PLAINTIFF'S EXHIBIT
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DUST CONTROL IN A CONVENTIONAL ASBESTOS TEXTILE FACTORY

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INTRODUCTION

The first recommended threshold limit value (TLV) for asbestos exposure was that of Dreesen et al of the U.S. Public Health Service.[1] In 1938 following a survey of 541 employees of four North Carolina asbestos textile mills, they proposed a standard of 5 million particles/cubic foot (mppcf) for the prevention of asbestosis. This standard was included in the American Conference of Governmental Industrial Hygienists (ACGIH) list of maximum allowable concentration (MAC) values in 1946 and, in 1948 was placed on the ACGIH listing of TLVs. ACGIH TLVs became legally enforceable standards in 1968 for those industries to which the Walsh-Healy Act applied.[2]

The standard proposed by the British Occupational Hygiene Society in 1968[3] and adopted in Britain in 1970[4] was based upon the concept of a cumulative dose and the risk of less than 1% of exposed persons developing the earliest signs of asbestosis. This standard of 100 fiber years per cm^3 was interpreted as meaning that a similar risk applied for an exposure of 2 fibers/cm^3 for 50 years, 4 fibers/cm^3 for 25 years, etc.

In the United States, a federal standard of 12 fibers/cm^3 greater than 5 μ in length, 2 mppcf, was promulgated on May 20, 1969, under the provisions of the Walsh-Healy Public Controls Act. This also was proposed as an interim standard under the Occupational Safety & Health Act, 1970 on May 29, 1971 but was soon replaced by an Emergency Temporary Standard of 5 f/cm^3 on December 7, 1971.

As required by the Occupational Safety & Health Act, a permanent standard for asbestos exposure was promulgated six months later in June, 1972.[5] This standard permitted exposure to airborne concentrations of asbestos fibers, longer than 5 micrometers, provided that the 8 hour time weighted average (TWA)

concentrations to which any employee may be exposed "shall not exceed 5 fiber per cubic centimeter of air." The standard also stipulated that, effective July 1, 1976, "the 8 hour TWA airborne concentrations of asbestos fiber to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air."

Thus, industry knew that it had a target to obtain by July, 1976 and decisions had to be taken as to how the task of complying would be achieved. We decided that, irrespective of the standard demanded, we would use the most effective and practicable means of reducing dust to the lowest possible level and would continue to manufacture asbestos textiles by conventional methods. In this paper we will describe the engineering methods which enabled us to achieve our target and still maintain the continuity of the operation. The project was completed in July, 1977.

HISTORICAL DETAILS

The plant, acquired by us in November 1969, was run down in the preparation-carding and weaving areas. Much work was needed to make it a productive and profitable venture. The employee union demanded certain commitments before signing over its negotiated contract to us and one of those, the development of a "safe workplace" for its membership, we readily agreed to.

In 1969 approximately 87,000 cubic feet per minute (CFM) of exhaust air was collected in a baghouse and could be recycled to the workplace. Approximately 9,000 CFM of exhaust air was collected in a cyclone collector exhausting to the atmosphere.

The baghouse air was collected from preparation and carding. The cyclone air was collected from weaving and filling winding. There were no other areas in the plant with exhaust ventilation. Waste fiber was removed from the bag-house in open-top boxes and from the cyclone periodically by shovels.

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The chrysotile asbestos fiber was brought into the plant in compressed bales. The asbestos and carrier fiber storage areas were orderly with little or no noticeable dust emission.

Olf-fashioned methods were used for fiber preparation, including blending, opening and mixing. The opened fiber was stored in stock-holding bins of about 3,000-4,000 pounds capacity. The pneumatic line that fed fiber to the bins did so by means of a ceiling condenser mounted over a crossing conveyor belt that was located on top of the bins some 25 feet above floor level. The fiber had to be removed from the bins by hand, using a pitchfork to transfer it to a loose cart from whence it was taken to the front of the card-feed hopper and hand-fed to the carding machines. (Figure 1)

The cards were built in the late 1930's and early 1940's. The roving from these cards, wound on wooden spools, was very weak and broke constantly. Breaks of this type contributed to the dust problem in the later spinning operation. The cards had enclosed and exhausted cylinders but were dusty due to poor design, poor upkeep and inadequacy of the extraction system. Under-card wastes were removed by a mechanical rake, delivered pneumatically to the baghouse and removed by shakedown. A portion of the waste was re-used and the rest bagged off and sold.

