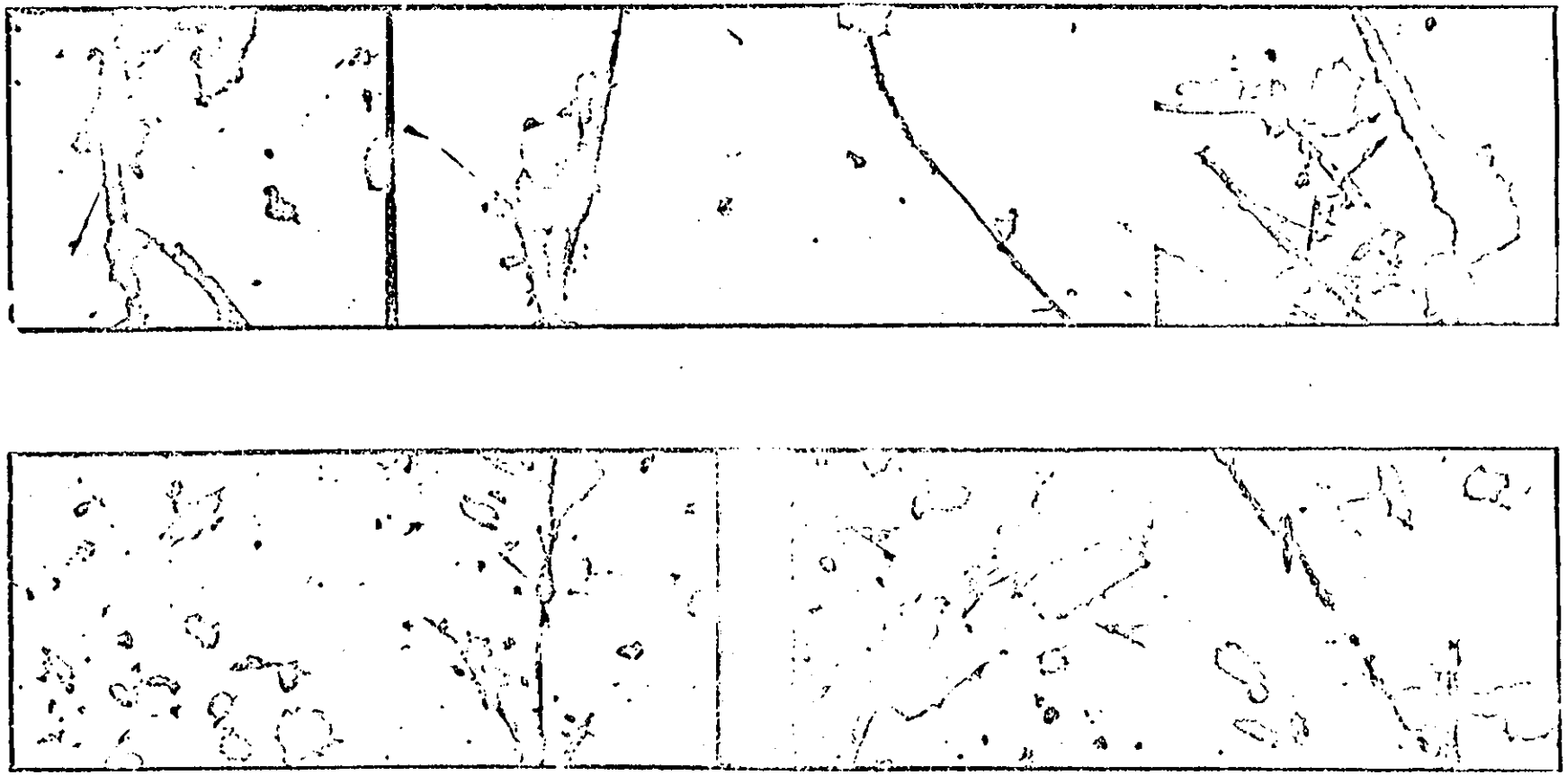
2. Secondly -- since the limit of resolution of the microscope lenses used in dust counting does not permit seeing particles very much smaller than one micron, one may ask if there are many fibers of great length, but of such small width that they are invisible?

Samples of atmospheric dust were obtained for examination by the electron microscope, by mounting the small specimen slide used with this instrument, in the dust collecting zone of the electric precipitator. In order to eliminate very large fibers, the air being sampled was caused to pass first through a glass spiral coated with adhesive on its interior. This subjected the dust particles to centrifugal force and the largest ones would be precipitated out, much as they might be in the nasal passages of man.

