ASBESTOS INFORMATION ASSOCIATION
NORTH AMERICA
1835 K Street, N.W., Washington, D.C. 20006 • (202) 223-4835

14 October 1976

Docket Officer
Docket H-033
U.S. Department of Labor
Room N-3620
200 Constitution Avenue
Washington, D. C. 20210

Dear Sir:

On April 9, 1976 this Association; together with a number of manufacturing companies and other trade associations; filed written comments upon the Oct. 9, 1975 OSHA proposed rulemaking concerning certain occupational exposures to asbestos. One part of those written comments was a technological feasibility and economic impact study of the proposed regulation by Roy F. Weston, Inc. of West Chester, PA. Since the April 9 filing; certain minor errors and discrepancies in the Weston report have been called to the attention of the Weston organization. Although these errors and discrepancies do not, in our opinion, affect the validity of the major conclusions of the Weston study and do not require any change in the recommendations of the AIA/NA and associated companies and trade associations; we have asked Roy F. Weston, Inc. to comment upon the criticisms directed toward their report and, in the interest of furthering the credibility of our efforts, enclose herewith their response.

We would be pleased if you would confirm to us in writing that this addendum to our April 9, 1976 response to the Oct. 9, 1975 proposed rulemaking has been entered into the official record of proceedings.

Very truly yours,

Guy G. Gabrielson, Jr.
Chairman, AIA/NA Asbestos
Regulation Task Force

GGG:v
Enclosures

01-02054 ATTACHMENT A

WESTON

ADDENDUM TO REPORT ISSUED BY ROY F. WESTON, INC.

"TECHNOLOGICAL FEASIBILITY AND ECONOMIC IMPACT

OF OSHA PROPOSED REVISION TO THE ASBESTOS STANDARD"

Dated 29 March 1976

1. The 1974 consumption of asbestos in the United States was 846,000 tons as reported by the Bureau of Mines (Minerals Yearbook, 1975 ed.). There is a typographical error on page 2-10 of the subject report which states that U.S. consumption of asbestos in 1974 was 817,000 tons. Accurate data concerning the U.S. consumption of raw asbestos fiber for 1975 were unavailable during the time Weston was engaged in this project. Estimates of U.S. asbestos consumption were solicited from AIA/NA members, compared with Bureau of Mines data from the appropriate period, and projected for the calendar year of 1975. The Weston projections were then reviewed by AIA/NA members. Both parties agreed that 900,000 tons was a reasonable estimate for U.S. asbestos consumption for 1975 considering consumptive trends from 1970 through 1974 which showed an average increase in U.S. asbestos consumption of about 4 percent per year.

In reviewing the estimate, one must realize that this projection was formulated in December 1975. With census data on imports/exports lagging calendar time by 3 to 4 months, the estimate of 900,000 tons for 1975 was projected using data from January through August 1975. This fact coupled with several unforeseen circumstances at major asbestos mining and milling installations ultimately combined to reduce 1975 U.S. imports by 227,000 tons (compared with 1974). The actual 1975 asbestos consumption in the U.S. for 1975 was 605,000 tons.

Table 2-1 of Weston's report shows that 526,800 tons of asbestos consumption were reported as responding to the industry survey. This was equivalent to an industry coverage of 58 percent assuming that total asbestos usage in the U.S. was 900,000 tons in 1975. Based upon more recent data for total U.S. asbestos consumption in 1975 (605,000 tons), the survey data show an industry response of approximately 87 percent, indicating a broader data base than previously estimated. This expanded industry profile reinforces

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the quality of the conclusions reached for the Primary Asbestos Industries. However, it may revise the economic impact of the proposed asbestos standard since total segment expenditures were estimated, in part, on the tons of asbestos consumed by the companies responding to the industry survey as a fraction of the total segment's estimated consumption. The word "may" in the previous statement is emphasized since these estimates of capital and operating expenditures are predicated upon reasonable assumptions - a necessity when 100 percent industry coverage is not practical in all cases.

Weston made projections of total industry capital and operating expenditures to implement the proposed standards based upon: survey data; engineering judgments; industrial hygiene and medical requirements; and, current technological and economic status of the industry segments. Changes in the U.S. asbestos consumption pattern for 1975 were reflected in survey responses for items such as: employment, degree of asbestos exposure, sales volume, tons of asbestos processed, products manufactured, etc. All assumptions are documented in the subject report under their appropriate area of influence.

Given the estimate of asbestos consumption at the time of the project execution compared with current data, the extent of Primary Asbestos Industry coverage on a tonnage basis, the reasonableness of necessary assumptions involved with projecting capital and operating expenditures, and the fact that circumstances reflective of 1975 economic pressures were factored into the survey data, Weston concludes that the subject report findings and conclusions remain valid.

2. The Asbestos Paper segment of the Primary Asbestos Industry was estimated in the subject report to account for 38.0 percent of the U.S. consumption of asbestos in 1975. While this value may seem high in comparison with other estimates of the percentage of consumption by this segment, it must be emphasized that this definition was used by the company responding to Weston's survey as best describing its product. The definition of the industry segments as they appeared in the report and survey questionnaire were mutually agreed to by Weston and AIA/NA representatives. As such, they may not exactly coincide with U.S.

Bureau of the Census SIC Codes for asbestos paper products. Examples of Asbestos Paper products which are included in the subject report definition are asbestos felts, underlayments, and latex sheets as well as the more conventionally defined commercial and electrical grade asbestos papers. The latter two categories of the Asbestos Paper segment (i.e. commercial and electrical grade papers) account for approximately 2 percent of annual asbestos consumption in the U.S.

3. In estimating expenditures necessary for the Consumer Asbestos Industries to implement the proposed standards, Weston assumed that it is very unlikely these industries would exceed the proposed ceiling or 8-hour TWA standards. This assumption was based upon Weston's definition of the Consumer Industries: "those industries that purchase a finished asbestos-containing product (from a primary or secondary industry), and apply, install, erect, or consume the asbestos-containing product without further physical modification of the product." As a result, expenditures required to attain the proposed regulations were limited to operating costs in the form of industrial hygiene, medical, employee training, and recordkeeping expenses. Capital expenditures for control equipment to prevent asbestos fiber release into the environment were not required, by definition.

Recently, however, Weston has been advised of uses of asbestos containing products heretofore classified as consumer industries where the release of asbestos fibers <u>may</u> produce an 8-hour TWA employee exposure in excess of the proposed standard. An example of this is the use of asbestos textiles in the production of protective clothing wherein the interior of a protective garment is not laminated or coated with a sealing material. Employees using such garments may experience an exposure in excess of the proposed 8-hour TWA standard depending upon the particular circumstances and work activities in which they are engaged.

Two options are available to account for these exceptions to Weston's inclusion of these activities in the consumer industry. First, those employees who may experience asbestos exposure in excess of the proposed standards could be included in the secondary industries where both capital (control equipment) and operating (industrial hygiene and medical) expenditures are

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1835 K Street, N.W., Washington, D.C. 20006 • (202) 223-4885

22 October 1976

Memorandum: MEMBERS

Subject: Items of Interest

The following items are invited to your attention:

A. Addendum to Weston's Technological Feasibility and Economic Impact Study -- Subsequent to submission on April 9, 1976, of the AIA/NA response to OSHA on the proposed revision to the asbestos manufacturing standard, certain minor errors and discrepancies in the technological feasibility and economic impact study prepared by Roy F. Weston, Inc., were brought to our attention. These comments were passed to Weston with the request that they be reviewed and submitted to AIA/NA as an appropriate addendum to their study. This has been done and the changes have been transmitted by AIA/NA letter of October 14 to the OSHA Docket Officer. (See Attachment A.) The addendum does not affect conclusions of the Weston study nor the recommendations of the Association to OSHA.

It may be noted at paragraph 2 of section 1 of the addendum (Attachment A) "several unforeseen circumstances" is the explanation for reduction in 1975 U.S. asbestos imports. More specifically, the labor strike in Canada, fire at Asbestos Corp's King Beaver Mill, and landslide at J-M's Jeffry Mine could have been cited. In addition, the actual 1975 consumption figure for the U.S. is listed as 605,000 tons. This figure relates to U.S. imports since "total consumption" would have had to include reserve stocks consumed by companies during the reduction of imports from Canada in 1975. These clarifying points are not considered of such significance as to require a further change to the addendum. Such explanatory information can be provided at the public hearing.

B. OSHA Response to Supplemental TBA Data -- The Association's letter dated September 17 forwarded to OSHA supplemental data provided AIA/NA by TBA Industrial Products, Ltd., in refutation of the "new evidence" listed in the proposed revision to the asbestos standard (manufacturing) concerning exposure experience at a TBA factory. Mr. Gabrielson's letter of September 20 to Dr. Corn offered to discuss the TBA supplemental data (copies of letters were forwarded to members by AIA/NA memo of 9/21/76). Responses from Dr. Corn and the Docket Officer dated October 20 and September 23 respectively are enclosed for information as attachments B & C.

C. Revision of Association By-Laws -- An initial draft of revised AIA/NA By-Laws, prepared by counsel was provided to members by memo. dated August 27 for review preparatory to consideration at the September 8 Board of Directors meeting. At the board meeting, it was explained that the Executive Commitee had developed a number of suggested changes but that time available at the Board Meeting precluded discussion. It was agreed that a revised draft would be forwarded to members as soon as practicable. Enclosed is the revised draft. Review by members at the earliest convenient date is requested. Submission of comments by November 9 would facilitate a final review by the Executive Committee at meeting November 11 prior to formal action at the December 9 meeting of Directors. As previously indicated, the primary purpose of revising the AIA/NA By-Laws is to permit a broadening of membership which could result in increased income for defrayment of costs for expanded programs and activities through establishment of an associate class of membership. Other changes have been made to modernize the By-Laws in view of the Association's experience since its founding five years ago.

D. Resolution Concerning Contract for Technological Feasibility and Economic Impact Study of Construction Industry -- By memo. dated September 22 the decision of AIA/NA directors in meeting September 8 with regard to engaging a consultant to conduct an economic impact and technological feasibility study of the effect of asbestos regulation on the construction industry was reviewed. To carry out the desire of directors at the September 8 meeting, a poll of the membership for agreement to complete the study and to provide for the necessary funds to pay for the total study was initiated through a "Written Consent by All the Directors to Take Action Without a Meeting," with action to be completed by members not later than close of business October 12. Twenty-eight members out of a total membership of 32 have now responded, all in the affirmative. The resolution as set forth in exhibit A to the September 22 memo. is thus approved by majority vote of directors.

Accordingly, the Secretary of the Association has been instructed to advise the Association's accounting firm, Frank C. Frantz, to forward to members an assessment statement of 18% of dues for fiscal (calendar) year 1976, payable on receipt. The balance of study costs will be borne by normal dues revenue in 1977. Work on the study is well underway by Equitable Environmental Health, Inc., and a status report will be provided members in the near future.

R. H. Mereness

R. H. Mereness
Executive Director (Secretary)

Enclosures

ROY F. WESTON INC
WESTON WAY
WEST CHESTER PA 19380
PHONE (215) 692-3030
TELEX 83-5348

WESTON
ENVIRONMENTAL CONSULTANTS-DESIGNERS

ASBESTOS INFORMATION ASSOCIATION/NORTH AMERICA

INDUSTRY QUESTIONNAIRE (1) (2)

Company Name ______________________________

Plant Address ______________________________

Corporate Affiliation ______________________________

Name of Plant Contact ____________________ Title ____________________

Phone Number (   ) __________

Note: This cover page will be detached from the remainder of the questionnaire to insure confidential handling of all information.

(1) For assistance in completing the information in this questionnaire, please contact Mr. Jerry L. Hebb, Roy F. Weston, Inc., phone (215)692-3030.

(2) If, for any reason, you do not choose to participate in the study by completing this questionnaire, please return it directly to Mr. Jerry L. Hebb at Roy F. Weston, Inc.

Company Code #________

Plant Code #________

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I. General Product/Process Information

1. Which of the following industry segments best describes the asbestos-containing products in your operations? (Check more than one, if appropriate).

_____ Asbestos Cement Products (pipes, sheets, siding shingles)
_____ Asbestos Paper Products (asbestos felts, latex sheets, underlayments, electrical and commercial papers)
_____ Floor Tile
_____ Coatings (roof coatings, caulks, sealants, paints, adhesives and undercoatings)
_____ Friction Materials (automotive linings, disc components, blocks, clutch facings)
_____ Gasket, Packing, Sealing Devices
_____ Joint Cements
_____ Asbestos Reinforced Plastics
_____ Asbestos Textiles
_____ Asbestos Drilling Muds
_____ Asphaltic Paving
_____ Distribution/Resale
_____ Miscellaneous (Specify) ______________________

2. Which of the following categories best describes the operation at your plant? (Check more than one, if appropriate).
   a. _____ Manufacture a product where raw asbestos is used.
      What tonnage of raw asbestos do you use per year? _________
   b. _____ Process a product which already contains asbestos.

3. In reference to Question 1, for each industry segment, give the specific asbestos end product(s) (siding, pipe, etc.) manufactured, handled, or used at this location and the annual volume of each (in pounds, tons, square feet, etc.).

Industry Segment	End Product(s)	Annual Volume

Company Code #________
Plant Code #________

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4. What was the aggregate sales value of asbestos containing products manufactured at this plant during the last five calendar years:

1971 $ ______
1972 $ ______
1973 $ ______
1974 $ ______
1975 $ ______

5. What was the level of capital expenditure for plant improvement and expansion of production facilities for asbestos containing products during the last five calendar years? (Include capital expenditures for environmental control, plant improvement and expansion).

1971 $ ______
1972 $ ______
1973 $ ______
1974 $ ______
1975 $ ______

6. What is the total plant employment at this location? ______

7. Give the approximate percentage of the employees whose asbestos exposure falls in the following categories:
   a. Continually in the work environment (operating, production, materials handling personnel) ______
   b. Frequently in the work environment (maintenance, supervisory personnel) ______
   c. Only occasionally (less than 5 times per week) in the work environment (management, engineers) ______
   d. Never or very infrequently enter the work environment (secretaries, sales personnel) ______

8. What unions (locals) represent your employees, if any? ______
   ______
   a. How active have the unions been in the area of employee health and safety (demands for hazard pay, shorter work periods, etc.)?

Active Area	Extent of Activity (V--Very, M--Moderate, N--None)
______	______
______	______
______	______
______	______

   b. What is the current pay scale range of unionized personnel? ______
   ______

Company Code # ______
Plant Code # ______

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II. Control Technology/Cost Information

9. Provide a brief description of each step in your operation as it relates to asbestos handling or movement. Interest is primarily in the location of dust sources (bag slitting and dumping, sanding/finishing, etc.) and in dust control at these sources (hoods, etc.) rather than in the production equipment. A block flow diagram is suggested. There should be one such diagram for each product group and/or process used. Include raw materials er .ry and finished product handling. A blank page has been inserted at the end of this section for the block flow diagram(s) and description(s). If additional space is needed, please attach extra sheets.

10. Has control equipment been installed at each step or combination of steps in the block flow diagram(s) where asbestos is released to reduce worker exposure to airborne asbestos? Yes _____ No _____

List control equipment in use:

Step	Type of Equipment	Date Installed

11. What is the total cost of control equipment listed in Question 10?
a. Capital cost (installed) $ ____________
b. Operating cost (annual) $ ____________
(Note: give horsepower, exhaust volume, etc., if operating costs are unknown.)
c. What effect has this equipment had on your process, product or production rate? ____

Company Code # ________
Plant Code # ________

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d. Did this equipment increase or decrease the plant/process energy requirements (electrical power, space heating, etc.)? Increase ______ Decrease ______ By how much? ______________________

12. What process modifications or work practice changes, if any, were instituted to reduce worker exposure to asbestos? ______________________

a. Capital Cost (installed) $ ______________
b. Operating Cost (annual) $ ______________
c. What effects have these process modifications or work practice changes had on your process, product, or production rate? ______

d. Did these process modifications or work practice changes increase or decrease the plant/process energy requirements? Increase ______ Decrease ______ By how much? ______________________

13. Have the control equipment or work practice changes reduced airborne asbestos levels in all of the work areas? Yes ______ No ______

List the ranges of asbestos fiber counts in the work areas involved:

Work Area	Range of Asbestos Fiber Counts: Before Modifications/ Changes	Range of Asbestos Fiber Counts: After Modifications/ Changes

14. Have the control equipment or work practice changes reduced air-time-weighted average exposure to airborne asbestos in all of the work areas? Yes ______ No ______

Company Code # ______
Plant Code # ______

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Work Area	Range of TWA Asbestos Fiber Counts: Before Modifications/ Changes	Range of TWA Asbestos Fiber Counts: After Modifications/ Changes

The present asbestos standard sets a maximum allowable Time-Weighted Average (TWA) exposure of 5 fibers/cc over an 8-hour period. This, by statute, will be reduced to 2 fibers/cc in July, 1976. The proposed standard would reduce this level to 0.5 fibers/cc at some time in the future. If you have already reached 0.5 fibers/cc at each step where asbestos is released into the work place, please go on to Part III; if not, please complete the following:

15. At each location where asbestos dust is released, do you feel you have installed the "Best Available Technology?" Yes ______ No ______
Best Available Technology (BAT) is defined as control equipment, process modifications, work practice changes, or combinations thereof, which have been demonstrated to provide the most effective control or reduction of contaminant emission.

16. If not, what do you consider the BAT to be, and how effective will it be in reducing airborne asbestos at each location? (Can be control equipment, work practices, process modifications, or combinations thereof).