Spinning was dusty mainly due to yarn breaks. As the end broke, it hit the adjacent ends and created dust.

Twisting suffered from the same problem but to a lesser degree. Winding was done dry without exhaust ventilation and this created dust.

Weaving was done dry with air extraction on some looms. Attempts at exhausting automatic looms had been unsuccessful and those fitted with wet pans were not effective because only a portion of the yarns in each type was wetted. The yarns for weaving was wound dry and the warp yarns were supplied from creels in a dry state. No dust controls had been attempted on these processes.

Inspection and shipping was probably the cleanest operation in the plant due to the nature of the job and there were no dust controls. The cloth and tape was wrapped in kraft paper and shipped.

At the time of the plant's acquisition, dust counts were barely below 12 fcc, (the maximum allowable concentration recommended by the ACGIH) and the productive process was inadequate for a profitable venture. We recognized that the plant had potential and needed a textile facility for our friction materials plant in Pennsylvania.

It was decided to convert the product line from typical asbestos textiles into yarn and cloth for use in friction materials manufacture and to reduce dust generation where possible.

The strategies to be used were:

1. Increase carding production by upgrading and reclothing the cards, convert the tape condenser cards to ring condensers and produce a quality roving of a coarser count from all cards wound on cheeses instead of jackspools.

2. Upgrade the raw material by using Cassiar fiber in Grades A and AA and Bells 3-T, by using good long staple cotton combined with rayon and by the introduction of a core yarn (for carrier) at the card to allow for good roving strength for spinning.

3. Change the method of spinning and twisting from ring spindles to flyer spindles.

4. Start a program to reduce dust generation in weaving by dampening the yarns at the loom and winding for weaving.

The action plan necessary to accomplish the above took nearly four years from 1969 - 1973.

CORPORATE POLICY

In 1974 we formulated a comprehensive corporate policy which included the elimination of asbestos from products where a viable substitute for it could be found. All other asbestos containing products would be manufactured by a "clean system." Control measures were to be developed to cover the entire process from the introduction of the raw asbestos through the disposal of waste, scrap and rejected material.

An intensive study was made of all asbestos and asbestos containing products. Products were identified for elimination from manufacture and others were identified as candidates for manufacture under the "clean system" concept. Restructuring of the manufacturing system and capacities was then planned.

In June 1975 a comprehensive "clean system" plan for asbestos textiles, requiring the expenditure of $12.3 million, was approved. It provided $2.6 million for the redesign and conversion of the conventional textile operation to a "clean system" process. The remaining $9.7 million was for a wet extrusion process plant and for the close out of yarn manufacturing at the Pennsylvania plant.

STRATEGIES DEVELOPED FOR THE "CLEAN SYSTEM" PLAN

In order to accomplish the objectives for the conventional textile plant, the following strategies were developed:

1. Elimination of all man-handling of raw asbestos fiber by use of a closed system where possible.

2. Reduction of dust generation by effective exhausting or wetting where possible.

3. Utilization of as much of the existing equipment as possible from the Pennsylvania plant and the textile plant by relocating, rebuilding and modifying as required.

4. Upgrading an expansion of existing buildings and simplification of vacuum cleaning by having smooth walls and avoiding ledges and surfaces that catch and retain dust.

5. Provision of a maximum volume of fresh clean air to the workplace by use of heated or humidified make-up air units.

6. By design, provide for a safe, clean method of waste collection and reuse and/or removal.

The action plan required nearly two years for completion, reducing fiber counts to less than 1 f/cm^3 and increasing the plant capacity considerably.