Studies with other industrial dusts employing this spiral indicate that very rarely do cubical particles larger than three to five microns succeed in passing through the several turns of the spiral.

In samples obtainedwith this apparatus in a card room having a good dust control, we obtained pictures, some of which are reproduced in the attached Figure. They demonstrate first, that the cubical particles seen by a low power light-microscope are in fact bundles of fiber resembling a life-size handful of partially opened fibers.

The picture further demonstrated that there are many fibers of considerable length, some fully 50 microns, whose other dimension is only a fraction of a micron; the fiber is therefore invisible in the dust counting microscope.



ELECTRON PHOTOMICROGRAPHS OF AIR-BORNE ASBESTOS DUST - MAGNIFICATION 5500 X

THIS CIRCLE 1 MICRON DIAMETER -

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They also showed some fibers a few microns in length whose diameter is only 0.01-0.02 microns, although the commonest particles are bundles of fibers about 0.1 micron in width.

In addition to the light these observarions throw on the sub-microscope character of asbestos dust, they are cited to indicate the other qualities that might be pertinent to evaluation of dust exposure, to supplement the dust count technique now in use.

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INHERENT DUSTINESS OF STOCK

In investigations of the type being presently considered, a primary aim must be to develop improvements in dust control with the minimum of waste motion and expensive experimentation on a plant scale. At the stage of development of the industry, causes of dust are very often not obvious. An examination of dust count records made available to us, combined with the few tests we performed ourselves, provide numerous instances of variation, the cause of which is not apparent.

We undertook recently to measure the amount of dust in the roving of different manufacturers by suspending a measured quantity of roving in alcohol, then making a dust count in the same manner as with air samples. The result would be expressed in millions of particles per yard of roving or per gram, etc. and would be of great advantage in relating differences in dustiness to the causative factor. Such a measurement technique would be essential in appraising the actual value of oil.

We do not have sufficient data on this effort on which to draw conclusions. There are difficulties to be overcome, and the solution depends on more laboratory experimentation.

Another test method which would be of value is a standardized mechanical abuse of roving in a small vessel while sucking a stream of air with resulting dust as in the sampling for ordinary dust counts. A test of this kind, in conjunction with the dustiness index would be of value in evaluating the oiling practice, or it might take the place entirely of the procedure previously outlined.

OUTLINE OF RECOMMENDED PROCEDURES
FOR ASBESTOSIS INVESTIGATIONS

X. ENGINEERING

A. Dissemination of Existing Information

Provide factual information to Institute members with least possible delay; prepare bulletins with design sketches on some or all of the several subjects listed below, to be distributed singly as ready. Additional field observations required in many cases.

1. Carding dust control: for various makes of machines
2. Dust in preparation, miscellaneous operations
3. Wet weaving equipment
4. Exhaust for Dry weaving
5. Exhaust for winders, etc.
6. Design of duct work
7. Design of dust house

B. Development of New Techniques for Dust Control

In this category, the problems for which there are no present answers: like twisting, spinning, appraisal of operation, efficiency and cost of commercial dust collectors, etc.

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II. MEDICAL

A. Institution of Periodic Medical Examinations

This is urgently recommended to all companies. Medical advice as to organizational procedures will be given by the Foundation upon request.

B. Organization of a Diagnostic Panel for Asbestosis

Arranged by the Foundation's Medical Director and organized to meet in Pittsburgh at suitable intervals for scientific review of diagnostic problems, reading of x-ray films, etc. Panel to consist of individual company physician or medical consultants together with other medical authorities to be determined.

C. Statistical Study of Existing Medical Records

Designed to find answers to important questions concerning medical and physical nature of asbestosis; especially concerned with records of State of North Carolina, Metropolitan Life Insurance Company, etc.

III. PHYSICAL TESTING -- (Further Dust Studies)

Studies of physical and chemical characteristics of asbestos dust designed, in conjunction with medical studies, to provide more significant information concerning the nature of the dust exposure; to develop supplementary techniques for measuring remaining asbestosis hazard after reduction of dust to meet the present standard; to insure that effective control of dust has been attained.

This is a step by step program aimed at the elimination of asbestosis cases from the plants of Asbestos Textile Institute members.