Locations	BAT	Estimated Asbestos Fibers/cc

Company Code # ________
Plant Code # ________

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17. What is the expected cost of BAT in terms of:
    a. Capital Cost (installed) $ ________
    b. Operating Cost (annual) $ ________
    c. Plant/Process Energy Requirements, Increase ________
       Decrease ________
    d. Personnel Requirements, Increase ________ Decrease ________
    e. Process/Product Effects, Increase $ ________
       Decrease $ ________
       Explain ________
    f. By what date could BAT be implemented? ________

18. If the Best Available Technology does not reduce worker exposure to a TWA of 0.5 fibers/cc and a ceiling of 5 fibers/cc at all points, provide your considered judgment on the possibility, cost, and timing to develop new technology to achieve this level. What approach might be used? ________

19. If the proposed 0.5 fibers/cc level is adopted, what action is foreseen at your plant? ________

III. Industrial Hygiene and Health Information

20. The existing and proposed standards require certain industrial hygiene practices where workers are exposed to airborne asbestos below the established TWA or ceiling levels. Do you (provide cost data where available):

	Yes	No	Cost/ Man-Year	Total Plant Cost/Year
a. Provide preplacement employee medical exams?	___	___	___	___
b. Provide annual employee medical exams?	___	___	___	___
c. Provide termination employee medical exams?	___	___	___	___

Company Code # ________
Plant Code # ________

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	Yes	No	Cost/ Man-Year	Total Plant Cost/Year
d. Retain medical records (20 year period)?	___	___	______	______
e. Maintain records of employee exposure to asbestos fiber (3 year period)?	___	___	______	______
f. Dispose of waste materials which may contain asbestos in sealed containers?	___	___	______	______
g. Provide caution labels for all material containing unbound asbestos?	___	___	______	______
h. Provide initial monitoring (sampling) of the work place for airborne asbestos?	___	___	______	______
i. Provide periodic monitoring (sampling) of the work place for airborne asbestos?	___	___	______	______

21. Certain provisions of the existing regulation require additional industrial hygiene practices where levels of airborne asbestos exceed TWA of ceiling standards. Where these requirements apply to your plant, do you:

	Yes	No	Cost/ Man-Year	Total Plant Cost/Year
a. Have a respirator program (for use in certain work situations or emergencies)?	___	___	______	______
b. Provide worker rotation where employee is unable to function normally while wearing a respirator?	___	___	______	______
c. Provide protective clothing (for employee exposed to asbestos greater than the ceiling level)?	___	___	______	______
d. Provide change rooms (where special clothing is required?	___	___	______	______
e. Provide separate locker facilities (where special clothing is required)?	___	___	______	______
f. Provide laundering of special clothing?	___	___	______	______
g. Post caution signs (where levels are greater than the ceiling or TWA levels)?	___	___	______	______

Company Code # ______
Plant Code # ______

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22. Do you employ a company physician? Yes ______ No ______
If yes: Full-Time __________; Part-Time __________ Part-Time hours/week __________

23. Do you employ an industrial hygienist? Yes ______ No ______
If yes: Full-Time __________; Part-Time __________ Part-Time hours/week __________

24. Who performs your medical examinations (clinic, resident physician, etc.)?
____

25. The proposed standards expand the scope of industrial hygiene practices into areas such as: shower requirements, regulated areas, expanded respirator programs, and employee education programs. In general, how do you believe your employee will react to such practices? ______
____
____
____
____

IV. Economic Impact Information

26. Considering individually the major products manufactured at this location, has implementation of asbestos exposure control procedures and industrial hygiene programs affected the cost of these products? Yes ______
No ______
If yes, specify:

Products	Implementation Cost, $/Unit of Production Increase	Decrease

27. Have you experienced a shift or change in product sales due to the cost impact described in Question 26? Yes ______ No ______

Company Code # ________
Plant Code # ________

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a. If yes, specify:

Products	Sales Change, $/Year Increase	Decrease

b. If sales have decreased, has the demand been satisfied by:

	Yes	No
Other Asbestos Products	___	___
Asbestos Substitute Products	___	___
Imported Asbestos Products	___	___

c. Which of the above has had the greatest impact on your sales?

____

28. Considering individually the major products manufactured at this location, do you expect the future implementation of BAT control procedures and expanded industrial hygiene programs to affect the cost of your products?
Yes ______ No ______
If yes, specify:

Products	Implementation Cost, $/Unit of Production Increase	Decrease

Company Code # ________
Plant Code # ________

01-0205748

29. Would you expect to experience a shift or change in product sales due to the cost impact described in Question 28? Yes ______ No ______

a. If yes, specify:

Products	Sales Change, $/Year Increase	Decrease
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______

b. If you expect a sales decrease, will the demand be satisfied by:

	Yes	No
Other Asbestos Products	___	___
Asbestos Substitute Products	___	___
Imported Asbestos Products	___	___

c. Which of the above would you expect to have the greatest impact on your sales? ______________________________

30. What is the typical age of production equipment in use at your plant in your particular industrial segment?

Segment	Typical Production Equipment Age, Years 0 - 5	5 - 15	15 - 25	25+
______	______	______	______	______
______	______	______	______	______
______	______	______	______	______
______	______	______	______	______
______	______	______	______	______

31. In your opinion, with the implementation of BAT and the proposed OSHA standard to control worker exposure to asbestos, what portion of the existing production equipment may continue to be economically utilized? (Consider the portion of capital equipment retained as a percentage of the total production area investment).

Company Code # ________
Plant Code # ________

Less than 10% ________
10 - 25% ________
25 - 50% ________
50 - 75% ________
Greater than 75% ________

32. Within your community, which estimate best describes the portion of the total work force employed at your plant?

Less than 10% ________
10 - 25% ________
25 - 50% ________
50 - 75% ________

V. Information Regarding Manufacturers/Fabricators of Asbestos-Containing Products

The proposed regulations apply to every place of employment where asbestos, or a product containing asbestos, is manufactured, processed, packaged, stored, applied, used, or otherwise handled. It is extremely important to our assessment to include estimates of the number of people involved as your products are ultimately used and the possible asbestos exposure levels of these individuals. Insofar as is possible, kindly provide the following information:

33. Who uses the asbestos-containing products you produce (construction industry, auto repair garage, fabricator, etc.)? ________________

34. Describe how your products move from your plant through the final consumer ________________

35. Estimate numbers of people and what levels of asbestos dust exposure, if any, may occur at each step (from further processing, fabrication, installation, etc.)? ________________

Company Code # ________
Plant Code # ________

01-0205750

36. Provide names of your customers and appropriate trade association so that Weston might obtain more comprehensive information in these areas

____
____
____
____
____

Company Code # ________
Plant Code # ________

01-0225751

Existing Fiber Counts

A summary of time-weighted average fiber counts is presented in Table 4-3. It covers all processing steps of Floor Tile production.

Fiber introduction data ranges from less than 1.0 to in excess of 4 fibers/cc TWA. It is not known to what extent the use of pelletized asbestos rather than raw fiber influences the range of results. Pelletized asbestos has been available to primary industries for approximately 5 years; however, information collected by Weston indicated that the use of pelletized asbestos appears to be in the developmental or trial stage rather than the general rule. The extent existing processes and products permit the use of pelletized asbestos is not fully known. Indications are that using pelletized asbestos in fiber introduction yields low worker exposure TWA levels (in the 0.5 to 1.0 range), while the use of bagged raw asbestos for fiber introduction can exceed 4.0 fibers/cc TWA.

Dry blending of the asbestos fibers generates worker exposures of approximately 1.8 fibers/cc TWA. This process is enclosed and does not require sustained worker attendance near the equipment. Banbury mixing data indicates worker exposure levels of approximately 1.5 fibers/cc TWA. These levels have been recently achieved through the installation of hooded exhausts and better housekeeping. Data from milling of the plastic mass shows exposure levels ranging from less than 0.5 to approximately 0.75 fibers/cc. The extent to which these data are influenced by the proximity of the mills to the dry fiber operations, by general background levels, and by emissions directly from the mill are not known.

The calendering operation yields low exposure levels (less than 0.75 fibers/cc TWA). The interpretation of these data is unclear, since the operation is largely automatic and unattended. These readings should be minimally influenced by background counts, since the equipment is sufficiently removed from the dry fiber operations. Sufficient data for the other operations such as embossing, cutting, inspection, and packaging are not available, although worker exposure levels for these areas are expected to be low.

Table 4-3

Time-Weighted Average Fiber Counts
Floor Tile

Process Step		Fiber Count with Existing Control Technology		Projected Fiber Count Best Available Technology(1)
		Typical Fibers/cc	Range Fibers/cc	Fibers/cc
1	Receiving & Storage	1.0	0.25 - 2.5	0.5 or 1.0
2	Fiber Introduction	1.5	0.9 - 4.3	1.0
3	Blending	1.75	0.9 - 4.3	1.5
4	Banbury Mixer	1.5	0.8 - 4.3	1.25
5	Milling	0.75	-	0.75
6	Calendering	0.75	-	0.75
7	Embossing	0.75	-	0.75
8	Cutting	0.75	-	0.75
9	Inspection	0.75	-	0.75
10	Packing	0.5	-	0.5
11	Scrap & Rework	0.5	-	0.5

Data Base: Data collected from plants consuming 43,400 tons of asbestos annually, or 39 percent of the Floor Tile Segment.

(1) Projected fiber counts are estimates of average exposure after implementing BAT. Variations of these values are expected depending upon individual installations.

Best Available Technology (BAT)

This industry has already installed the elements of best available technology (hoods, dust evacuators, air bags, etc.) in anticipation of meeting the 2.0 fibers/cc standard to be effective in July 1976. More extensive use of dust control equipment already employed will likely result in only a small incremental decrease in asbestos exposure.

Further partitioning of the work areas relating to raw fiber handling and changes in plant layout may be possible to reduce worker exposure. Since much of the production line is automated, some controls and adjustments may be further removed from the immediate areas of fiber dust to reduce worker contact. Any work practices that result in moving the worker farther from the dust sources would be beneficial in reducing the eight-hour TWA exposures. Further reductions in exposure levels would require advanced technology: to automate fiber introduction, to isolate the worker from the sources of handling fiber, and to effect a general reduction in the background of fiber dust.

Advanced Technology

Because the Floor Tile segment handles large quantities of raw bagged asbestos, improved packaging techniques and automatic bag-opening machines would represent a major advance towards worker safety. If the industry could shift to using 100% pelletized asbestos (already in trial operation), fiber exposure would be further reduced.

It is estimated that application of advanced technology to floor tile manufacturing could reduce and maintain worker exposure to 1.0 fibers/cc TWA or less in nearly all areas.

Economic Impact

Data and information supplied to Weston represent 39 percent of this segment (Table 2-1); however only 15 percent of this segment supplied usable data to generate cost information. The size of firms supplying usable data range from 3,900 to 9,000 tons of asbestos used annually. Unfortunately, these data do not include the large companies or the very small ones. The capital costs to achieve BAT for this segment are $2,720,000. Operating costs are projected to be $1,380,000/ year. This segment has 69 percent of its employees exposed.

The industrial hygiene and medical costs will be $6,000,000 for this segment. This represents 74 percent of the total annual costs ($8,060,000). The total annual costs to comply with the proposed standard represent 3.0 percent of this segment's Average Annual Sales. The total annual costs vs. Average Annual Sales range from 2.5 to 8.4 percent. The expected capital costs estimated by industry to comply with the proposed standard represent 33 percent of this segment's typical total annual capital expenditures. This low percentage indicates that a large amount of capital has been spent previously to achieve BAT.

Summary of Impact
Floor Tile Segment

Asbestos Usage		112,500 tons/year
Increased Cost of BAT to Industry Segment:		
Capital Cost to Achieve BAT		$ 2,720,000
Annual Costs:		
Capital	$ 680,000	
Operating Costs	1,380,000	
Industrial Hygiene and Medical Program	6,000,000	
Total Annual Costs		$ 8,060,000
Total Annual Costs versus Average Annual Sales		3.0 percent
Expected Capital Costs versus Typical Total Annual Capital Expenditures		33 percent

<u>Conclusions</u>

- Although further data are required, it is indicated that the Floor Tile segment is currently close to BAT control conditions, having mostly complied to a 2.0 fiber/cc TWA standard.

- Advanced technology would be required to achieve any significant reductions in current exposure levels. It is not known if the proposed 0.5 fiber/cc TWA can be attained in the foreseeable future.

Friction Products

Technological Feasibility

Friction materials are used in practically all industries as a key component in clutches for transmitting torque, brakes for slowing down or stopping motion or as torque limiters. These friction applications are not limited to brakes and clutches in automobiles, trucks, busses, construction equipment and railroad cars. Rather, these applications are found wherever motion must be controlled. The following examples show the diversification of friction material usage: farm tractors, presses, hoists, tensioning devices in production of wire and plastic rope and cable, lift trucks, machine tools, shuttlecars, specialized mining equipment, chainsaws, drilling equipment, spinning and knitting equipment, x-ray machines, wheel brakes, tape recorders, typewriters, bicycle brakes, snowblowers, and washing machines. This industry segment is composed primarily of five major companies; foreign competition, some from Korea, has started to penetrate the market.

The industry employs asbestos typically bound in cured resin compounds to form hardened friction materials. These pads may be bonded, riveted, or otherwise attached to machined metal pieces (as in the production of brake shoes). Asbestos is an essential ingredient in these products because it imparts strength, good friction properties, can withstand high temperatures, and is a good insulator.

Process Description

Figure 4-4 illustrates a typical manufacturing scheme that is employed in manufacturing friction products.

The manufacturing plants for friction products are large, centralized facilities. The plant layouts include machinery such as drilling presses, grinders, mills, lathes, metal stampers, curing ovens, molds and presses, paper machines, conveyors, mixing vats, and chemical operations.

The manufacturing of friction products is highly labor-intensive and involves many processing operations before the finished product is obtained. Some manufacturers provide incentive pay to the employees to maintain high output. Millions of disc brake pads and tens of millions of automatic transmission plates are manufactured yearly at a given site.

The products flow directly to the original equipment manufacturers (automotive and industrial) or to hundreds of thousands of marketing outlets.

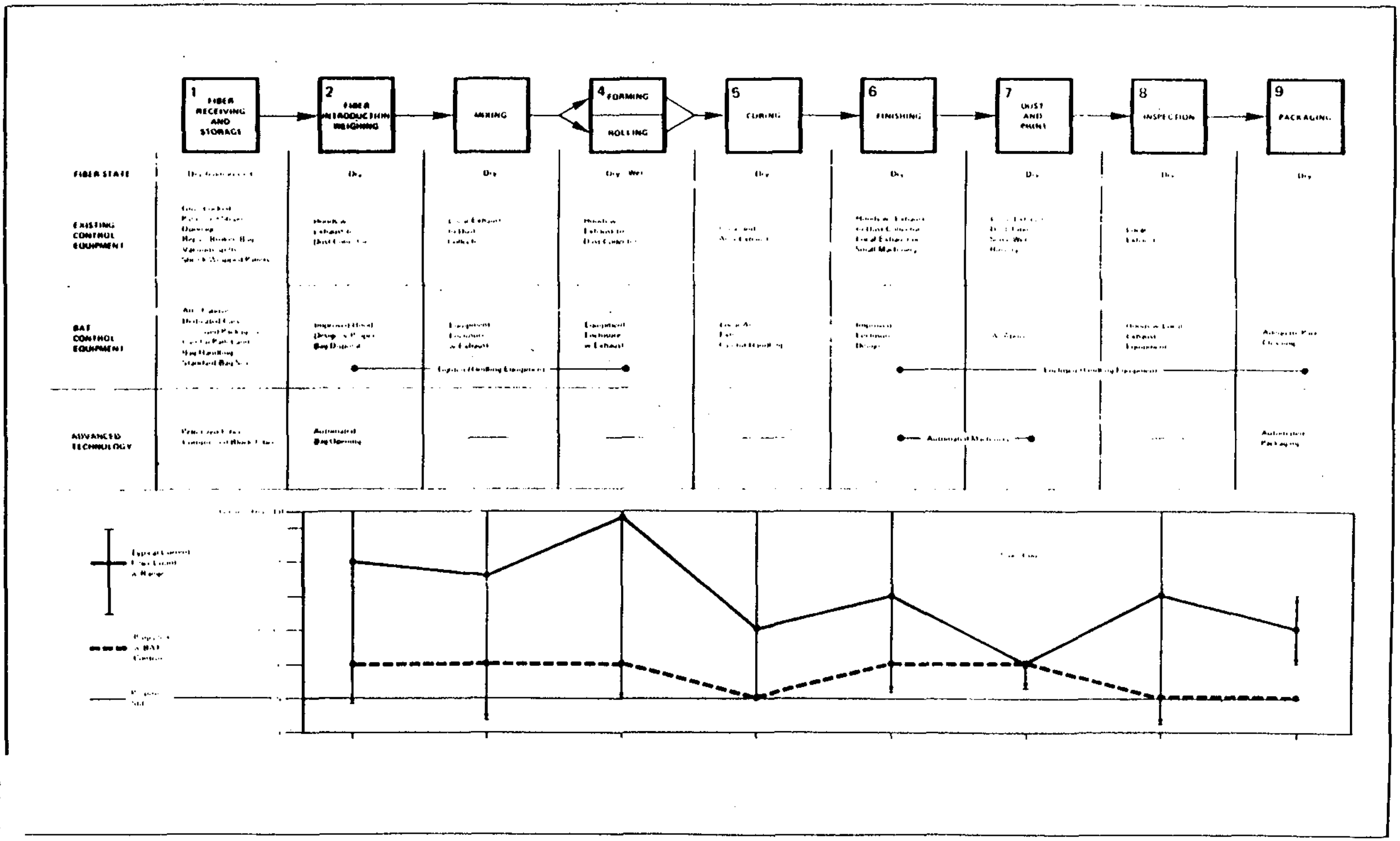

FIGURE 4-4 DIAGRAM OF PROCESS FLOW AND FIBER COUNT
– FRICTION PRODUCTS

01-0205

The asbestos bags are weighed, manually opened, and placed in movable hoppers for in-plant transportation. The hoppers are dumped into mixers. The formulations may be mixed either wet or dry depending on the product specification. The mixers blend the asbestos, fillers, and liquid resin.

The mix is fed through a compression molder or an extruder, depending on the required product. Formed strips are cut and bent into various widths and lengths. A parting compound is added to prevent parts from sticking.

Dry-mixed formulations are transferred to pressing molds where slabs are formed. Some formulas require a preheating step. The slabs are then hot pressed, which causes the resin to flow and bind the mixture. The formed slabs are sawed into specific parts and sent to a curing oven.

Following curing, the parts undergo a number of finishing steps to produce the final block. These machine-assisted manual operations include grinding, sawing, drilling, blanking, tapping, and boring.

The brake pads may be packaged and sold to a secondary manufacturer or may be applied directly to brake shoes by bonding or riveting.

The asbestos formulations are processed wet where it is practical to meet product specifications. This reduces the potential for asbestos fiber elution. In some instances, automatic transmission plates are presoaked in transmission fluid to reduce dusting.

Work Practices/Controls

Extensive centralized vacuum exhaust systems are employed with trunk connections to evacuate dust from individual machine operations. Hoods and enclosures are extensively employed. Where raw fiber is handled, the plant layout is generally arranged to isolate this operation from other production areas. Many products undergo a brushing operation to remove latent dust. Manual inspection of parts is carried out on down-draft air exhausting tables to minimize worker exposure.

Workers in the industry are generally highly trained and highly skilled. The employers provide extensive safety training and incentives to minimize hazards in the working environment. The workers are encouraged by incentive pay.

Constant houskeeping is conducted round-the-clock, as most plants operate three shifts per day and up to seven days per week at peak periods. Vacuuming is the general housekeeping practive; however, brooms are also used where the spilled material is difficult to vacuum.

Existing Fiber Counts

Because of the complexity of the manufacturing operations, the frequent handling and transporting of components throughout the plant, the high volume of production, and the extensive machine-assisted manual operations, the fiber count data reported for 8-hour TWA exposures varies over a wider range than any other primary segment.

Table 4-4 illustrates the ranges of 8-hour TWA fibers/cc data received for the Friction Products segment.

The Friction Products segment has collected extensive exposure data for all phases of its operations, but interpretation of the data is complex. The nature of the work place, the largely individual manual techniques, the multitude of operations, and the influence of many variables cause the monitoring techniques and calculation procedures for TWA exposures to be subject to considerable error and deviation. The following factors influence the data received:

- Worker practices: these practices may be identifiable (e.g., carelessness) or unidentifiable (e.g., individual skill and technique).

- Percent of asbestos in product being processed: formulations and operations characteristically have asbestos concentrations from 30 to 70%.