ACTION PROGRAM

Plant Facility

A new addition of 50,000 square feet of floor space was built utilizing the "smooth surface" approach. This new floor space was designated for spinning, twisting equipment, an office and a maintenance shop/boiler room. (Figure 2)

Fresh make-up air with added heat and humidity was provided for by installing three 50,000 CFM, and one 65,000 CFM roof mounted units. These required that an additional 500 horsepower boiler be installed giving a total boiler horsepower of 750.

Additional exhaust air was provided by installing a 110,000 CFM baghouse of the pull through type having two 125 horsepower backward inclined blade fans. There are ten bag cell modules, five on each fan. Shakedown and waste removal is accomplished by screw conveyors dumping through rotary air locks into plastic bags. This allows for a total of nearly 200,000 CFM of exhaust air. The building is thus under a slight positive pressure. The starting and stopping of the make-up and exhaust air have to be tied together electronically to prevent damage to the building.

Blending/Opening

A "fiber control" blending line is used to blend the asbestos, carrier and waste. Each feed hopper is enclosed and under a negative pressure, opened at the feed end only so as to allow the bags of asbestos to be opened in an area draughted away from the operator and into the hopper. (Figure 3)

The under card waste is returned pneumatically to its respective feed hopper of the blend line, where the long fibers are separated from the shorts and sand, by passing through the screen of a ceiling condenser directly into the hopper. The hopper is completely enclosed and exhausted. This eliminates the job of under-card fly removal once done manually.

The blended stock is conveyed pneumatically to a "reserve hopper" kept under negative pressure where up to 5,000 pounds can be stored for work in process inventory, allowing blendline changes for versatility in mixes.

The stock or mix is transferred pneumatically to card feeds. It has been found that air velocity of 2,000 fpm minimum will carry the mix through a ten inch diameter duct up to three hundred feet away to a card feed providing that there is no increase in duct elevation and a minimum number of turns. 4300 fpm is used to maintain the efficiency of the system. (Figure 4)

These processes eliminated the job of "stock hauling."

Carding

An acceptable, high quality roving can be produced from a single cylinder card providing the card is fed with a mix having an intimate blend, uniformly opened and made into a web having uniform density and weight. This conserves exhaust air in carding, allows for higher card loads per operator and reduces card maintenance.

The feed decided upon is the CMC "EVENFEED." The design concept of the feed is an air laid web. Level control in the hopper is controlled by two photo electric cells, a high level, and a low level control. The ceiling condenser runs constantly. An air operated damper valve is controlled by the indications of the photo cells. Low level indication will open the damper located on the clean air side of the ceiling condenser, allowing fiber laiden air to pass through the condenser, and thus, depositing fiber into the feed hopper of the "EVENFEED." High level indication will close the damper, stopping the flow of fiber to that unit.

It has been determined that no more than six "EVENFEEDS" can be serviced at a time due to the production capability of the fiber opening mechanisms (FOM) and amount of fiber that can be kept moving through an air duct. Thus, there are six cards to a line.

Controlling the total system, (six cards, six EVENFEEDS, one FOM, one reserve hopper) for one line of cards demands sophisticated electronic controls. An electronic scanning system that can scan the photo cell indications in any predetermined sequence is employed on each card line. Depending on roving count desired, and production rate of the cards, the system is scanned once every 15 to 45 seconds for hopper level control. This allows a uniform feed to the cards.

Controlling dust emission at the cards has been accomplished by double enclosing the cards and exhausting the enclosures into a baghouse, and at the same time forcing fresh make-up air from overhead ducts downward through the work alley, passing by the operator and into the enclosure opening. (Figure 5)

The function of the double enclosure is to minimize and contain dust generated by the card. The secondary enclosure surrounds the immediate card area, opening only at the front for roving removal. There are service panels

that may be opened or removed for card maintenance. (Figure 6)

Spinning and Twisting

The spinning room has been designed to create a cross draft in the room. Fresh make-up air is brought into the room through the ceiling on one side and distributed by means of a header and duct system across the room. This allows approximately 5 air exchanges per hour with no air extraction from machinery.

The spinning and twisting is done on flyer type frames, although they have had their speed reduced to minimize noise and dust (approximately 900 RPM spindle speed). Roving is wound on cheeses and carrier core yarns are used. Work practices are the main contributing factor in reducing dust in this area.

Winding for Sales

We use mainly Foster 77 winders. The winders are enclosed and exhausted effectively, having the backs, sides and top covered, leaving a portion of the front open for operator access. Suspension of heavy, clear, plastic strips vertically in the face opening of the enclosure allows good operator access and visibility while maintaining a high air velocity low volume system. (Figure 7)

Work practices in this area are also a major contributing factor in achieving low dust counts.

Weaving

All weaving is now performed with wetted yarns. The wetting of the warp yarns is done by padding-rolls immersed in water troughs located behind the harness section of the looms. Filling yarns are wetted in the same manner during winding. They are again immersed in water just prior to weaving. A resin treatment is also applied at the loom in the same manner as wetting. This serves to "lock in" the fibers in the woven fabric, minimizing dust generation from the fabric in later use. The weaving area has narrow fabric and heavy hand looms. Yarns manufactured by the wet dispersion process elsewhere are now being introduced in weaving in this plant and this will further insure

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Inspection and Shipping

Due to the nature of the job and resin treatment applied to the cloth in weaving, dust has nearly been eliminated in inspection.

The yarns are now packaged in stretch wrapped plastic on pallets. The cloth is packaged in plastic bags and tapes are packaged in shrink wrapped plastic. Dust has virtually been eliminated in this area. (Figure 8)

OPERATING PRACTICES

Before the implementation of engineering design and methods at the plant, it was recognized that engineering alone would not maintain a "clean system." During the construction phase, development of work practices and administrative procedures was given a high priority. When the construction phase was completed, these new practices and procedures were ready for implementation.

Work Practices

All employees, including supervisors and management, are expected to maintain constant attention to performance of stipulated work practices.

Examples of work practices, to assure the efficient operation of the "clean system" are:

a. Maintenance - All processes except spinning, twisting and weaving are enclosed and ventilated. Special provisions, such as lock-out procedures, protective clothing and equipment, and supervisory monitoring procedures have been instituted to protect personnel from excessive dust exposure during periodic and emergency maintenance situations, in the enclosed operations.

b. Waste Handling - These operations can easily get out of control without good work practices. Wetting methods and bagging procedures

have been given priority consideration. Waste is handled by classification, such as bag house waste, loom waste, roving waste, etc. with specific responsibility for proper handling being assigned to designated personnel.

c. Baghouse Operations - These areas offer the greatest probability for spills or malfunctions to occur. Attending personnel are required to wear protective clothing and respirators when entering the hopper areas of the interior baghouses. These areas are posted, requiring authorized entry only with protective equipment. (Figure 9)

d. Clean-up Methods - Routine clean-up operations at Marshville require the use of industrial utility vacuum cleaners on a continuous basis. Special clean-ups of building overhead areas, pipes, etc. are performed by personnel in protective clothing and respirators. (Figure 10)

e. Equipment Removal - From time to time it is necessary to move machinery and equipment. The work practice used requires a thorough cleaning of the equipment to eliminate loose asbestos and then oiling to suppress any dust that may have escaped the cleaning process.

f. Warehouse Surveillance - In the storage and moving of bagged raw asbestos fiber or packaged finished goods, tears and holes are sometimes created by handling equipment which allows the escape of airborne asbestos dust. The work practice requires the immediate patching of all bags or containers at the time of rupture, or when discovered, and before further moving. (Figure 11)

Administrative Procedures

Administrative procedures are used to supplement the engineering controls, methods and work practices and to further assure effective use of the "clean

system." These procedures range from mandatory measures to optional additional personal protection for employees. The following are examples of the administrative procedures used at Marshville.

a. Protective Equipment - During any emergency situation, protective clothing including a respirator must be worn. This includes, for example, emergency maintenance of enclosed equipment or rupture of a pressurized fiber carrying duct. Special clean-up crews must also use this equipment. These procedures are necessary as airborne levels of asbestos dust during clean-up or emergency maintenance operations are unpredictable.