- Asbestos fiber breakdown: high mechanical forces subjected to the compounds at various operating phases break the asbestos fiber chain into many distributions of sub-fibers. Where fibers are broken to a length of less than 3 to 1, the asbestos is not counted by the

Table 4-4

Time-Weighted Average Fiber Counts
Friction Products

	Process Step	Fiber Count With Existing Control Technology Typical fibers/cc	Range fibers/cc	Fiber Count With Best Available Technology (1) fibers/cc
1	Receiving & Storage	1.0	0.25-2.5	0.5 or 1.0
2	Fiber Introduction & Storage	2.5	0.4 -4.6	1.0
3	Mixing	2.3	0.2 -8.0	1.0
4	Forming or Rolling	3.3	0.5 - 22.0	1.0
5	Curing	1.5	0.5 -3.5	0.5
6	Finishing	2.0	0.6 -7.4	1.0
7	Adjustment & Printing	1.0	0.7 -1.0	1.0
8	Inspection	2.0	0.1 -15.0	0.5
9	Packaging	1.5	1.0 -2.0	0.5

Data Base: Data collected from plants consuming 35,100 tons of asbestos, or 60 percent of the Friction Products Segment.

(1) Projected fiber counts are estimates of average exposure after implementing BAT. Variations of these values are expected depending upon individual installations.

sampling technique, thus reducing the relative exposure data. However, a fiber may be broken into several components greater than 5 microns, thus increasing the relative exposure levels.

Best Available Technology (BAT)

The segment currently has a heavy investment in control equipment. This equipment includes vacuum exhaust dust collection, hoods, partitioning, and isolation. The best available technology for control equipment would be an extension of these devices where they are now not applied.

Further development of work practices, industrial engineering methods, and house-cleaning are in part BAT as well as control technology. Stricter control supervision can be employed to minimize worker carelessness or poor technique. A larger janitorial work force can be developed for continually maintaining cleaner work areas.

Projected Fiber Counts (with BAT)

Since extensive control equipment is already in use, additional engineering controls will have little influence on the average exposure levels already in existence. However, these controls may eliminate certain isolated high exposures experienced in today's friction products segment.

Advanced Technology

Far-reaching advances will be required by the friction products segment to effect a significant lowering of existing asbestos TWA exposures. New facilities and processes will be required. Automatic handling of the raw asbestos and intermediate products is required. Considerable industrial engineering work practices and worker techniques need to be developed and implemented.

Economic Impact

Data and information supplied to Weston represents 60 percent of the segment (Table 2-1); however, only 46 percent of this segment supplied usable data to generate cost information. The size of firms supplying usable data ranges from 500 to 9,500 tons of asbestos used annually.

The capital costs to achieve BAT for this segment are $29,800,000. Operating costs are projected to be $3,360,000. This segment has 90 percent employees exposed. The industrial hygiene and medical costs will be $6,570,000 for this segment; this represents 38 percent of the total annual costs ($17,380,000). The total annual costs to comply with the proposed standard represent 7.8 percent of this segment's average annual sales. The total annual costs versus average annual sales range from 1.0 to 25 percent. The expected capital costs estimated by industry to comply with the proposed standard represent 316 percent of this segment's typical total annual capital expenditures.

Summary of Impact
Friction Products Segment

Asbestos Usage		58,500 tons/year
Increased Cost of BAT to Industry Segment:		
Capital Cost to Achieve BAT		$29,800,000
Annual Costs:		
Capital	$7,450,000	
Operating Costs	3,360,000	
Industrial Hygiene and Medical Program	6,570,000	
Total Annual Costs		$17,380,000
Total Annual Costs versus Average Annual Sales		7.8 percent
Expected Capital Costs versus Typical Total Annual Capital Expenditures		316 percent

Conclusions

- Significantly improved work practices and major incorporation of advanced technology are required to significantly reduce worker exposure to airborne asbestos to less than 1.0 fiber/cc TWA.

- The industry cannot achieve the proposed 0.5 fibers/cc TWA in all process areas through engineering controls and work practices in the foreseeable future.

- No substitute has been proven for the asbestos in the friction product, nor can the country do without it; therefore, the friction product companies must pass the cost on to the customer. This could results in substantial loss of business to imported friction products.

Paints, Coatings, and Sealants

Technological Feasibility

The production of roof coatings, caulks, sealants, paints, adhesives, and undercoatings generally involves mixing asbestos and other fillers into an asphalt base. Solvents may be added to reduce the viscosity and to allow spray application. Upon application, the solvents vaporize out of the coating, leaving a tough, semi-hardened consistency.

Several types of blends, with varying ingredients, are required for different product lines such as tennis court surfaces, roof coatings, automobile undercoatings, and foundation sealants. The products are compounded normally using proprietary blends to provide cost effectiveness, ease of application, color and texture, and resistance to weathering.

Small manufacturers, such as those producing 1.0 MM gallons per year, normally have one production line for all products produced. In general, their product mix is small and the equipment is scheduled to produce the desired product. Larger manufacturers, producing in excess of 3.0 MM gallons per year, may have a wide product mix and several production lines oriented to a specific product. Smaller manufacturers package and ship their coatings nearly exclusively in five-gallon metal pails. Large manufacturers may ship their coatings in five-gallon pails, barrels, and tank cars. Thus, batch sizes produced may vary from several hundred gallons to several thousand gallons, depending on the size of the company, type of product, method of containerizing, type of existing equipment, and size of order. Specialized products and techniques exist in the industry, such as oil-in-water emulsions for coatings, but are not covered in this report.

Figure 4-5 illustrates the basic manufacturing operations for coatings manufacturing. A small manufacturer may have all production steps in one or two areas. A larger manufacturer with several production lines has separate locations (partitioned work areas or separate buildings) for the different production stages.

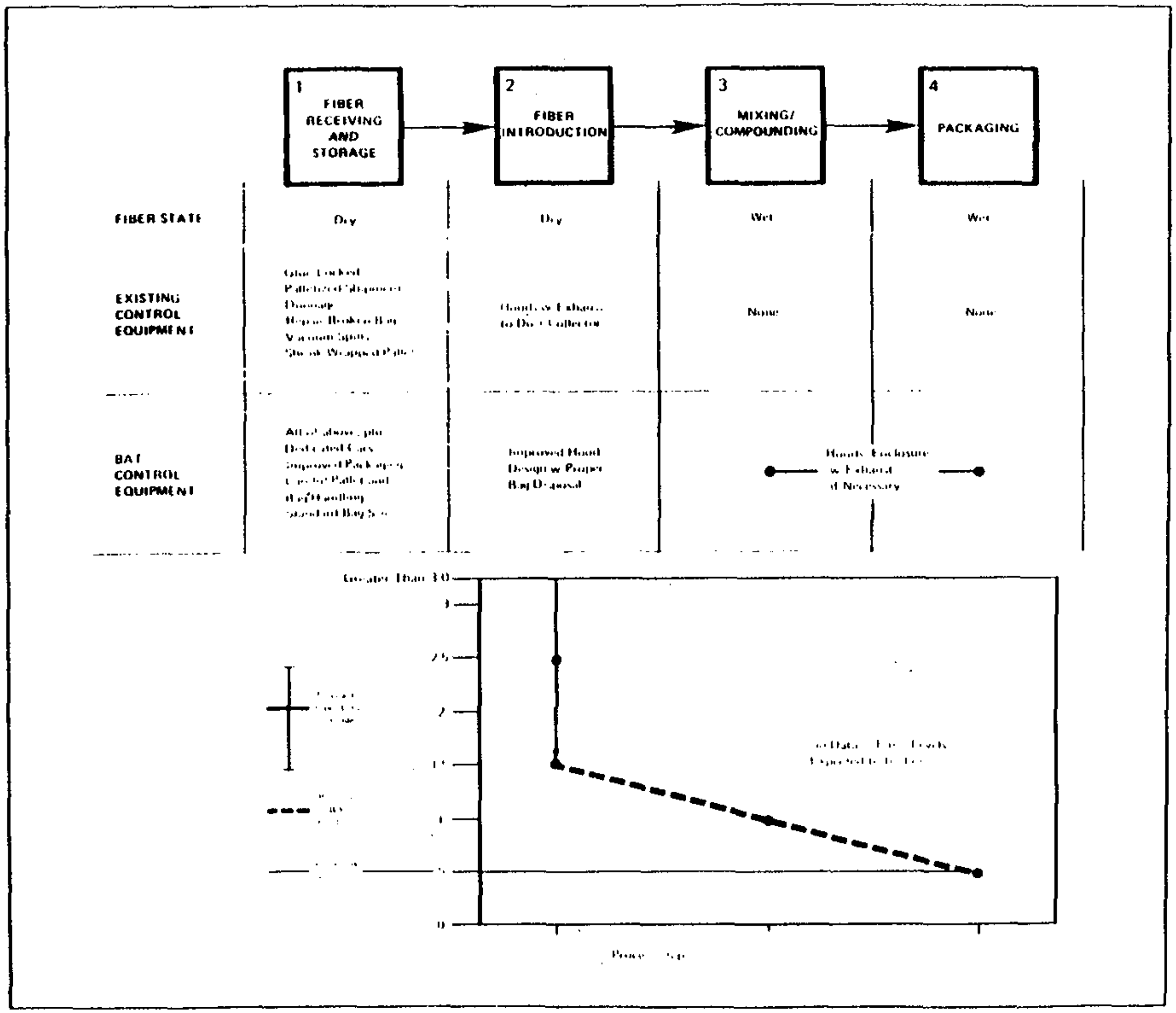

FIGURE 4-5 DIAGRAM OF PROCESS FLOW AND FIBER COUNT PAINTS, COATINGS, AND SEALANTS

Process Description

Fiber introduction is the key phase with regard to worker exposure. The pallets of asbestos are moved to a staging area and weighed. The bags are manually slit and dumped either into a hopper or directly into a fluffing machine. This machine breaks down the compressed fibers to an open, free condition to enable dispersion and encapsulation during asphalt mixing.

Cutting the bags and dumping the free asbestos subject the worker to localized asbestos exposure. Fiber can also become airborne or can fall to the floor, causing house-cleaning problems and contributing to an overall background level of asbestos exposure. Worker tidiness and care, equipment arrangement, and housekeeping procedures highly influence the amount of asbestos exposure resulting from this operation.

Empty bags containing residual asbestos create a disposal problem in this operation. As several bags may be emptied at once, a waste receiver is often made available for direct disposal. Where the bags are laid on the floor or otherwise remain loose until the fiber introduction is completed, free asbestos creats a housekeeping problem in the work area. Several thousand emptied asbestos bags are disposed of by a single coatings manufacturer in a year's time.

Typically, fluffed asbestos fiber is transferred to hoppers or directly to a batch mixing tank. Fiber transfer may be pneumatic, mechanical (conveyors), or manual. Pneumatic transfer systems are enclosed and use bag filters for the exhaust air. Conveyors are generally enclosed. Manual transfer may be employed for small operations or for specialized, low-volume requirements.

The fluffed fiber and other dry materials are brought into contact with asphalt (and solvents as required) in a batch tank. The material is mixed until an even dispersion is achieved. The batch mixing tanks are normally enclosed to prevent fiber dispersion. After a short mixing time, the asbestos fiber is bound in the asphalt. Upon completion of mixing, the asbestos is considered completely encapsulated in the asphalt with little chance for fiber dust exposure. When the batch is finished, the material is pumped to the packaging (containerizing) operation.

The predominant packaging for coatings is five-gallon pails with sealed lids. Special orders are sometimes filled using drum containers. Bulk shipments such as in tank cars are infrequent.

Work Practices/Controls

Hoods, dust evacuators, and air bag-filters are employed in the fiber introduction areas in new and large plants. Some smaller plants do not have this equipment. The plants employing the higher technology also have enclosed conveyors, for handling loose fiber, equipped with dust exhausts and bag-filters are installed. No control equipment is installed or believed required from the mixing area through to the end of manufacturing.

It is standard practice to tape ripped or torn bags to prevent asbestos problems in house cleaning. Vacuum cleaners are used to pick up loose asbestos throughout the manufacturing plant. Respirators are used where loose asbestos is handled.

Larger plants employ equipment layout such that the fiber introduction operation is partitioned or isolated from areas producing little asbestos emissions. Smaller plants or older facilitities may not have restricted areas of higher asbestos source contamination.

Varying degrees of housekeeping are employed. Those that employ advanced housekeeping immediately vacuum accidential asbestos spills and routinely clean the building. Inspection of others, however, shows asbestos dust on most horizontal surfaces such as light shades, window frames, and rafters. In this condition, normal air currents can dislodge the asbestos fiber dust and contribute to a higher background reading.

Existing Fiber Counts

Fiber count data have been received from several manufacturers for the fiber introduction areas. Table 4-5 presents these data. Extensive fiber count data for other manufacturing areas have not been collected by the indusry. The survey data show the 8-hour time-weighted averages to range from 1.5 to 8.0 fibers/cc TWA, with a typical exposure level of 2.5 fibers/cc TWA for fiber introduction. On the basis of the data, four of the 12 locations will meet the 2 fiber/cc TWA

Table 4-5

Time-Weighted Average Fiber Counts
Paints, Coatings, and Sealants

Process Step	Fiber Count with Existing Control Technology		Fiber Count with Best Available Technology[1]
	Typical Fibers/cc	Range Fibers/cc	Fibers/cc
1 Receiving & Storage	1.0	0.25 - 2.5	0.5 or 1.0
2 Fiber Introduction	2.5	1.5 - 3.0	1.5
3 Mixing Compounding	-	-	1.0
4 Packaging	-	-	0.5

Data Base: Data collected from plants consuming 20,500 tons of asbestos, or 30 percent of the Paints, Coatings, and Sealants Segment.

(1) Projected fiber counts are estimates of average exposure after implementing BAT. Variations of these values are expected depending upon individual installations.

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standard. One exceeds the 5 fiber/cc standard. Interviews with small, privately owned coatings manufacturers that do not have control equipment or fiber counts have disclosed that enforcement of a 2 fiber/cc standard might force them out of business because of dwindling profits and high capital requirements for compliance. None of the reporting manufacturers meet the 0.5 fiber/cc 8-hour TWA proposed standard.

Best Available Technology (BAT)

Where the bags are manually slit and dumped, hooded exhausts are employed with dust collectors. A central vacuum system (as well as portable) is used to clean up any spillage. Local containers for used bags are placed in the work area for immediate discard of the bags. Conveyors are enclosed when handling loose fiber with an exhaust system to a dust collector. Batch tanks, fluffers, and mixers are enclosed to prevent fiber loss.

Point sources of fiber dust, such as bag opening, are located in a remote or partitioned area to minimize carryover into other manufacturing areas.

Project Fiber Counts (with BAT)

With regard to fiber introduction, the data from the coatings industry show that BAT will likely meet the 2.0 fibers/cc TWA but will not achieve the proposed 0.5 fibers/cc TWA. The proposed peak 5.0 fiber/cc standard is expected to be exceeded regularly because of variations in manufacturing operations, human factors, equipment adjustment, and maintenance.

No data are available to assess the fiber levels achievable by BAT in other areas in the coatings segment, because these areas were considered by industry to be historically very low and no data were taken. However, the proposed 0.5 fiber/cc TWA may be exceeded by existing background levels in these areas. This would be particularly troublesome where these areas lie close to the fiber introduction operation because of plant layout.

Advanced Technology

Response by the industry indicates a need for development of improved packaging techniques for the raw asbestos and for automatic bag-opening machines. Improved packaging may include recyclable bulk containers, enclosed pallets to shield the bags from physical damage, and reinforced bags.

Automatic bag-opening machines would eliminate the manual operation and remove the worker from a major point source of asbestos. Bag opening could be accomplished in a completely enclosed area with the fiber dust evacuated and collected.

Economic Impact

Data and information supplied to Weston represents 30 percent of the segment (Table 2-1); however, only 12 percent of this segment supplied usable data to generate cost information. The sizes of firms supplying usable data, range from 200 to 2,000 tons of asbestos used annually.

The capital costs to achieve BAT for this segment are $4,230,000. Operating costs are projected to be $550,000. This segment has 38 percent of its employees exposed, the lowest of all primary segments. The industrial hygiene and medical costs will be $2,730,000 for this segment; this represents 63 percent of the total annual costs ($4,340,000). The total annual costs to comply with the proposed standard represent 1.6 percent of this segment's average annual sales. The total annual costs versus average annual sales range from 0.2 to 3.7 percent. The expected capital costs estimated by industry to comply with the proposed standard represent 143 percent of this segment's typical total annual capital expenditures.

Summary of Impact
Paints, Coatings and Sealants

Asbestos Usage		67,500 tons/year
Increased Cost of BAT to Industry Segment:		
Capital Cost to Achieve BAT		$4,230,000
Annual Costs:		
Capital	$1,060,000	
Operating Costs	550,000	
Industrial Hygiene and Medical Program	2,730,000	
Total Annual Costs		$4,340,000
Total Annual Costs versus Average Annual Sales		1.6 percent
Expected Capital Costs versus Typical Total Annual Capital Expenditures		143 percent

Conclusions

- With many small companies in the coatings manufacturing industry, the level of control equipment for asbestos fiber varies greatly from company to company. Privately owned small companies generally have a lesser degree of control than larger companies and corporations, which have installed control approaching BAT.

- The fiber introduction process, bag handling, and raw asbestos fiber handling are the phases in coatings manufacturing which result in the major sources of fiber exposure.

- Reported 8-hour TWA fiber count data vary widely from plant to plant (ranging from 1.5 to 8.0). Most data are below the current 5 fibers/cc TWA. One-third of those reporting are near the 2 fibers/cc standard. None report data or indicate that the 0.5 fibers/cc TWA can be achieved with BAT.

- BAT is an extension of existing control equipment already in use at most locations. Full application of BAT may enable compliance with the 2.0 fiber/cc TWA, but attainment of the 0.5 fiber/cc TWA is not indicated.

- Development of advanced technology is indicated in asbestos packaging, shipping, and handling. An automatic bag opening machine would be a major breakthrough. No data are available to indicate the fiber exposure levels achievable with this advanced technology.

Asbestos Cement Sheet

Technological Feasibility

Asbestos cement sheet is a flat or corrugated cement product using asbestos fiber as a reinforcing agent. The material is durable, strong, fireproof, and has excellent weathering resistance. It is widely used in construction applications such as roofing and siding for both industrial and residential buildings. It is also used in the manufacture of heaters, boilers, vaults and safes, electrical equipment mounting panels, welding shields, and many other applications requiring a non-combustible or heat-resistant sheet.

This industry segment also includes other asbestos-containing products, bound with cementatious materials other than portland cement. These sheet materials are generally thicker than the sheets described above, ranging from ½" to 4" in thickness. The products are used in specialty applications such as laboratory furniture and firedoor construction.

Process Description

The raw materials and manufacturing processes used to make asbestos cement sheet are similar to those used for asbestos cement pipe. Asbestos fiber is combined with cement, sand and water; the sheet is formed, cured, and finished.