   Respirators and dual lockers are made available to all employees regardless of how little asbestos dust exposure may occur.

b. Disciplinary Enforcement - Employees are required to adhere to the work practices and procedures developed to operate the "clean system." To enforce the program graduated disciplinary measures are used up to and including dismissal to emphasize and support the importance attached to carrying out the work practices.

c. Clean-up Personnel - Clean-up personnel, working continuously on each shift have been added to compliment the engineering achievements. These employees are in addition to those who performed this function prior to the engineering changes and represent more than a doubling of this effort.

d. Employee Information - Achievement of a "clean system" process stimulated a renewed effort in the employee educational program. Audiovisual instructional materials, pamphlet handouts and verbal

instructions by first line supervision are all used to re-emphasize the importance of limiting asbestos dust exposure to the lowest achievable level.

e. Dust Monitoring - Monitoring of asbestos dust exposure to individuals and work area dust levels is performed at a frequency considerably greater than is now required by the OSHA asbestos standard in view of the fact that dust levels in all areas are controlled to levels well below the permissible limits. Each month a selected number of dust samples are taken. Additionally a complete and extensive survey is accomplished annually to assure that the baseline exposure level is known.

CONCLUSION

The plant has approximately 150,000 square feet of floor space and employs slightly over 200 people. It has capacity for making in excess of 8,000,000 pounds of asbestos textile products and friction yarns annually. The clean-up and expansion program was completed under the forecasted budget monies and slightly over in time. Despite increased energy costs, the manufacturing cost has not increased per pound of product made. Increased productivity has helped offset inflation and energy costs.

The improvements in dust control can be quantified by studying the mean asbestos fiber counts in various manufacturing areas. Figure 12 indicates the dust levels in this plant in 1969, on acquisition in 1974 when the "clean system" was proposed and in 1978 after completion of the project. All levels are maintained below 1 fiber/ml, 8 hour TWA. The dustiest operations have been totally enclosed or eliminated.

The importance of work practices cannot be over emphasized. Poor work practices or carelessness in adherence to good work practices at any single operation within the plant, can result in widespread contamination and possible dust exposure.

It is recognized and accepted that although the engineering designs embarked upon have been completed, experience will determine what additional improvements can be made or need to be made. It is also recognized that operational procedures may have to be modified from time to time. It is our intention to reduce employee dust exposure to the lowest possible level achievable by reasonably practicable means with the goal of providing a safe and healthy workplace. It is also our intention to continue to produce conventional asbestos textiles in the knowledge that the plant described is probably the cleanest of its kind.

This paper also serves to illustrate the difficulties which might be encountered when conducting epidemiological studies in industry to determine dose-response relationships when technical achievements in environmental sampling, raw material production and engineering controls undergo changes over a period of time while the process and final product remain essentially unaltered.

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FIGURE CAPTIONS

FIGURE 1 HAND-FEEDING A CARD HOPPER

FIGURE 2 NEW ADDITION BUILT DURING MODERNIZATION OF PLANT

FIGURE 3 OPENING BAGS OF ASBESTOS WITH EXHAUST AIR DRAUGHTED AWAY FROM THE OPERATOR AND INTO THE HOPPER (NOTE BREACH OF WORK RULES- USE OF EMPTY ASBESTOS BAGS TO MAKE WORK-APRON)

FIGURE 4 THE STOCK OR MIX IS TRANSFERRED PNEUMATICALLY TO CARD FEEDS

FIGURE 5 GENERAL VIEW OF FRONT OF CARDS SHOWING ENCLOSURE AND OVERHEAD DUCTS FOR FORCING MAKE-UP AIR DOWNWARD THROUGH THE WORK ALLEY, PASSING BY THE OPERATOR AND INTO THE ENCLOSURE OPENING

FIGURE 6 OPENING SERVICE PANELS FOR CARD MAINTENANCE

FIGURE 7 ENCLOSED AND EXHAUSTED WINDING OPERATION

FIGURE 8 YARNS PACKAGED IN STRETCH-WRAPPED PLASTIC AND STACKED ON PALLETS

FIGURE 9 VIEW OF OUTSIDE BAGHOUSE

FIGURE 10 ROUTINE CLEANING IN PROGRESS

FIGURE 11 PATCHING DAMAGED BAGS OF ASBESTOS FIBER

FIGURE 12 SUMMARY OF ANNUAL MEAN ASBESTOS FIBER COUNTS IN VARIOUS AREAS DURING 1969, 1974 AND 1978

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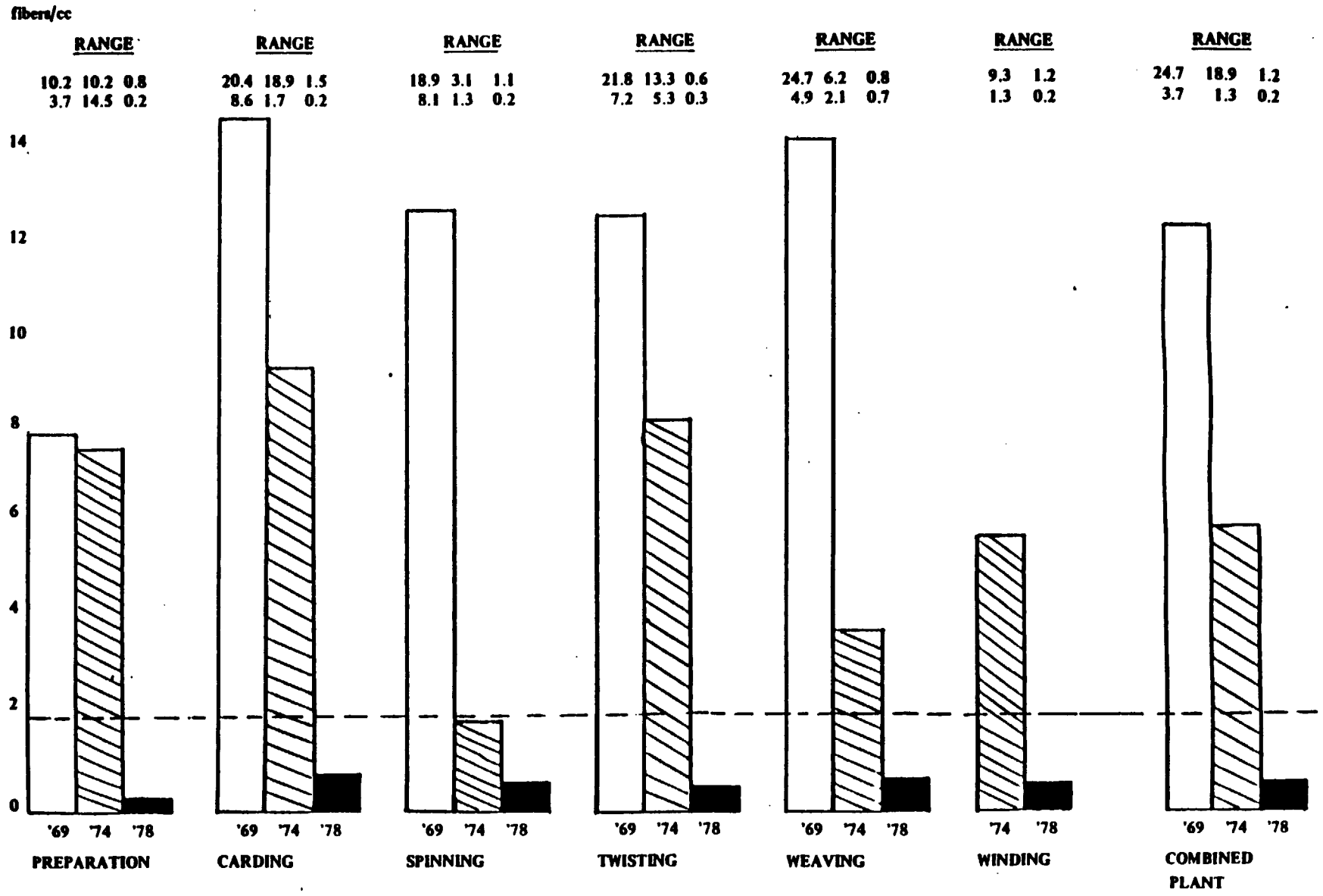
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