Bags of fiber are manually opened and dumped at the fiber introduction step. The fiber is either dumped directly into the dry mixer or conveyed to the mixer by bucket elevator and screw conveyor. The first mixer breaks the compressed fiber lumps, thereby opening the fiber structure and obtaining maximum use of its reinforcing properties. Sand and cement are added at this point, and the solids are mixed until uniform.

The dry raw materials are conveyed to a second mixer, where water is added. After water is added, the mortar must be used within a short time, before the cement starts to set; therefore, the two mixing steps are required. Once the water is added, the sheet is formed in large presses. After the sheet has obtained preliminary set, it is removed from the press, allowed to cure further in the air, and is then cured with steam.

Although sheet-forming casts a nearly uniform size, some trimming of the edges and ends is generally necessary after curing. Cut-off saws using diamond or carborundum wheels are used to trim the sheet to standard size. Even more important than edge trim is uniform sheet thickness. In the final manufacturing step, the cured and trimmed sheet is sanded to a uniform thickness.

In applications such as residential siding, the formation press is grooved to form the siding pattern. Several applications of paint are applied to the sheet between the curing and finishing steps, and the final product is oven-dried to cure the thermal-setting paint. No sanding is used in this application, but sheets are stamped to size before packaging. Corrugated roofing and siding are also produced without the final sanding step.

The thicker specialty products generally start by dry-mixing asbestos with lime and fine silica. The sheet is formed by pressing at high temperature and high pressure. While in the press, the lime and sand react to form a calcium silicate binder reinforced with asbestos. These products do not require the extensive curing of the portland cement sheets, but still require edge and end trim and surface sanding.

In addition to sheet formation, some large consumers have forced the sheet producer to do some initial fabrication, to reduce fiber exposure at the consumer's plant. Initial fabrication takes the form of cutting or punching standard sizes or shapes and drilling or punching holes.

Work Practices/Controls

Figure 4-6 illustrates the processes involved in sheet production. At the fiber introduction step, hoods and local exhaust are the control equipment in general use. Exhausted air is vented to the atmosphere through dust collectors. Bags are manually placed in the hooded area. The bags are slit and dumped; the empty bag is removed and placed in a large plastic bag for disposal. The A/C sheet segment uses paper bags. Raw material make-up is a batch operation. The batch make-up rate depends on sheet thickness; fiber introduction occurs for 2 to 6 hours per shift.

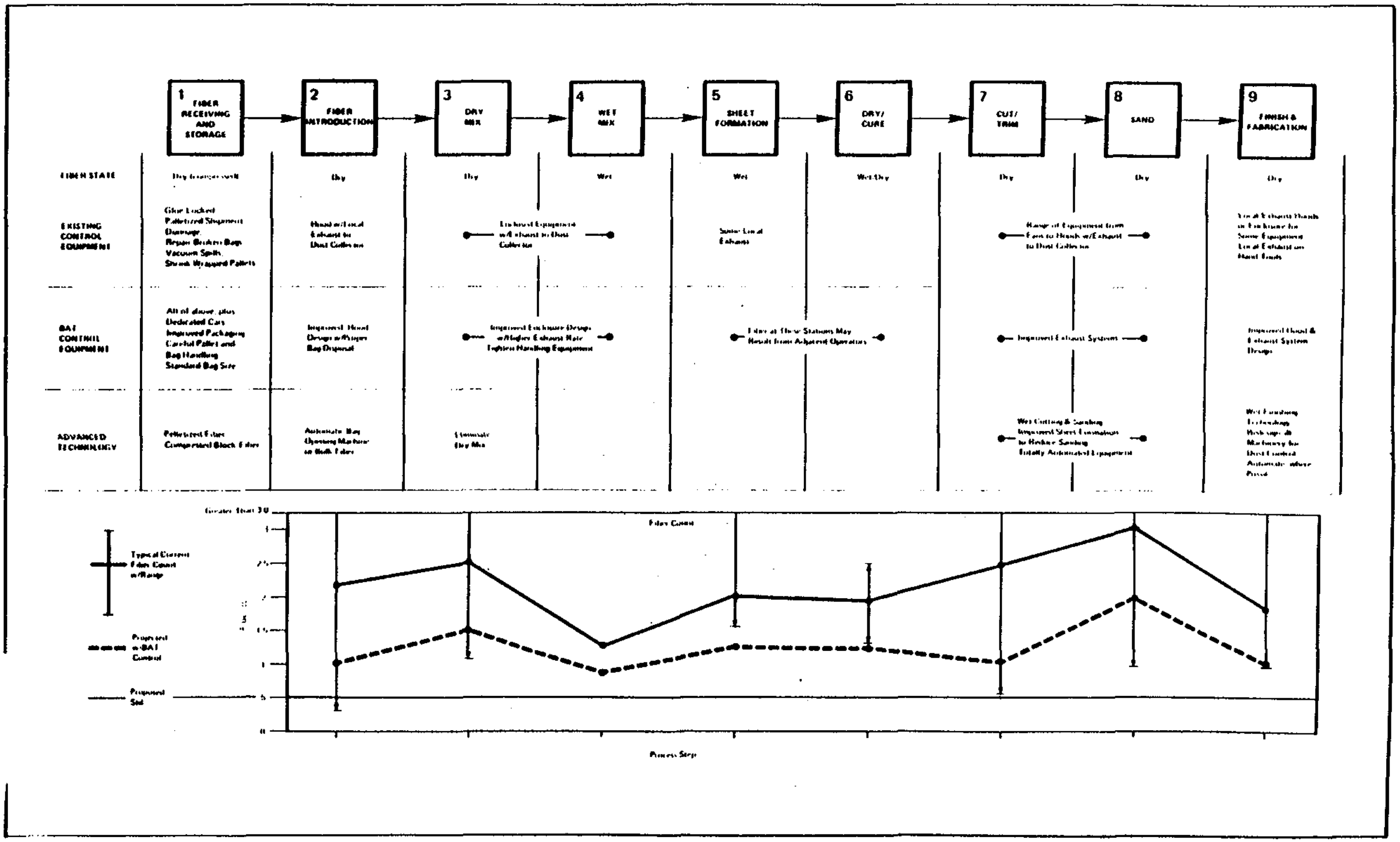

FIGURE 4-6 DIAGRAM OF PROCESS FLOW AND FIBER COUNT — ASBESTOS CEMENT SHEET

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Local exhaust of enclosed mixing equipment is the control technology used at both the dry and wet mix processing steps. Exhausted air is vented to the atmosphere through fabric fiber (bag) dust collectors. Dry mortar conveying equipment between the fiber introduction step, dry mixing, and wet mixing steps also results in an area dust source. Some exhaust of the materials-handling equipment is obtained through exhaust of the mixing equipment.

Although the wet mortar is not expected to be a significant fiber source, some exhaust equipment is in use at the sheet formation press. Good housekeeping controls are also necessary when handling the wet mortar. While the wet material does not release fiber, abrasion from local traffic will result in significant airborne fiber concentrations if a spill is allowed to dry.

No control equipment is used at the drying or curing steps. Good housekeeping is again required to minimize fiber release.

A broad range of dust control equipment and work practices were reported for the cutting, trimming, and sanding operations. The level of control technology ranged from area ventilation using exhaust fans to extensive equipment enclosures, exhausted to a dust collector. Some wet sanding was reported by an asbestos cement sheet manufacturer to be in use at one of his customers' plants; however, no wet sanding is currently practiced at any asbestos cement sheet manufacturer responding to our survey.

Local exhaust with hoods or enclosures is generally used for major pieces of finishing or fabricating equipment. Local exhaust is generally used on hand and small tools.

Existing Fiber Counts

Typical TWA fiber counts in the A/C sheet segment vary from 1.0 to 3.0 fibers/cc through all processing steps. (See Table 4-6).

Fiber introduction into the process results in a range of counts from 0.3 to greater than 3 fibers/cc, with a typical value of 2.3. The adjacent dry mixing operation has a TWA fiber count range of 1.1 to greater than 3, with a typical value of 2.5 fibers/cc. The TWA fiber counts at the fiber

Table 4-6

Time-Weighted Average Fiber Counts
Asbestos Cement Sheet

Process Step	Fiber Count with Existing Control Technology: Typical Fibers/cc	Fiber Count with Existing Control Technology: Range Fibers/cc	Fiber Count with Best Available Technology(1) Fibers/cc
1 Receiving & Storage	1.0	0.25 - 2.5	0.5 or 1.0
2 Fiber Introduction	2.3	0.3 - 8.7	1.0
3 Dry Mix	2.5	1.1 - 8.4	1.5
4 Wet Mix	1.25	-	0.9
5 Sheet Formation	2.0	1.6 - 3.5	1.25
6 Dry/Cure	1.9	1.3 - 2.5	1.25
7 Cut/Trim	2.5	0.6 - 6.7	1.0
8 Sand	3.0	0.9 - 8.0	2.0
9 Finishing & Fabrication	1.8	0.9 - 3.6	1.0

Data Base: Data collected from plants consuming 48,000 tons of asbestos, or 89 percent of the Asbestos Cement Sheet Segment.

(1) Projected fiber counts are estimates of average exposure after implementing BAT. Variations of these values are expected depending upon individual installations.

introduction and dry mix steps of the A/C sheet process are higher than at the same steps in its sister process, A/C pipe. The reason for higher counts may be found in the fact that at some installations the fiber is introduced directly into the first mixer, with a resulting higher fiber emission rate and TWA exposure.

A typical TWA fiber count for the wet mixing operation is 1.25 fibers/cc. This fiber count is approximately the same as in the A/C pipe segment. Airborne asbestos fiber results from agitation in the mixer before the solids are thoroughly wetted. Conveying equipment in the area also adds to the background fiber count.

TWA fiber count in the sheet formation step and the drying and curing step is 2.0 and 1.9 fibers/cc, respectively. Counts at these two steps ranged from 1.3 to greater than 3 fibers/cc. This number is unexpectedly high for a wet processing step, and the only explanation seems to be background fiber levels from adjacent operations.

Sheet trimming and sanding represent the highest exposure levels in the A/C sheet process, at 2.5 and 3.0 fibers/cc. The very nature of these operations generates airborne asbestos fiber. Although control equipment has proven effective, it is difficult to control fiber loss from the large surface area of a sheet during sanding. In addition, loose fiber remaining on the sheet tends to become airborne as the material is handled.

The finishing and fabricating operation has a typical TWA fiber count of 1.8 fibers/cc, with a range of 0.9 to greater than 3. Actual employee exposure at this processing step is highly variable, because of variations in schedule and the extent of fabricating required.

Best Available Technology (BAT)

BAT for the fiber introduction step in an A/C sheet plant requires a well-designed hood or enclosure and adequate ventilation. Proper bag handling, both before and after the bag is emptied, is also required to achieve the lowest level of exposure. Improved hood design should provide for empty bag disposal through the rear of the hood to minimize bag handling.

As in the A/C pipe segment, hydropulpers cannot be used to eliminate the bag slitting and dumping steps because they could contaminate the product with cellulose.

Adequate enclosure of the dry and wet mixing operations, with adequate exhaust rate, will be considered BAT at the two mixing steps. Where screw conveyors are involved, they should be tightened and maintained to minimize fiber escape. It is highly unlikely that BAT fiber levels could be achieved in a process where the asbestos is charged directly to the mixer. The large opening in the mixer, with such an arrangement, tends to result in considerable fiber loss.

If improvements elsewhere in the sheet manufacturing operations do not reduce the background fiber levels at the sheet formation, drying, and curing steps, hoods and local exhaust should be installed to control fiber exposure. Improved exhaust systems should be considered BAT control for the trimming and sanding steps. Wet sawing and sanding should be seriously considered, in addition to enclosure and ventilation, to provide minimum employee exposure. Since wet sanding in such a process has not yet been demonstrated, it cannot be truly defined as BAT; however, it appears that only minor development work would be necessary to adapt wet processing to these steps. In addition to reducing the fiber losses during the actual cutting and sanding, wet processing will tend to flush loose fibers from the sheet surface.

Improved hood and exhaust system design is considered BAT for the finishing and fabrication operations.

Projected Fiber Counts (with BAT)

If Best Available Technology is applied to the fiber introduction step, the projected exposure is estimated at 1.0 fiber/cc. The estimate at this processing step is based primarily on the projected exposure levels for the A/C pipe segment fiber introduction step. Centralized fiber introduction should also be adopted where production rates warrant, to reduce background fiber concentrations.

TWA fiber levels at the dry mixing and wet mixing steps, with BAT equipment installed, are estimated at 1.5 and 0.9 fibers/-cc, respectively. The sheet formation and curing steps have projected TWA exposures of 1.25 fibers/cc. As noted above, the fiber count at these two work stations is most likely not attributable to the immediate operation, but rather a background fiber level from adjacent processing steps.

Improved exhaust systems applied to the cutting and trimming operations should reduce TWA fiber levels to 1.0 fibers/cc. Exposure at the sanding operation is estimated at 2.0 fibers/cc, even after the application of BAT systems. A TWA fiber count of 1.0 fibers/cc is projected if wet sanding techniques are employed.

A TWA exposure of 1.0 fiber/cc is projected for BAT installed at the finishing step. This is a higher exposure level than projected for the cement pipe finishing operations, but the more extensive use of small, powered tools with less efficient exhaust enclosures will result in higher fiber emissions.

Advanced Technology

Advanced technology in the fiber introduction step should be considered as either automatic bag-opening or bulk fiber shipment and introduction. Automatic bag-opening will be the first of these technologies developed, and its use in other industry segments indicates automatic bag-openers should be available for use in the A/C sheet segment within one to two years. Bulk fiber shipments will take considerably longer to develop and implement.

Elimination of the dry mixing operation has been suggested as an advanced technology, based on comments received from the A/C pipe segments. Considerable development will be required to establish the feasibility of such a process modification.

Wet cutting and sanding lies somewhere between advanced technology and BAT control equipment. A totally automated dry-end handling system should be investigated, to eliminate or substantially reduce operator exposure at these typically high-emission-level operations. Wet finishing and fabricating techniques should also be developed for use not only at the sheet plant but also at the secondary fabricator. Automated equipment should be developed and installed where applicable.

Economic Impact

Data and information supplied to Weston represents 89 percent of the segment (Table 2-1); however, only 37 percent of this segment supplied usable data to generate cost information. The size of firms supplying usable data range from 4,000 to 6,000 tons of asbestos used annually.

The capital costs to achieve BAT for this segment are $3,300,000. Operating costs are projected to be $130,000. This segment has 64 percent of its employees exposed. Industrial hygiene and medical costs will be $1,120,000 for this segment; this represents 54 percent of the total annual costs ($2,070,000). The total annual costs to comply with the proposed standard represent 3.0 percent of this segment's average annual sales. The toal annual costs versus average annual sales range from 1.2 to 3.5 percent. The expected capital costs estimated by industry to comply with the proposed standard represent 256 percent of this segment's typical total annual capital expenditures.

Summary of Impact
Asbestos Cement Sheet Segment

Asbestos Usage		54,000 tons/year
Increased Cost of BAT to Industry Segment:		
Capital Cost to Achieve BAT		$3,300,000
Annual Costs:		
Capital	$ 820,000	
Operating Costs	130,000	
Industrial Hygiene and Medical Program	1,120,000	
Total Annual Costs		$2,070,000
Total Annual Costs versus Average Annual Sales		3.0 percent
Expected Capital Costs versus Typical Total Annual Capital Expenditures		256 percent

Conclusions

- The A/C sheet industry is currently in compliance with existing regulations. All processing steps are below the 5.0 fiber/cc TWA standard. However, four of nine processing steps currently exceed 2 fibers/cc.

- Implementation of Best Technology Available will be required to meet the 1 July 1976 TWA exposure standard. Even with the implementation of BAT, no processing step in the asbestos cement sheet industry will be below the proposed 0.5 fibers/cc TWA exposure level.

- Implementation of BAT control equipment will require three to five years, based on industry estimates.

- The economic impact of implementing BAT requirements for this segment, while not as severe as for other segments on a percentage of sales volume, is significant because of the availability of substitutes for asbestos cement sheet. Manufacturers will have to absorb much of the anticipated production cost increase or risk a reduction in the market for their asbestos products if they pass all of the cost increases on to the customers.

Gaskets and Packings

Technological Feasibility

Asbestos is the most widely used material for gaskets and packing because of its resilience, strength, chemical inertness, and heat resistance. These asbestos materials are used in nearly every industry, household, machine, and transportation vehicle.

A wide variety of products is manufactured using raw asbestos fiber, textiles, and asbestos paper. The asbestos may be bonded under heat and pressure with materials such as nitrile rubber or chloroprene for resistance to oil and solvents. In fact, a wide range of materials is used in compounds with asbestos to engineer a product of highly specialized properties. Although some dry asbestos packing is used to seal furnance doors, rotary kins and high-temperature refractory equipment, packing generally incorporates a lubricant and is typically made by braiding asbestos yarns which are impregnated with a grease-base lubricant.

Process Description -- Gaskets

Many varied operations for the production of gaskets are known to exist. However, the information received for this industry is sparse and permits only a limited treatment. In general, however, gaskets are manufactured by the processes as described by Figure 4-7.

Asbestos bags are manually opened and dumped into mixing tanks. In some cases, the compressed raw asbestos is dumped into a fluffer for fiber opening before the mix step. Fillers and bonding materials are added to the fluffed asbestos in the mixer, and the mixture is blended. Mixing may be a dry or wet operation, according to the product requirements, and multiple production lines may be employed.

The formulation from the mixer is calendered into sheeting. The sheeting may be packaged and sold to secondary manufacturers, i.e. gasket cutters, for further processing, or it may be sold in sheet form to distributers for the maintenance market.

The gasket cutters generally form gaskets from sheets by die cutting, while the maintenance user cuts the sheet manually.

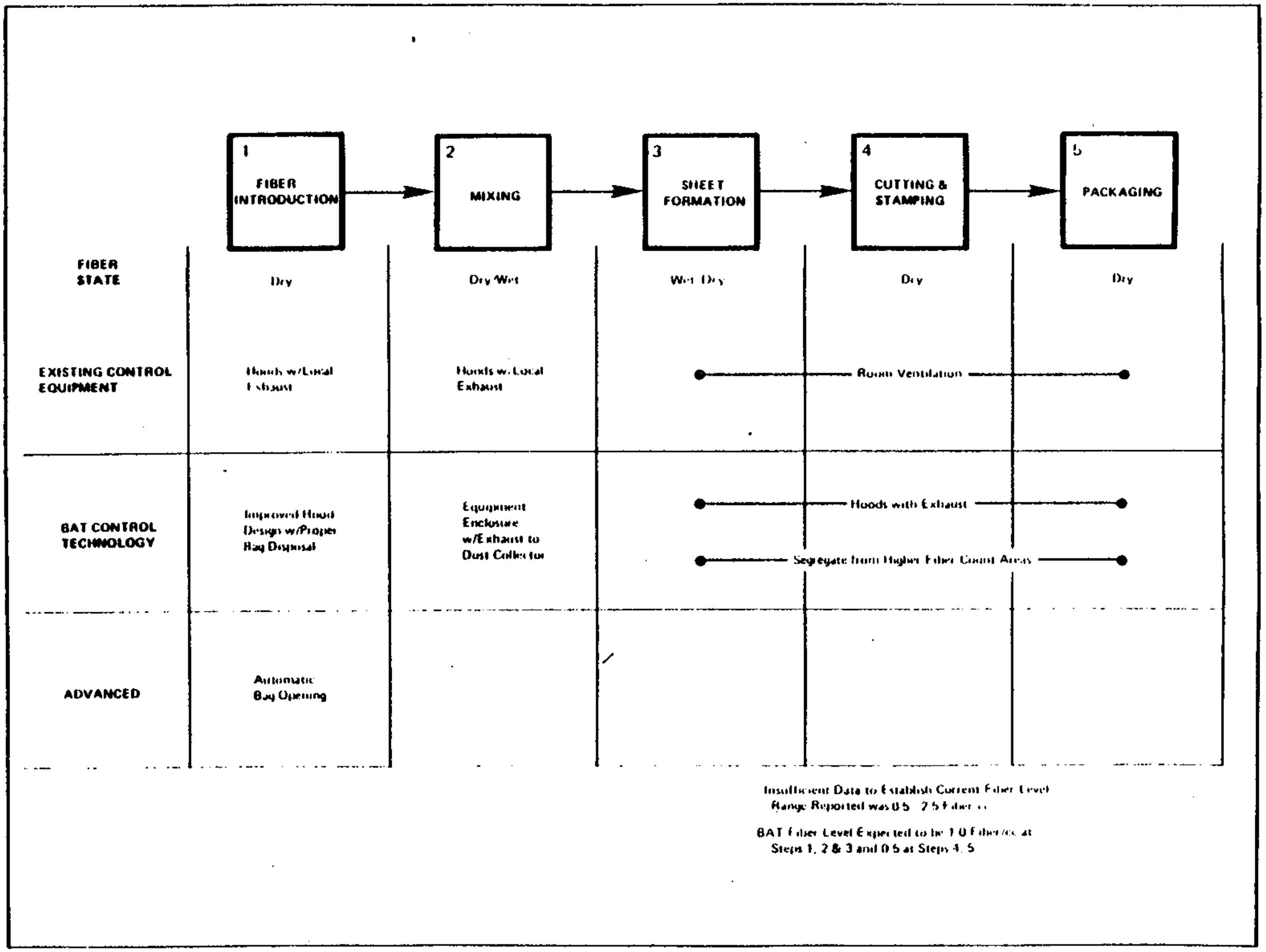

FIGURE 4-7 DIAGRAM OF PROCESS FLOW AND FIBER COUNT – GASKETS

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EXECUTIVE SUMMARY

Background

The Asbestos Information Association/North America (AIA/NA) formed an industry task force and engaged Roy F. Weston to perform a feasibility and impact study. The study concluded with a report of the technological feasibility and economic impact of the Department of Labor's proposed revision to the existing asbestos standard, which was published in the Federal Register Thursday, 9 October 1975. The Department has granted two separate 60-day extensions for interested parties to comment. The second comment period ends Friday, 9 April 1976.

To determine the feasibility and impact of the proposed revision to the asbestos standard, Weston investigated how asbestos fibers are processed and incorporated into other products as they move through the industrial sectors (Construction Excluded) on their way to a final resting place or product. The asbestos products industry can be classified into three sectors: primary, secondary, and consumer industries. (See Figure 2-1, page 2-3, for a graphic display of the Asbestos Products Industry.)

Each industry group (primary, secondary, and consumer) was investigated to collect data and information for this study. The information was collected from firms in each of the three industry groups, as well as trade associations, governmental agencies, colleges and universities, and other sources. For the most part, "hard" data (rather than opinions) were requested. The Weston project team collected the data in three ways:

- Plant visits and inspections
- Questionnaires
- Telephone interviews

Once the raw data were assembled, the technical, engineering and economic information was compiled on each industry group (primary, secondary, and consumer). The primary industries were further broken down into ten segments, since these are where asbestos is introduced into the manufacturing process. Technological feasibility and economic impact were developed for each industry group. In addition, foreign trade impact was developed for the consumer industries.

Process Description -- Packings

Asbestos-based packing is manufactured by a variety of processes, as illustrated in Figure 4-8. The most common process is to impregnate dry yarn with lubricants, which coats the fibers. The impregnated yarns are braided into a continuous length of packing, which is then calendered to a specific size and cross-sectional shape. It may then be coiled, boxed and sold to the maintenance trade, or it may be cut and die-formed to manufacturer's specifications. Occasionally impregnation follows braiding.

A variation of braided packing is made by extruding a mixture of asbestos fiber, binder, and lubricants, and then braiding lubricated asbestos yarns over the extrusion. For certain applications the percentage of binder in the extrusion is increased and the overbraiding is omitted.

Work Practices/Controls

The largest problem area for the segment is centered around the manual handling, opening, dumping, and mixing of raw asbestos from bags. These problems are common to all segments of the primary asbestos industry. Most companies employ dust collectors for the mixing operation. The use of respirators has also been reported.

Existing Fiber Counts

Little data has been received, and analysis is difficult. These data are listed in Table 4-7.

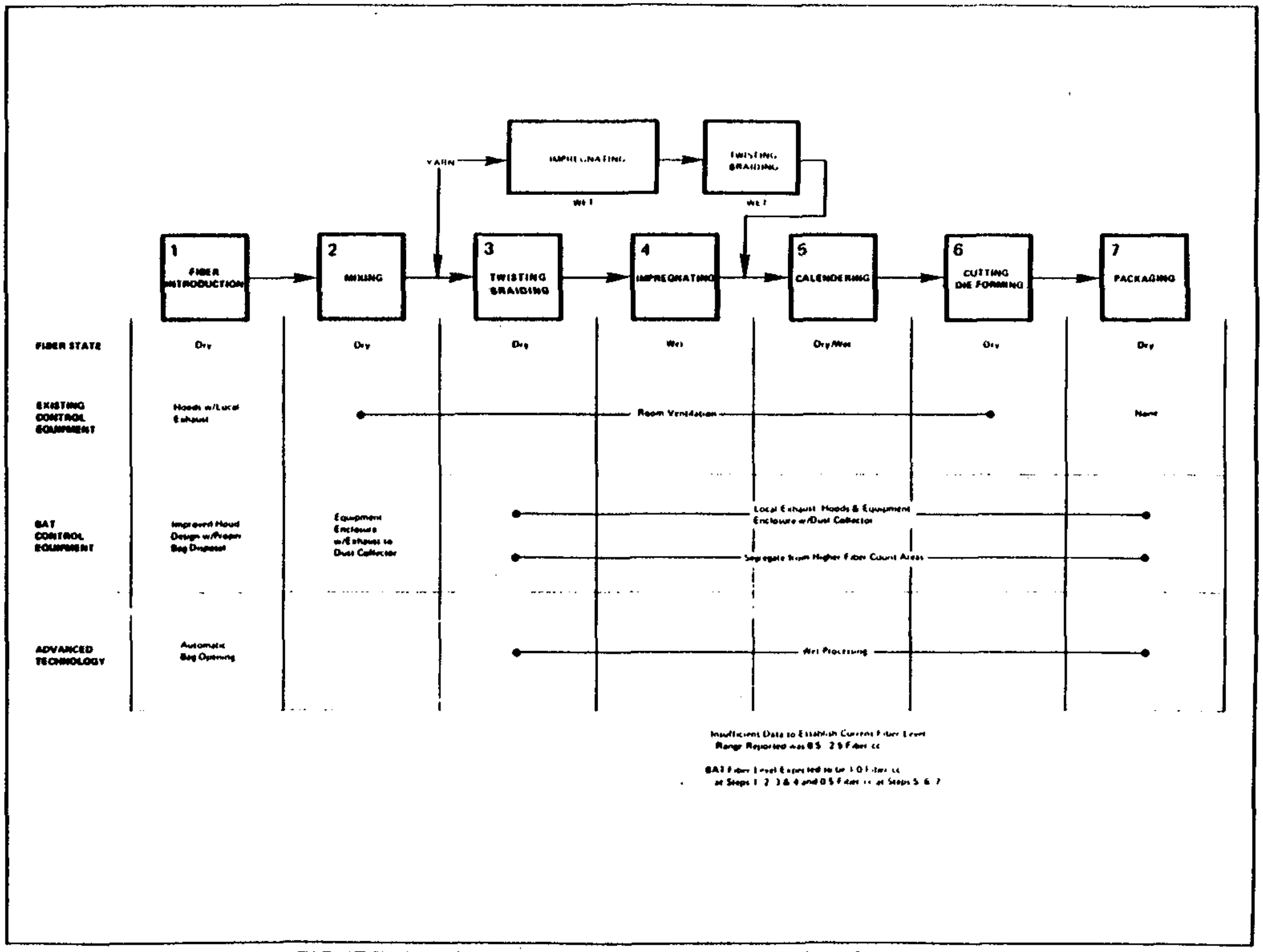

FIGURE 4-8 DIAGRAM OF PROCESS FLOW — PACKING

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Table 4-7

Existing Fiber Counts

Operation	TWA Range Fibers/cc
Fiber Introduction	0.5 - 2.5
Mixing	0.014 - 1.0
Braiding and Twisting	---
Sheet Formation	---
Cutting	---
Packaging	---

For the basic gasket and packing processes, fiber exposure levels in the fiber introduction area are of the most concern. Where mixing is accomplished with a wetted compound, fiber evolution is low. Data for fiber levels in the braiding, sheet formation, cutting, and packaging steps were not received in sufficient quantity to estimate employee exposure since these companies surveyed felt that they are complying with the existing standards and to the 2.0 fibers/cc TWA level for July 1976.

Best Available Technology (BAT) and Projected Fiber Counts (with BAT)

Hoods and dust evacuators are BAT control equipment for areas where raw asbestos is handled. The data reported in the fiber introduction and mixing steps have been obtained where this control equipment is in use.

Advanced Technology

The advanced technology for bagged asbestos handling, as described in the section on "Receiving and Storage", is applicable to the gasket manufacturing industry. This technology includes automatic bag-opening machines and improved packaging of raw asbestos.

Economic Impact

Data and information supplied to Weston represents 41 percent of the segment (Table 2-1); however, only 37 percent of this segment supplied usable data to generate cost information. The size of firms, supplying usable data, range from 2 to 2,400 tons of asbestos used annually.

The capital costs to achieve BAT for this segment are $16,000,000. Operating cost are projected to be $1,100,000. This segment has 21 percent employees exposed. The industrial hygiene and medical costs will be $5,550,000 for this segment. This represents 52 percent of the total annual costs ($10,650,000). The total annual costs to comply with the proposed standard represents 7.3 percent of this segment's average annual sales. The total annual costs versus average annual sales range from 3.0 to 7.5 percent. The expected capital costs estimated by industry to comply with the proposed standard represent 148 percent of this segment's typical total annual capital expenditures.

Summary of Impact
Gaskets and Packing Segment

Asbestos Usage		27,000 tons/year
Increased Cost of BAT to Industry Segment:		
Capital Cost to Achieve BAT		$ 16,000,000
Annual Costs		
Capital	$4,000,000	
Operating Costs	1,100,000	
Industrial Hygiene and Medical Program	5,550,000	
Total Annual Costs		10,650,000
Total Annual Costs versus Average Annual Sales		7.3 percent
Expected Capital Costs versus Typical Total Annual Capital Expenditures		148 percent

Conclusions

- The gasket and packing industry will be affected by the proposed 0.5 fibers/cc TWA; the extent of this impact, from a technical feasibility review, has not been defined because of the lack of an adequate data base.

- Larger firms are not at a higher control technology level than smaller plants; hence the market shares are not expected to change significantly. However, the 7.3 percent cost (as a percentage of sales) is expected to be difficult to pass onto customers, for it may cause customers to switch to non-asbestos based products.

Asbestos-Reinforced Plastics

Technological Feasibility

Asbestos-reinforced plastics are polymeric materials to which asbestos fibers are added in order to modify the composite's physical and chemical characteristics. These composite materials are multi-component blends in which the asbestos fiber is the load-carrying member and the polymeric matrix fills the gaps between the fiber and distributes the applied stress to the fibers. The plastic material provides a shape and a smooth surface to protect the fibers and may also provide thermal or electrical resistance.

Since the fiber serves to reinforce the matrix, its strength properties must be superior to those of the matrix. In the case of asbestos-reinforced plastics, a typical fiber-to-polymeric strength ratio is in the order of 100-to-1. In addition to imparting excellent strength to the plastic, the asbestos fibers are not soluble in, nor attacked by the resins or polymers; nor is the fiber affected by the processing temperature of the compound.

Asbestos fibers are used to reinforce phenolic, polyester, and epoxy resin and in a wide range of thermoplastic polymers. Their industrial, commercial, and residential uses are as ubiquitous as the term "plastic" implies.

Process Description

As shown in Figure 4-9, the production of asbestos-reinforced plastic begins with the introduction of dry asbestos fiber (Step 2). In this operation, the bag of asbestos is normally opened manually, and the contents are dumped into a storage hopper and conveyed to the dry blending step. Alternatively, the asbestos may be introduced directly into the dry blending step without intermediate storage and handling. Pulpable bags are not used in the industry segment since the asbestos must be intimately mixed with resins and additives in a dry state under somewhat gentle agitation to protect the fibers from abrasion and fracture. Therefore, the bag would not be broken down sufficiently to allow the components to be used even if they were desirable.

As previously mentioned, dry blending (Step 3) is needed to achieve homogenous mixture of asbestos, catalysts, additives,

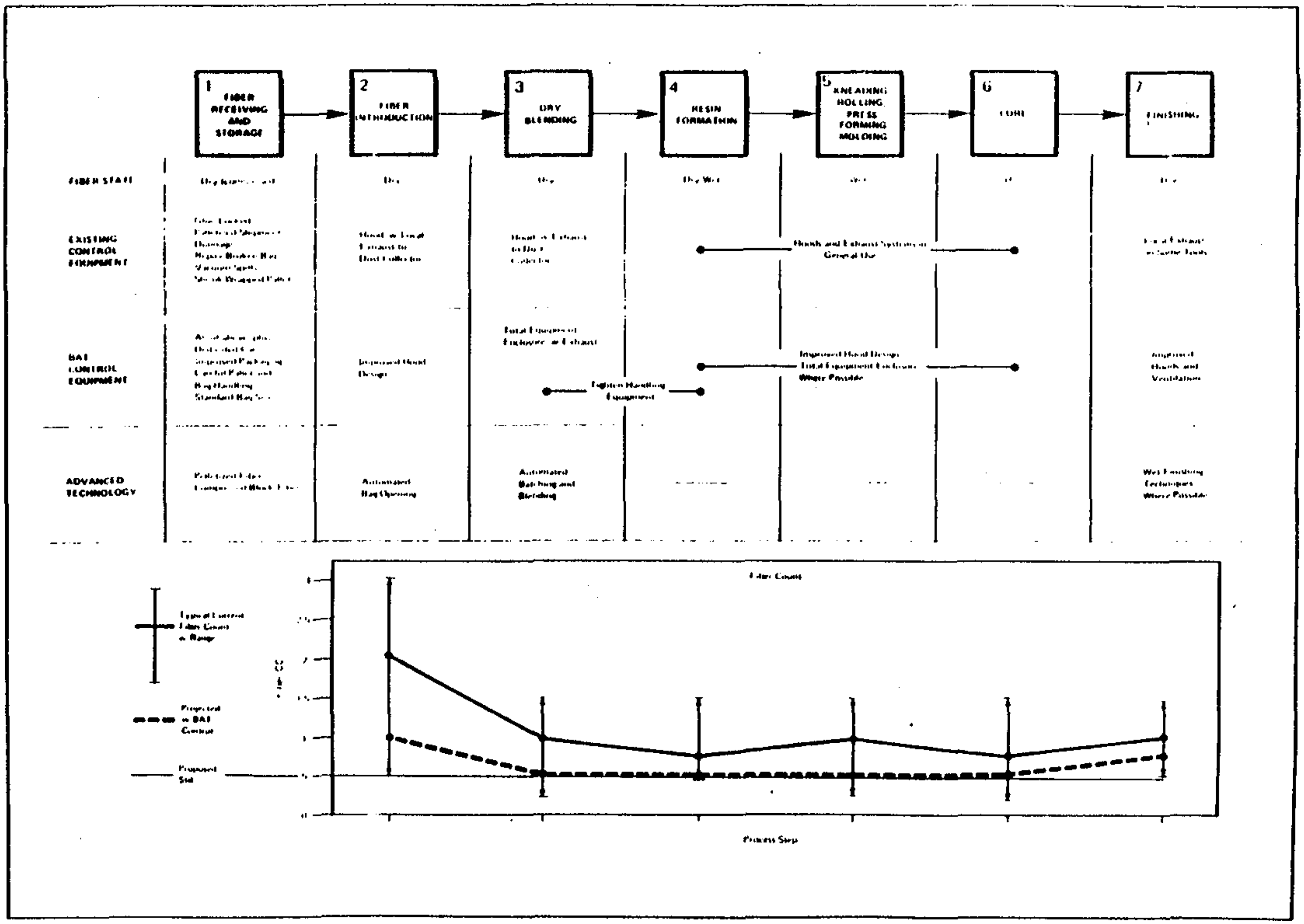

FIGURE 4-9 DIAGRAM OF PROCESS FLOW AND FIBER COUNT
— ASBESTOS-REINFORCED PLASTICS

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and the matrix components (polymer). A wide variety of equipment is used throughout the industry to insure a low-shear, well-mixed blend.

From the blending step, the mixture is then formed into a resin (Step 4). Some manufacturers refer to this step as a "preforming" operation in which the mixture is heated by external energy (steam, electricity) as in extrusion, or by internal shearing friction as in a Banbury mixer. The product from these operations is a pellet, powder, or some similar "preform", which is either packaged and sold as an intermediate product or conveyed directly to a type of forming process (Step 5).

Step 5 also has many equipment and process variations incorporated under the general term of forming: rolling, stamping, pressing, and molding. Basically, the resin or preform is remelted and shaped into the final product under controlled conditions to achieve desired shape and texture characteristics.

Following the molding process, the formed product is cured (Step 6). This step involves control of cross-linking and thermosetting reactions to achieve specified strength and stiffness characteristics. When the reactions are carried to their desired ends, the rough product is then sent to a finishing step. Finishing (Step 7) operations are similar to other asbestos industry segments in that they involve sanding, grinding, polishing, drilling, sawing, etc. The degree of finishing (e.g. rough sanding vs. polishing) is dictated by product uses and the variety of applications for these plastic materials.

Although there are considerable variations to the asbestos-reinforced plastics manufacturing operation, the foregoing description is common to nearly all products. Specific processing steps, requiring greater explanation to fully describe asbestos dust exposure, will be included in the next paragraphs.

Work Practices/Controls

The asbestos content of asbestos-reinforced plastics is relatively small compared with the other ingredients involved in forming the resin. The handling of this quantity of dry asbestos fiber is normally accomplished by manual bag opening (and empty bag disposal) methods. Control technologies involve central ventilating systems with exhaust hoods in the area. Some large manufacturers use limited enclosure of their areas to minimize the asbestos dust exposure to outside areas and for better control of exhaust air flow. Pulpable bags are not used since the container is not suitable as an ingredient for making the resin. Additionally, the subsequent dry blending step is not designed for, nor can the product tolerate, the high shear force required to degrade the bag to a useful ingredient, if indeed its composition were a required ingredient.

Housekeeping procedures range from manual sweeping of floors and equipment to central vacuum cleaning systems and mobile sweeper/vacuum machines.

The dry blending step involves mixing the dry ingredients necessary to compound the material. These ingredients include asbestos, resins, polymers, additives, and catalysts. All substances are introduced into the mixing step in a dry form and are agitated to form a homogeneous blend. The degree of agitation may be described as gentle to moderate and is sufficient to produce a uniform mixture.

Control equipment includes exhaust hoods, local process exhaust equipment, and partial enclosures to control air flow and minimize asbestos dust exposure to surrounding areas. Housekeeping and maintenance practices are identical to fiber introduction areas.

After the individual ingredients have been thoroughly mixed, the blend is formed into the actual resin. A variety of equipment may be involved, depending upon the end-product specifications. In general, the resin is formed by either of two processes: externally heated extrusion or internally heated (friction/shear) Banbury mixer. Both processes produce a product which is sometimes called a "preform". This resin is then used in subsequent processes to form the end product. In some plants, this preform is drummed as a pellet or flake and sold as a product for other to form. In most locations the preform is transported to the next step (forming or molding) within the same plant. Control equipment in general use includes exhaust hoods and partial enclosure of process equipment. Housekeeping and maintenance practices include central vacuum cleaning systems, mobile floor sweeping/vacuuming equipment, and manual floor/equipment cleaning.

The forming step involves actual formation of an end product from the preformed resin. The polymer portion of the resin is the shape-forming ingredient of the preform. The final product is shaped by remelting the preform and submitting it to rolling, stamping, pressing, or molding. Remelting serves to start the polymerization, cross-linking, and thermosetting reactions; forming gives the desired shape of the end product. Dust control equipment and housekeeping practices are generally similar to those in resin formation.

The curing step carries the thermosetting reactions to completion. The use of catalysts, additives, promoters, etc. in the original blend is coupled with controlled time and temperature conditions to achieve desired strength, shape, and stiffness characteristics.

This step involves close control of time/temperature conditions of the formed product. This normally requires an enclosed area, furnished with a ventilating system. In those processes where air curing is involved, hoods and local enclosures are provided. Housekeeping procedures are similar to those employed in other steps of dry processing.

After the product is cured, it is sawed, ground, drilled, machined, etc., to render the product suitable for sale as finished goods. The degree of finishing and the type of process used depends upon the end use of the product.

Asbestos dust is released when the plastic products are finished. Hand and portable tools are normally supplied with local exhaust systems connected to the central ventilation/collection system. Larger, stationary machines are supplied with local exhausts near the finishing surface and, in some cases, are supplemented with hoods over the finishing machine itself. Area or machine partial-enclosures are used to some extent where larger quantities of dust are released. Housekeeping practices are again similar to those employed in previous dry processing steps.

Existing Fiber Counts

As shown in Table 4-8, the asbestos dust exposure in fiber introduction ranges from 0.5 to 3.0 fibers/cc TWA. A typical exposure may be 2.0 fibers/cc TWA. These exposures are characteristics of a high prevalence of manual bag opening,

Table 4-8

Time-Weighted Average Fiber Counts
Asbestos-Reinforced Plastics

Process Step		Fiber Count with Existing Control Technology		Fiber Count with Best Available Technology (1)
		Typical Fibers/cc	Range Fibers/cc	Fibers/cc
1	Fiber Receiving & Storage	1.0	0.25 - 2.5	0.5 or 1.0
2	Fiber Introduction	2.0	0.5 - 3.0	1.0
3	Dry Blending	1.0	0.2 - 1.5	0.5
4	Resin Formation	0.75	0.5 - 1.5	0.5
5	Kneading, Rolling, Etc.	1.0	0.25 - 1.5	0.5
6	Cure	0.75	0.2 - 1.5	0.5
7	Finishing	1.0	0.5 - 1.5	0.75

Data Base: Data collected from plants consuming 9,900 tons of asbestos, or 55 percent of the Asbestos-Reinforced Plastics Segment.

(1) Projected fiber counts are estimates of average exposure after implementing BAT. Variations of these values are expected depending upon individual installations.

emptying, and handling for disposal. Control procedures are, therefore, limited to hoods and exhaust systems and partial enclosure of the bag-opening step.

The range of asbestos dust exposure for dry blending is 0.2 to 1.5 fibers/cc TWA, with a typical exposure of 1.0 fibers/cc TWA. The blending step is a dry-mixing operation employing exhaust hoods and partial enclosures.

The asbestos dust exposure for resin formation ranges from 0.5 to 1.5 fibers/cc TWA, with a typical exposure of 0.75 fibers/cc TWA. Most dust exposure is involved in handling and introducing the dry blended mixture into the resin formation step.

The range of asbestos dust exposure for the forming step is 0.25 to 1.5 fibers/cc TWA. A typical exposure is 1.0 fibers/cc TWA. The majority of asbestos dust is released before remelting, arising from handling the dry preform from the previous step. After remelting, the asbestos is bound in the polymer matrix.

The asbestos dust exposure for curing ranges from 0.2 to 1.5 fibers/cc TWA, with a typical exposure of 0.75 fibers/cc TWA.

The range of asbestos dust exposure from the finishing step is 0.5 to 1.5 fibers/cc TWA, with a typical exposure of 1.0 fibers/cc TWA. Normally, only minor finishing is provided for the cured product. Thus, the amount asbestos fiber released is less than other asbestos industry segments. Additionally, the contents of asbestos in the product is low compared to such products as asbestos cement pipe or sheet. Therefore, for the same degree of finishing, a lower asbestos fiber release is expected as the content of asbestos in the product is decreased.

Best Available Technology (BAT)

In general, BAT for fiber introduction involves the use of improved ventilation systems in the bag-opening area, minimizing the handling of empty bags, partial enclosure of this area, and revised housekeeping practices which minimize manual sweeping and maximize the use of central vacuum cleaning and mobile sweeping/vacuuming systems.

The use of improved ventilation systems, coupled with total enclosure of process equipment, where practical, is suggested as BAT for the dry blending step. Housekeeping and maintenance procedures must be improved to prevent release of asbestos dust from equipment used in handling the blend outside of the enclosed equipment area.

The resin formation, forming, and curing steps require similar improvements as in the preceding disucssion of BAT for dry blending.

Finishing operations are common to many of the asbestos industry segments discussed in this report. Asbestos dust exposure may be controlled by: employing more extensive local exhaust systems with increased air flow; better cleaning of finished material to remove dust adhering to the surface; using more automated equipment where practical in operations that are routine or semi-continuous; and improving housekeeping to minimize dust accumulation on equipment and floor areas.

Projected Fiber Counts (with BAT)

The use of BAT in the asbestos-reinforced plastics industry segment would reduce airborne asbestos exposure in the fiber introduction step to 1.0 fibers/cc TWA.

The use of BAT in the dry blending, resin formation, forming, and curing steps will reduce asbestos exposure to 0.5 fiber/cc TWA.

By employing BAT, the finishing step will reduce asbestos dust exposure to 0.75 fibers/cc TWA.

Advanced Technology

The successful development and commercialization of a fully automated bag-opening and bag disposal operation will reduce asbestos exposure below levels attainable by BAT in fiber introduction. Variations of this equipment are available; however, reliability of operation must be improved before the concept can qualify as BAT in the asbestos-reinforced plastic segment.

Fully automated batching/blending equipment is being developed to reduce manual handling of dry compounding ingredients.

This equipment would allow an operator to be located away from potential asbestos exposure and would control the blending step from a remote, climate-controlled environment.

Wet-finishing equipment must be developed to supress asbestos dust release from sanding, grinding, and similar operations. These techniques are practiced to a limited extent in other industry segments; however, the extension of their use to plastics finishing require considerable development because of the variety of processes involved, the extensive use of highly versatile hand-operated tools, and the ultimate ending of the product.

Economic Impact

Data and information supplied to Weston represents 55 percent of the segment (Table 2-1); however, only 34 percent, of this segment supplied usable data to generate cost information. The sizes of firms supplying usable data range from 65 to 4,500 tons of asbestos used annually.

The capital costs to achieve BAT for this segment are $1,100,000. Operating costs are projected to be $110,000. This segment has 45 percent of its employees exposed. The industrial hygiene and medical costs will be $2,310,000 for this segment; this represents 86 percent of the total annual costs ($2,690,000). The total annual costs to comply with the proposed standard represent 2.4 percent of this segment's average annual sales. The total annual costs versus average annual sales range from 0.9 to 2.6 percent. The expected capital costs estimated by industry to comply with the proposed standard represent 23 percent of this segment's typical total annual capital expenditures.

Summary of Impact
Asbestos Reinforced Plastics Segment

Asbestos Usage		18,000 tons/years
Increased Cost of BAT to Industry Segment:		
Capital Cost to Achieve BAT		$1,100,000
Annual Costs:		
Capital	$ 270,000	
Operating Costs	110,000	
Industrial Hygiene and Medical Program	2,310,000	
Total Annual Costs		$2,690,000

Total Annual Costs versus Average Annual Sales	2.4 percent
Expected Capital Costs versus Typical Total Annual Capital Expenditures	23 percent

Conclusions

- Production steps involving dry blending, resin formation, forming, and curing will be capable of reduced asbestos exposure levels (to 0.5 fibers/cc TWA) after employing BAT.

- Production steps involving fiber introduction and finishing will be capable of reducing asbestos exposure levels to 1.0 fiber/cc and 0.75 fibers/cc TWA, respectively, TWA after employing BAT.

- The majority of manufacturers will be capable of achieving the 2.0 fibers/cc TWA standard by improving present operations and installing BAT in selected steps.

- Significant development is needed for equipment (control and process) capable of reducing asbestos exposure levels below 1.0 fiber/cc TWA in the fiber introduction step.

- At present, best estimates of commercilaization of advanced technologies to achieve asbestos exposure levels below 1.0 fiber/cc TWA range between three and seven years.

- At present, it is not possible to state with certainity that development of advanced technologies will be capable of reducing asbestos exposure to 0.5 fiber/cc TWA in all process operations.

- The costs to comply with the proposed standard will be greater for small companies because of their lower developed technology base. As these increased cost are passed on to customers, the smaller firms will experience a reduced share of the market.

Asbestos Textiles

Technological Feasibility

Asbestos textiles have a variety of uses because they combine unique properties of asbestos: incombustibility, and resistance to heat, corrosion, and biological attack. A few of the uses include clutch and brake linings, boiler insulation, fire protective clothing, fire barriers in building construction, mechanical packing, gaskets, ironing board covers, insulation in electrical generators, and ship-board pipe and vessel insulation. In most uses, asbestos textiles are coated or bound with such materials as resins, elastomers, and metal before evolving into the final product. Asbestos yarns may be reinforced with many materials such as cotton, nylon, polyester, and wire.

Approximately 65 percent of the U.S. demand for asbestos textiles is supplied domestically, primarily by three major producers. Foreign imports account for the remaining 35 percent of the U.S. demand. Foreign competition is intense and is enjoying a growing market share. The asbestos textile segment is highly technical and automated, employs specialized machinery for high rate production, and uses proprietary and patented technology. The basic yarns, cloths, and other products are further processed by a host of secondary manufacturers before the ultimate product reaches the end user. Thus, although asbestos textiles account for only one to two percent of the U.S. consumption of raw asbestos, the market value per unit of asbestos is perhaps the highest of the asbestos industry.

Process Description

Two basic process variations are employed in asbestos textile manufacturing: conventional and wet. The conventional process accounts for the major portion of product and is further subdivided into a dry process and a damp process. The dry and damp processes are identical except that during the "damp" process the yarn is moistened to reduce fiber evolution. (The moisture may be applied by contact with water on a roller or a mist spray).

The dry-process manufacturers produce a small volume of highly specialized yarn without contact with water. The newly developed wet process yields a yarn by extruding a chemically dispersed slurry into a chemical coagulant. The resulting wet process yarn is dense and tends to hold the asbestos fibers better than the conventional process. This results in smaller amounts fibers released to the work environment. Major disadvantages with the wet process yarns are poor absorption and reduced impregnation characteristics.

A textile plant may produce 15 or more products. Thousands of operations may occur simultaneously as hundreds of strands are wound and rewound, spun, twisted, braided, and woven. With the operations speeding along throughout the entire plant, hundreds of point sources of asbestos fiber dust are generated in any given area. (See Figure 4-10.)

Raw asbestos fibers in semi-compressed bags are manually handled (warehoused, transported, slitted, and dumped), creating potential worker exposure to asbestos similar to other asbestos segments.

Asbestos yarn is normally a specific blend of different grades of asbestos (primarily different fiber lengths) to impart desired processability and product quality. Therefore, it is necessary to weigh the various asbestos ingredients before the bags are manually opened and dumped into blenders.

The raw asbestos grades and other ingredients are dumped into several blending machines. The blending machines are continuously operating devices that gently mix the components of the formulation. The mixing is achieved as the asbestos slowly moves toward the rear of the machine, is drawn up an incline, and tumbles back to the bottom. Part of the mix is carried up the incline and falls into a hopper. The rear of the blending machine is enclosed and hooded to minimize fiber elution. As the hoppers are filled with the blended fibers, they are transferred to the carding operations.

The carding machine combs the fiber mix into a paralleled (oriented) fiber mat. This mat is mechanically pressed and layered into a lap. At the finishing card, the lap is separated into thin continuous strips of fiber, called "roving". To impart strength and other characteristics to the asbestos, cotton or rayon or other materials may be added to the roving. The lap, matting, or roving may be packaged and sold to secondary industries. Otherwise, the roving proceeds to the spinning frames.

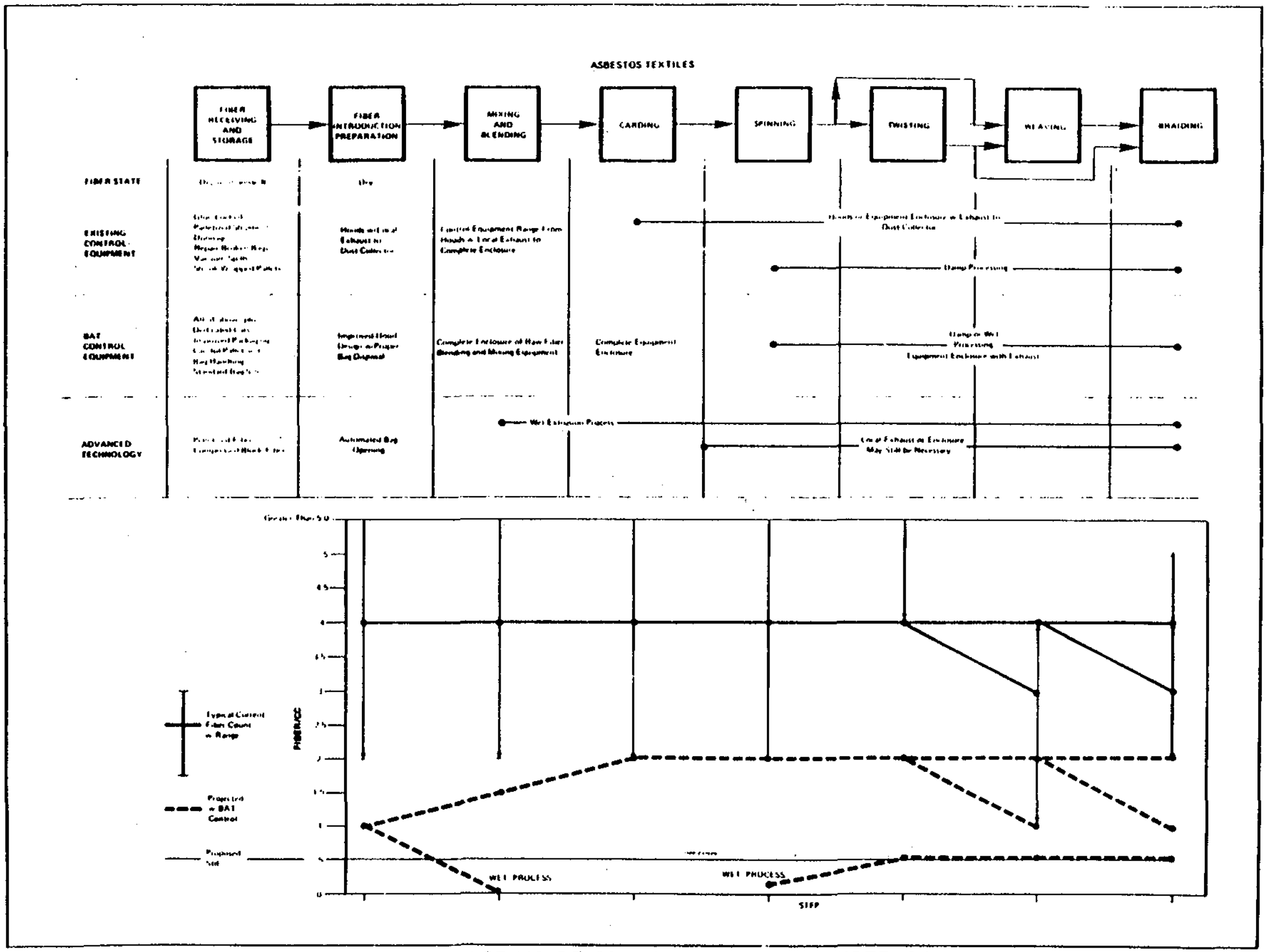

FIGURE 4-10 DIAGRAM OF PROCESS FLOW AND FIBER COUNT — TEXTILES

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The roving is spun (twisted) to specified turns per inch to impart strength. Other materials may be added to give certain desired characteristics. In the damp process, the roving is wetted with wet rollers before spinning. This damp process is employed to reduce asbestos fiber dust during subsequent processing. Where essential for product quality, the roving is not wetted; the remainder of the processing is with dry material (dry process).

During spinning and further processing, many of the strands will break. The whipping ends released fiber dust as they fly around the spindles. During this high-speed processing, strands repeatedly break. The strands are repaired manually, requiring constant worker attention. Dust release is particularly severe in dry processing.

Spun roving, called "single yarn", may be twisted with other single yarn, wire, or other material to produce plied yarns. Plied yarns may be coated to produce thread or treated yarns. Otherwise, the plied yarn may be woven to produce tapes, cloth, or woven tubing; or it can be braided to produce cord, rope, or braided tubing. Spun yarn otherwise may by-pass the twisting steps and go directly to producing woven, braided, or treated products.

At the weaving looms, the yarn is first put on a beam or creel, which handles a large number of strands to feed the loom. A damp or dry loom may be used to create cloths of different characteristics.

The wet process differs generally from the other processes in that the raw asbestos is dumped directly into a slurrying tank with water and chemicals. The slurry is extruded directly into a strand. These strands proceed to the spinning and other operations similar to conventional processing. The wet process thus avoids blending and carding, which generate asbestos dust. Since wet-processed textiles possess different characteristics, secondary manufacturers must devise new production techniques to compensate for the altered processability and final product quality.

Work Practices/Controls

Housekeeping problems arise during fiber handling and introduction because of damaged bags and spillage of raw asbestos fibers. Continual vigilance and frequent vacuuming are employed to clean up spills. Hoods, dust evacuators, and bag filters are generally employed where raw fiber is dumped from the bags. The blending machines are normally partially enclosed with dust evacuators to minimize worker exposure to airborne asbestos. Blended asbestos fiber is often manually transported to the carding machine. Plastic sheet covers enclose the hoppers during this transfer. Loading raw fiber into the carding machine sometimes is a manual operation in which the worker picks the asbestos up with his hands and dumps it into the carding machine.

In some plants, special equipment layout has been incorporated to eliminate the transporting operation. Special blending machines were developed and located adjacent to the carding machines. The blender automatically feeds the carding machine. In general, fiber introduction, blending, transporting, and carding are high exposure areas because of the necessity for manual handling of raw fiber.

Where matting, lap, or roving is sold to secondary manufacturers, the handling of this material by workers results in potentially high fiber exposure. Normal tending of these areas by workers results in exposure to high background levels of airborne asbestos. The mechanical working of dry asbestos fibers in the blending and carding operations necessarily evolves asbestos fiber into the air and the entire processing area becomes a potential exposure hazard (in contrast to being a controllable point source). Respirators are used by workers in these areas.

Although spinning, twisting, weaving, and braiding are expansive operations and are highly mechanized, constant worker attendance is required to repair broken strands and to make equipment adjustments. Broken strands are a constant problem. These broken ends whip asbestos into the air until they are repaired. Additionally, the continuous high speed working of the yarn (spindling, spinning, twisting, weaving, etc.) constantly evolves asbestos fiber into the air. Since thousands of strands undergo multiple processing throughout large work areas, isolation of point sources is impractical.

Existing Fiber Counts

High 8-hour TWA fiber counts are incurred throughout the entire asbestos textile manufacturing. Table 4-9 presents these counts. Dry processing presents particularly severe exposure problems, because no phase of the operation uses wetted strands

Table 4-9

Time-Weighted Average Fiber Counts
Asbestos Textiles

Process Step	Fiber Count with Existing Control Technology				Fiber Count with Best Available Technology (2)	
	Typical Fibers/cc	Damp Fibers/cc	Dry Fibers/cc	Wet (1) Fibers/cc	Conventional Fibers/cc	Wet Fibers/cc
1 Receiving & Storage	1.0	0.25 - 2.5		0.25 - 2.5	0.5 or 1.0	
2 Fiber Introduction	4.0	2.0 - 10.0	2.0 - 10.0	2.0 - 8.0	1.0	
3 Mixing & Blending	4.0	N/A	2.0 - 10.0	N/A	1.5	N/A
4 Carding	4.0	N/A	2.0 - 10.0	N/A	2.0	N/A
5 Spinning	4.0	2.0 - 10.0	2.0 - 15.0	2.0	2.0	0.4
6 Twisting	4.0	4.0 - 10.0	No Data	2.0	2.0	0.5
7 Weaving	3.0	1.0 - 4.0	No Data	1.0	1.0	0.5
8 Braiding	3.0	2.0 - 5.0	No Data	1.0	1.0	0.5

(1) Data are estimates from pilot equipment
N/A - Not Applicable

Data Base: Data collected from Conventional Plants Consuming 12,900 tons of asbestos, or 96 percent Asbestos Textile Segment.

(2) Projected fiber counts are estimates of average exposure after implementing BAT. Variations of these values are expected depending upon individual installations.

to control dust. Dry processing exposure problems are particularly acute in the twisting area. Since damp processing wets the strands before they are spun, subsequent operations have minimized dust release (with respect to dry processing). However, both processes yield potentially high exposure levels in the fiber introduction, blending, and carding operations.

Wet processing eliminates the dust generated from the blending and carding operations since these steps are not employed. Fiber introduction is accomplished directly into a chemical slurry, and underwater extrusion is used to produce the strands. Wet processing still has asbestos fiber release into the atmosphere from fiber introduction, spinning, twisting, weaving, and braiding. Because of the high-moisture or coagulum content of the strands, wet processing inherently produces the lowest level of fiber counts in the work environment for this segment.

Best Available Technology (BAT)

The complexity of operations in the textile industry makes identification of the best available technology extremely difficult. Workers must be in direct contact with most operations to effect repairs and adjustments. Complete enclosures are not possible because the worker must have direct access to the process. Partial enclosures and exhausts have been installed.

Wet processing in general is in a trial development stage. Application of this technology requires scrapping the carding equipment, and the product will not satisfy all markets. New processes will need to be developed to impregnate the wet processed yarns.

In general, enclosures, hoods, and exhausts are BAT for raw-asbestos-handling operations such as bag opening, blending, wet mixing, and conveying of bulk fiber. Vacuum systems (fixed and portable) are BAT for controlling spillage and other house-cleaning problems.

Where practical, repetitive wetting of strands is used to control fiber levels. In some cases, spindles have been designed to stop rotating if a strand breaks, but this slows spinning and twisting speeds and directly influences spinning rates.

Projected Fiber Counts (with BAT)

Generally, application of BAT in the asbestos textile industry will lower the fiber exposure levels to 2 fibers/cc TWA. Major breakthroughs in technology or massive redesign of facilities will be required before the 0.5 fibers/cc TWA level can be achieved in all process areas.

Projected fiber counts for conventional processing are fairly complete. Fiber introduction and blending (essentially the same operation) and carding yield ranges from 1.0 to 2.0 fibers/cc TWA. The dampened spinning and twisting yield an exposure level of 2.0 fibers/cc TWA. Weaving and braiding operations yield levels of 1.0 fibers/cc TWA.

Little data was reported for the dry and wet processes. The dry process will have identical exposure levels as the damp process up to the spinning operation. The best attainable level for spinning and the remaining processes would be 2 fibers/cc TWA.

The wet process has the same handling problems with raw bagged asbestos handling as other processes. Depending on techniques and equipment employed, exposure levels in the fiber introduction area are believed to be about 1.0 fibers/cc TWA. The wet mixing operation is stated to yield exposure levels less than 2 fibers/cc TWA.

Spinning of wet fiber is reported to yield fiber counts of approximately 0.4 fiber/cc TWA, or less. Twisting, weaving and braiding are reported as 0.5 or less fibers/cc TWA.

Because there are several asbestos fiber sources in each operation, the fiber counts are essentially measured values by area rather than point source; these values are background levels, and therefore can significantly affect adjacent areas.

Advanced Technology

Extensive conversion to the developmental wet process is an alternative. This implies retiring some existing equipment, and extensive developmental time, and additional costs. Furthermore, all markets cannot be served with the wet-processed yarn.

Automatic bag-opening machines and automated fiber handling would be a break-through. Complete humidification of factories has been suggested. A step-by-step and area-by-area re-evaluation and redesign of machinery and plant layout would be required to significantly reduce asbestos fiber levels. Many complex developmental alternatives beyond the scope of this report are believed to exist:

Economic Impact

Data and information supplied to Weston represent 96 percent of the segment (Table 2-1); 96 percent of this segment supplied usable data to generate cost information. The sizes of firms supplying usable data range from 1,360 to 4,500 tons of asbestos used annually.

The capital costs to achieve BAT for this segment are $19,700,000. Operating costs are projected to be $1,550,000. This segment has 82 percent of its employees exposed. The industrial hygiene and medical costs will be $3,370,000 for this segment; this represents 34 percent of the total annual costs ($9,840,000). The total annual costs to comply with the proposed standard represent 11.8 percent of this segment's average annual sales. The total annual costs versus average annual sales range from 3.3 to 74 percent. The expected capital costs estimated by industry to comply with the proposed standard represent 273 percent of this segment's typical total annual capital expenditures.

Summary of Impact
Asbestos Textiles Segment

Asbestos Usage		13,500 tons/year
Increased Cost of BAT to Industry Segment:		
Capital Cost to Achieve BAT		$ 19,700,000
Annual Costs:		
Capital	$4,920,000	
Operating Costs	1,550,000	
Industrial Hygiene and Medical Program	3,370,000	
Total Annual Costs		$9,840,000

Total Annual Costs versus Average Annual Sales	11.8 percent
Expected Capital Costs versus Typical Total Annual Capital Expenditures	273 percent

Conclusions

- The asbestos textile segment will not achieve a 2.0 fibers/cc TWA standard by the effective date of July 1976. However, the industry is moving in this direction and, by implementing BAT, can be expected to achieve this level.

- Extensive redesign of production facilities, completely new plants, and new processes will be required by the asbestos textile segment to achieve any major reduction in fiber exposure levels below 2 fibers/cc TWA.

- The proposed 0.5 fiber/cc TWA is not achievable in the foreseeable future.

- Small firms may not be able to afford the cost to comply with the proposed standard, and therefore their market share may be lost to the larger firms or foreign competion. In 1975, foreign competion was 30-40 percent of the total asbestos textile market.

Miscellaneous Primary Industries

Drilling Fluids

Drilling fluids (muds) are essential for drilling oil and gas wells. The use of asbestos in drilling muds is well-established and can have a significant effect on lowering the cost of drilling and completing wells. Drilling muds are pumped down through the drill pipe and back up the annulus between the drill pipe and the well bore wall. When they arrive back on the surface, they flow over a shaker screen to remove the drill bit cuttings, and into a mud pit. The fluid is then recirculated through the hole. Materials needed to maintain the properties of the drilling fluid are added in the surface pit.

The main function of the drilling mud is to remove drill cuttings from the hole and to contain formation pressures in the hole. The mud also removes heat from the drilling action, acts as a lubricant, and prevents excessive hole erosion. The drilling mud must be such that it remains fluid enough to be pumped with minimum pump pressures. It must not be lost to the formation, yet it must overcome formation pressures to prevent ingress of oil, gas or water.

Asbestos is added to the drilling mud to improve its carrying capacity without appreciably increasing the viscosity. Other methods of improving the carrying capacity markedly increase viscosity, which increases pump pressures, thus reducing the power available at the bit and slowing down drilling. Slow drilling rates increase drilling costs. Asbestos is used in concentrations of from 2-5 pounds per barrel (1 barrel = 42 gallons) of mud.

Asbestos is added to the drilling fluid through a mud hopper or large funnel. Initially, a volume of mud of from 150 to 200 barrels is prepared. As drilling progresses, additions are made to the system for maintenance and to accomodate the volume of the hole being drilled. Typically, these conditions occur only once during an 8-hour shift. The amounts of asbestos added are small -- rarely exceeding 500 pounds at a time.

Over 30,000 wells are drilled per year in the U.S., using around 1,500 drilling rigs. The frequent moving from site to site makes fixed control equipment for asbestos fiber exposure infeasible. A normal drilling crew consists of four men working an 8-hour shift; that is, three 8-hour crews per day. Drilling sites may be miles from any population center and are subject to extremes of climatic conditions (for example, the north coast of Alaska to the Gulf of Mexico).

Existing Fiber Counts

Asbestos is handled in two forms. The major share of the market is divided between a wetted granular material and a coarse ground material. Worker exposure is low because of the physical properties of the asbestos and short exposure times. The coarse ground material is more dusty than the pelletized form; both are much less dusty than dry, loose fiber. TWA fiber counts were reported as 0.4 fibers/cc, with a maximum ceiling level of 1.9 fibers/cc.

Conclusions

- When using pelletized asbestos, the drilling mud industry is currently meeting the proposed level of 0.5 fibers/cc TWA.

Joint Cements

Joint cements are used to finish the installation of wall board for industry and home applications. The construction industry and the do-it-yourself home installations use this material.

There are two principal types of joint compounds. One uses a latex or water-soluble glue as a binder and "sets" by evaporation of the water. The other uses dehydrated gypsum as the binder (and principal dry ingredient) and sets by chemical reaction as the gypsum takes up the water of hydration. The first type is mainly limestone with lesser amounts of mica and 3-5 percent asbestos. This type is used in about 80 percent of the market, and is mostly sold in the ready-mixed, wet form. The gypsum-based material, with roughly 20 percent of the market, also usually contains asbestos and must naturally be sold dry and mixed just before use. The applicator mixes the compound with water in the field. Wet-mix products are manufactured and packaged in a can for ready use.

The manufacturing of joint cements incurs the common exposure potentials for handling raw asbestos fibers when bags are stored, moved, slit, dumped, and disposed of. The raw asbestos fiber is dry-blended or alternatively transferred to wet mixing before packaging.

The product flows from the manufacturer, to wholesalers, to retailers, to small contractors, and finally to appliers. The wet-mix product has little potential for asbestos fiber exposure until it is finally applied and allowed to dry. Sanding the product after it has dried can generate dust. The dry-mix material can potentially cause exposure to asbestos through the distribution chain if there is damage to the bag. Field mixing of the joint cement can lead to additional exposure.

Existing Fiber Counts

No data have been received from this segment but the shipping, receiving, and fiber introduction steps are similar to other industries in the asbestos field.

Best Available Technology (BAT) and Projected Fiber Counts (with BAT)

Hoods, enclosures, and air bag-filters make up the best available technology for asbestos receiving and fiber introduction. The BAT projected fiber count is 2.0 fibers/cc TWA.

Conclusions

- The joint cements segment will not attain the proposed 0.5 fibers/cc TWA with BAT.

Raw Asbestos Retailing

Raw asbestos is purchased by wholesalers and warehousers in 100-pound bags, repacked in small quantities, and sold to retailers. These wholesalers repackage the asbestos in 5- to 25-pound bags for resale. The ultimate customer may be a plumber who uses the asbestos in a cement compound for repair of boiler or pipe insulation. In addition to the exposure problems of users, significant exposure may exist in the repackaging operation.

Existing Fiber Counts

No data have been received for this industry, but the operations are similar to the shipping, receiving, and fiber introduction steps of other industries.

Best Available Technology (BAT) and Projected Fiber Counts (with BAT)

Hoods, enclosures, and bag-filters are the best available technology for asbestos receiving and fiber introduction. The BAT projected fiber count is 2.0 fibers/cc TWA.

Conclusions

- The raw asbestos retailing industry will not attain the proposed 0.5 fibers/cc TWA with BAT.

Conclusions for the Primary Industries

Technological Feasibility

Conclusions drawn from diverse industry segments generally have little value. In this case, however, such conclusions can reasonably be drawn, since many of the processing steps are similar, if not identical, and the problems for fiber release and control technologies employed are similar.

- The 10 primary industry segments have moved expeditiously to reduce worker exposure to airborne asbestos. Our study indicates that worker exposure was significantly reduced even before the 1972 standard was promulgated. Since adoption of the existing standard, further reduction in exposure has been achieved.

- The range of existing fiber counts reported by industry (Figure 2-1) indicates that 47.3 percent are between 0 and 2.0 fibers/cc TWA and that 52.7 percent are above 2.0 fibers/cc. Further, 9.7 percent have greater than 6.0 fibers/cc exposure. At process steps where the fiber source could be confined and available dust control equipment and technology could be implemented, fiber levels were reduced to a range of 1 to 2 fibers/cc TWA. There still remain large numbers of work stations and operations where readily available equipment was ineffective, where the dust source could not be confined or the nature of the operation inherently released fiber into the atmosphere, or where the dust source was beyond the control of the manufacturer (incoming fiber shipments). While significant progress has been made at these locations, levels of fiber exposure in the 2-6 fiber/cc TWA range still occur, with occasional fiber levels as high as 22 fibers/cc TWA.

- Considerable variation is experienced in fiber count readings at the same work station, using the same control equipment. Ranges as broad as 0-22 fibers/cc TWA have been reported. A major source of variation appears to be in the test method used to determine fiber count. Another significant source of variation in fiber count is the work practices and methods of the individual employee. Careful attention of the employee to work habits which minimize dust generation is a prerequisite to achieving and maintaining lower exposure levels. On the other hand, poor work habits will increase fiber exposure regardless of the level of engineering control.

- A significant portion of the airborne asbestos results from materials handling, rather than directly from processing equipment. While such a distinction may appear small, it has a profound effect on the strategy of control and on the ultimate level of control achievable. In process sources, a point or points of fiber release can generally be controlled. When fiber release is due to handling the raw fiber or product, it represents an area source, rather than a point source, and is therefore much more difficult to control. An analogous situation occurs in air pollution control technology when dealing with point vs. fugitive dust sources.

- In the majority of industry segments, the two major fiber release areas are fiber introduction into the process and product finishing. The fiber introduction step often results in high airborne fiber concentrations because fiber accumulates on the outside of the bag during transportation and because the bag must be opened, dumped, and disposed of. All of these steps involve intimate handling of the raw fiber and exposure to loose fibers which may have accumulated from previous handling.

- Once the asbestos enters the processing equipment, control of the fiber release is generally good. Often water or binders are added, further reducing the potential for fiber release. The product finishing step involves the mechanical modification of the asbestos-containing product. When such modification requires abrasion, such as in sanding, sawing, etc. fiber will again become airborne.

- Few data on ceiling exposures are available. Contacts have reported their concern with the TWA standard, rather than the ceiling concentration standard; however, no data exist to support their contention.

- Implementation of BAT will not reduce TWA exposure to 0.5 fiber/cc at all processing steps in the primary segments. Only 30 of 86 (35 percent) identified work stations were projected to be at or below the proposed 0.5 fiber/cc TWA exposure standard. Therefore, 65

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percent of the primary process steps are above 0.5 fibers/cc. The achievement of an exposure limit of 0.5 fiber/cc TWA is not feasible with the application of BAT for each process step.

- Application of BAT is projected to reduce TWA exposure to 2.0 fibers/cc TWA or less at all work stations in the primary industries.

- Implementation of BAT in the primary industries will require three to five years, based on industry estimates and on the implementation of the compliance schedules required by the existing standard.

- There is little question that reasonable monitoring in the work environment is necessary to determine the level of worker exposure. However, there are several factors which affect the feasibility of such a program.

    - The results of our study indicate a widespread lack of understanding and misapplication of the TWA and ceiling exposure, and personal and area sampling test methods and calculations.

    - The accuracy and reproducibility of the test procedure must be questioned in light of the wide variations in TWA fiber count reported at the same worker station, employing the same control equipment. Duplicate samples taken simultaneously from the same employee have indicated substantial variation in fiber count. While other factors can logically be expected to affect fiber count (variations in day-to-day work practices, raw materials, background fiber levels), the sampling and counting procedure must be questioned.

    - At present, only 74 laboratories are accredited by the American Industrial Hygiene Association (16) or participate in HEW's National Institute for Occupational Safety & Health asbestos counting program (58). We did not estimate in detail the total number of samples which would require asbestos counting; however, it does not appear feasible for the 74 laboratories to analyze the hundreds of thousands of samples which will be required by the proposed standard.

Economic Impact

- Capital Costs to achieve BAT, exclusive of previous capital expenditures, in 1975 dollars are estimated at $93,950,000 (Table 4-10) for nine of the asbestos industry segments. The Capital Costs to achieve BAT for the miscellaneous segment were excluded because the diverse responses from that segment were not amenable to further analysis. Concerning Capital Costs to achieve BAT, it should be noted:

  - BAT control equipment has already been installed at many work stations in order to meet the 2.0 fiber/cc TWA standard.

  - BAT will not achieve a uniform 0.5 fiber/cc TWA standard at all work stations.

  - In many installations, BAT will be achieved by modifying existing control equipment, rather than by installing new facilities.

- Total Annual Costs to achieve BAT, exclusive of current annual costs, is estimated at $66,440,000 (Table 4-10). These costs include annual capital costs for control equipment, annual operating costs, and the annual industrial hygiene and medical program costs to the requirements of the proposed standard. However, the $66,440,000 is based upon only 9 segments (excluding Miscellaneous) and is based on improving present operations to the BAT level, rather than meeting the 0.5 fiber/cc proposed level.

- The Total Annual Costs as a Percent of Average Annual Sales for each segment range from 1.6 to 11.8 percent (Table 4-10). For most of these segments, the cost increase can likely be passed on to the consumer with little or no loss in the market, in the form of price increases. Historically, cost increases resulting from implementation of the existing standard have been passed to the consumer with no market loss. However, up to this time, these cost increases have been eclipsed by "double-digit" inflation over the past three years, and by a 30 percent increase in fiber cost during the last 18 months.

- The Asbestos Textile and Friction Products segments are most likely to suffer market losses because of cost increases. Since the mid-1950's the Textile segment has faced severe cost competition from foreign producers. We cannot

Table 4-10

Summary of Economic Impact
Primary Asbestos Industries, by Segment

	Capital Cost to Achieve BAT	Annual Costs to Achieve BAT			% Increase in selling Price from Implementation of BAT	Expected Capital Costs (Percent) Vs Typical Total Annual Capital Expenditures
		Operating Costs	Industrial Hygiene & Medical Program	Total Annual Costs		
Asbestos Paper	$ 5,100,000	$ 200,000	$ 4,010,000	$ 5,510,000	1.7	172
Asbestos Cement Pipe	12,000,000	750,000	2,150,000	5,900,000	3.2	162
Floor Tile	2,720,000	1,380,000	6,000,000	8,060,000	3.0	33
Friction Products	29,800,000	3,360,000	6,570,000	17,380,000	7.8	316
Paints, Coatings, and Sealants	4,230,000	550,000	2,730,000	4,340,000	1.6	143
Asbestos Cement Sheet	3,300,000	130,000	1,120,000	2,070,000	3.0	256
Gaskets and Packing	16,000,000	1,100,000	5,550,000	10,650,000	7.3	148
Asbestos Reinforced Plastics	1,100,000	110,000	2,310,000	2,690,000	2.4	23
Asbestos Textiles	19,700,000	1,550,000	3,370,000	9,840,000	11.8	273
Overall Primary Industries	93,950,000	9,130,000	33,810,000	66,440,000[1]	5.1	

[1] Includes Annualized Capital Costs

predict the extent, additional Asbestos Textile business will be lost to foreign competition because of implementation of the proposed standard. The Friction Products segment has also recently experienced foreign competition, primarily from Canada. Further loss of business can be expected, as prices for domestically produced friction materials will increase because of the cost of implementing the proposed standard.

- The Expected Capital Costs as a Percent of Typical Total Capital Expenditures range from 23 to 316 percent (Table 4-10). Only two of the nine segments expect less than 100 percent (Floor Tile and Asbestos-Reinforced Plastics) to comply with the proposed standard, the other seven industry segments will be required to devote significant capital resources to implementing BAT. As previously indicated the BAT level is above the proposed 0.5 fiber/cc in many process steps.

SECTION 5
SECONDARY INDUSTRIES --
SPECIFIC DISCUSSION

Technological Feasibility

Method of Analysis

Secondary industries are those which continue the manufacturing process by receiving a material which contains asbestos (already modified by the primary industries) and further process, modify, or fabricate this product to produce another intermediate or final product. The secondary industry segments are highly diversified with respect to both the number of plants involved and the variety of final or intermediate products manufactured.

The major emphasis of this report involves the status of the primary industry segments producing asbestos products (or intermediates, excluding construction activities). However, since asbestos goods form the raw material for a great many plants, the full economic impact of the proposed asbestos standards cannot be fully assessed without a thorough investigation of the secondary industries (excluding construction activities). To achieve this, Weston solicited data and comments from a wide variety of plants representative of the secondary industries. The data are as varied as the products themselves, but have been categorized in order to derive specific conclusions. Weston is prepared to discuss the general status of the secondary industry segments; 23 percent of the responses, coupled with Weston's telephone contacts and plant visits, form the basis of the following discussion. To aid in the understanding of the secondary industries and to avoid duplication of descriptions among the segments, the secondary industries will be treated as one entity with appropriate areas of differences noted between major product segments.

Process Descriptions

The secondary asbestos industries produce products which are suitable for sale either to the customer directly as finished goods (e.g., impregnated roofing felts) or to another secondary industry (e.g., asbestos paper and metal sheets combined to form gasket material, which is then punched or cut by another secondary; asbestos textile fabric, coated with aluminum and then cut and tailored into fire protective clothing, etc.).

In many cases, the secondary industry overlaps the finishing area process steps carried out by the primary industries. Most secondary industries are involved with fabrication of an asbestos-containing product from one form into another. These fabricators employ techniques such as sanding, grinding, sawing, milling, punching, pressing, slitting, shearing, routing, etc., to mechanically modify the received "raw" material into a "finished" product. Therefore, the secondary industries are faced with reducing asbestos dust exposure in these steps much the same as in the primary industries. However, there are several important distinctions which must be made to separate this "common" exposure area.

The primary industries normally limit finishing steps to the end of the production process (machining of asbestos cement pipe, asbestos paper slitting and rewinding, etc.). Many of these operations occupy only a small area of the entire plant. Isolation of the finishing area from areas of lesser exposure is practical. The secondary industry often does finishing throughout the entire process operation; isolation of a high-exposure area is impractical since the entire plant is involved.

Fabrication or conversion of asbestos-containing materials into a product often involves the use of highly versatile, portable hand tools for sawing and sanding. Efficient dust control using local exhaust equipment sometimes does not serve to reduce employee exposure to below 5 fibers/cc TWA if the employee is performing this operation the entire day. It may be possible to develop a more efficient machine and dust control apparatus (wet sanding); however, the more specialized the equipment, the less versatile it becomes. The fabricator must purchase more elaborate equipment which may be used only a few times a month when he makes up an order. Alternately, he may choose to abandon this portion of his business, rather than work with a substance that produces high amounts of dust and that requires special equipment.

The primary industry segment is composed of large corporations whose level of control and process technology have evolved over many years of research, development, and experience. These large businesses have expended manpower and capital to overcome operational and dust-exposure problems. In many instances, the control technology is advanced beyond reach of the small to medium-sized fabricator. A secondary fabricator employing five to 20 people can hardly be expected to install expensive special finishing equipment without adversely affecting the capital stability of his business and the cost of his product. This point will be expanded in later discussions dealing with the economic impact of the proposed regulations upon the secondary industries.

Work Practices/Controls

Receiving and storage areas normally present less potential asbestos dust exposure in the secondary industry segments since their raw materials have been processed by the primaries and are received in a bound-asbestos or packaged form. Dust exposure, therefore, is limited to materials damaged either in shipping or storing operations or arising from dust clinging to products from abrasion in shipment or arriving from the primary industry supplier. These materials become exposure sources only if the fiber is released from the binding material or the package is broken and the material is abraided. (This may occur, e.g., when a fork lift operator runs over a spilled or broken piece of material.) Housekeeping practices that stress rapid clean-up of broken material with vacuum systems rather than manual sweeping are effective in minimizing dust exposure from these steps.

Basically, the secondary industry segments use the same type of control equipment and work practices as the primary industry segments to reduce employee exposure to asbestos dust. Control equipment and work practices used include: central vacuum systems for floor and equipment cleaning; down-draft tables, local exhausts on hand tools, and area hoods on large machines connected to a central ventilation system with air filtering through a bag-house; wet grinding and sawing where product integrity is not adversely affected; cleaning of raw materials and products to minimize dust exposure in handling and packaging; proper handling of scrap materials; and routine equipment and floor cleaning.

Although the control equipment and work practices employed by the primary and secondary industry segments are similar, the secondary industries are characterized by the prevalence of hand tooling and machining operations, which are more labor-intensive than primary industry's production operations in the finishing steps. The diversity of processes in some secondary industries and the "piece-work" or custom fabrication cause these secondaries to use highly versatile tools. The control practices emphasize the use of local exhausts to minimize asbestos dust exposure. These controls are effective in reducing the bulk of the dust generated, but cannot be expected to be highly efficient under all working conditions by virtue of their versatility.

Existing Fiber Counts

The variety of processing and control techniques employed by the secondary industries and of the raw materials arising from all of the primary industry segments makes the definition of a general range of asbestos exposures meaningless. The data which Weston has acquired indicate a categorization of the secondary industries by raw materials received from the primary industry suppliers. The secondary industries are segmented according to the categories presented for the asbestos primary industries: asbestos paper; asbestos cement pipe; floor tile; friction products; paints, coating and sealants; asbestos cement sheet; gaskets and packing; asbestos-reinforced plastics; and asbestos textiles. Table 5-1 illustrates general ranges of fiber counts in these industries.

- Asbestos paper products are used to produce gasket materials, thermal and electrical insulation, roofing products, etc. Secondary segment products are characterized by slitting, sawing, punching, pressing, converting, and leminating operations. The range of fiber exposure is 1.0 to 3.5 fibers/cc TWA.

- Asbestos cement pipe is manufactured and machined in the primary industries almost exclusively. The next step for this product is the construction (or plant maintenance) industry for installation. This segment's products, when used by the construction industry, are not subject to OSHA's proposed standard.

- Floor tile is manufactured, cut, and packaged for shipment by the primary industries. The next step for this product is either the construction industry (including builders and remodelers), or homeowners use for installation. Therefore, this segment's products (when used by the construction industry or homeowners) are not subject to OSHA's proposed standard.

- Paints, coatings, and sealants are similar to asbestos cement pipe and floor tile; that is, they are used by the construction industry and home remodeling markets. Thus, this segment's products, when used by the construction industry or homeowners, are not subject to OSHA's proposed standard.

Table 5-1

Time-Weighted Average Fiber Counts
Secondary Industries

Secondary Industry[1]	Range of Reported Fiber Levels Fibers/cc
Asbestos Paper	1.0 - 3.5
Asbestos Cement Pipe	Not Applicable
Floor Tile	Not Applicable
Paints, Coatings and Sealants	Not Applicable
Friction Products	2.5 - 6.5
Asbestos Cement Sheet	1.0 - 6.0
Gaskets and Packing	0.2 - 5.0
Asbestos-Reinforced Plastic	0.5 - 2.0
Asbestos Textiles	0 5 - 5.0

[1] Based upon the type of raw materials received by the secondary industries.

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- Friction products are used to manufacture brake and transmission assemblies for the automotive, truck, heavy machinery, and railroad industries. A wide variety of motion-controlling applications are dependent upon industrial friction components. These secondaries receive the friction products from the primaries and form them into a product which requires drilling, sawing, tapping, grinding, and cutting of the friction products to conform to the product specifications. The range of fiber exposure is 2.5 to 6.5 fibers/cc TWA.

- Asbestos cement sheets are used widely by the secondary industries for molten metal and glass supports and troughs, thermal insulation, building materials, etc. All operations require some machining -- punching, pressing, sawing, drilling, sanding, etc. -- which generates substantial amounts of asbestos-laden dust. The range of fiber exposures is 1.0 to 6.0 fibers/cc TWA.

- Gaskets and packings are used as fluid seals in a variety of devices. They may be impregnated with polymers, latex, and other materials to yield special properties. Gaskets and packings which have been treated with chemicals to further bind the asbestos fibers release less dust than unbound materials when undergoing additional processes such as pressing, punching, and slitting. For gaskets and packings which are received from a primary industry without a binder or as a yarn for making packings in the secondary segment, the range of fiber exposure is 1.0 - 5.0 fibers/cc TWA. Similarly, for those products which had been combined with a binder or impregnated in the primary industry, the range of fiber exposure is 0.2 to 1.5 fibers/cc TWA.

- Asbestos-reinforced plastics are used to make electrical switchboards and a wide variety of molded plastic products requiring a high strength-to-weight ratio. Secondary industries cut, drill, mill, and grind these materials according to product needs. The range of asbestos exposure is 0.5 to 2.0 fibers/cc TWA.

- Asbestos textiles are processed into packing materials, friction products, insulation, and protective clothing by the secondary industries. The textile product as received by the secondary may be bound with a resin which supresses dust evolution in the secondary processing; however, a portion of textile material is received as raw fabric. The secondary industries employ processes such as cutting, stamping, slitting, sawing, braiding, laminating, and sewing according to the specifications of the product. The range of asbestos exposure is 0.5 to 5.0 fibers/cc TWA.

Best Available Technology (BAT)

The Best Available Technology to be employed in the secondary industries to reduce employee exposure to asbestos is similar to that discussed for each of the primary segments, with the exception of the front-end processing steps (raw fiber receiving, fiber introduction, stock preparation, blending, etc.) involved with the primaries. A thorough examination of the primary industry segments indicates that technology is available to reduce employee exposures to asbestos below those which, based upon limited data, are prevalent in the secondary industries by a combination of control equipment, process modification and changes in work practices. In general, however, BAT for the secondary segments will be more difficult to implement because of the variety of processes, machining, products, and technologies present. The practical engineering and economic aspects of installing BAT in the secondary industries are more formidable and require careful evaluation on a plant-by-plant basis.

In general, BAT includes the use of central and local machine exhaust hoods; wet machining where possible; central and mechanical vacuum cleaning systems; proper handling of waste material; isolation of equipment with enclosures; and increased automation of equipment.

Projected Fiber Counts (with BAT)

It is not possible to estimate the asbestos fiber counts achievable in the secondary industries after implementing BAT segment by segment. The process, raw materials, product, and technology variations are so numerous, even within a given segment, that projections of fiber exposures are relevant only when considering a reasonably well-defined operation. For example, fiber exposure will vary between a drilling step and a sawing step even when both are processing an asbestos cement sheet product. Similarly, fiber exposure will vary between a drilling step handling a friction product versus one handling an asbestos cement sheet. Therefore, the process step, material handled, and products manufactured must all be considered when estimating the asbestos fiber exposure after implementing BAT.

If the secondary industries installed BAT similar to the primary industry segments, it is Weston's opinion that it should not be expected that employees will reach the same level of exposure as projected for the primary segments when both segments are working with the same type of asbestos-containing material. This judgment is based upon the following two points:

- The secondary segments are composed of a higher percentage of labor-intensive and custom-fabrication industries than the primary segments.
- BAT will not be identical for both segments because there are differences in products manufactured, processing steps, material inputs, and technologies.

Economic Impact

Method of Analysis

Based upon Weston's questionnaire survey, 23 percent of the total responses represented input from the secondary asbestos industries. The data contained in these responses, coupled with Weston's telephone contacts and plant visits, are not amenable to the same economic evaluation as that developed for the primary industries. The information obtained, however, does indicate rough economic trends. These trends need much greater study to define the true economic impact of the proposed regulations on this segment of the industry. However, Weston has developed reasonably accurate "order-of-magnitude" estimates of these economic trends by applying economic and statistical methods to extrapolate current data and to forecast the expenditures likely to be required in the secondary industries for compliance with the proposed regulations.

Development of Secondary Asbestos Usage

Table 2-1 indicates the asbestos usage for each segment of the primary industries. From this allocation and a knowledge of products manufactured in the primary segments, estimates of the quantity of asbestos-containing products (by asbestos fiber content) passed on to the secondary segments are possible. The next step for products manufactured by the asbestos cement pipe; floor tile; and paints, coatings, and sealants segments is either the contruction industry or the home remodeling (contractor and homeowner) industry. These primary segments, therefore, do not have an explicit secondary segment; they are passed directly to the consumer industries. Similarly, approximately 25 percent of the asbestos cement sheet and 70 percent of the Miscellaneous segments are without a definable secondary segment. Thus, of the 900,000 tons per year (fiber content) of primary asbestos products, only approximately 517,500 tons per year (57.7 percent) are passed through a secondary segment.

Development of Estimated Plant Employment Data

From the data presented in the employment section for primary industries, Table 3-1, approximately 37,539 employees are working 190 primary industry segment locations throughout the U.S. The average employment for each location is 198. In order to establish the employment in those industry segments which have a secondary segment, Weston consulted data published by the Department of Commerce, Dun and Bradstreet, and several other sources to arrive at a coefficient which represents the number of employees in the secondary industries, exclusive of those individuals engaged in repair or replacement of brake materials. This category of secondary industries (service stations, garages, dealers, and fleet repair) was given special attention due to the large number of establishments and employees exposed.

The sources of data were not all consistent, and at times differed in their estimate of number of locations. The problem is further complicated by the fact that the classification into primary segments is not totally compatible with the Standard Industrial Classification (SIC) Codes used in the data sources investigated.

However, after a thorough review of all sources (including the industry and trade association estimates of locations), Weston placed total employment in the secondary industries (excluding the brake service and repair sector) at 300,000 employees. Of this total, approximately 80 percent (240,000 employees) are considered production or maintenance personnel: the remainder are administrative and management (Source: 1972 Census of Manufacturers). In order to allocate the work force among the various secondary segments, Weston assumed that the level of employment in a segment (as a percentage of the total employment in the industry) was the same as the ratio of the quantity of asbestos (fiber content) products received by that segment to the total used in the secondary industries. (Table 5-4 gives the basis.) Following a similar line of reasoning, Weston estimated the total employment per location to be 25 employees, allowing the number of secondary asbestos industry establishments (excluding the brake service and repair sector) to be derived as 12,000 throughout the U.S.

Establishments engaged in the repair or replacement of brake (friction) materials are categorized as secondary industries since the employees are exposed to airborne asbestos in sufficient quantity likely to exceed the proposed TWA and ceiling concentrations of asbestos. Such establishments are classified as: service stations, independent repair shops, new car/truck dealer shops, and self-service fleet shops. Data on the number of establishments and employees involved in these services were compiled from information supplied by the Automotive Parts Rebuilders Association (APRA), the 1973 Service Job Analysis report (Hunter Publishing Company), and numerous private corporations involved with brake service shops. The data from these sources were assembled and classified by establishment and employees exposed and are presented on Table 5-2. The total number of employees exposed is approximately 1,970,000 in 246,000 establishments through the U.S.

Development of BAT Capital Cost Data

Based solely upon the questionnaire responses, development of a sufficient data base to project capital costs for implementing BAT was not possible. Weston supplemented this information with phone contacts to solicit input from as broad a range of secondary segments as time would permit. Upon receiving the data on both an inter- and intra-segment basis, Weston concluded that cost estimates by the industry members were extremely diverse because of the large differences in production techniques, sizes of plant, type of product, levels of technology, etc. In order to reduce these cost estimates into meaningful data, a common divisor was necessary. After several approaches were investigated, Weston selected two methods of data comparison which seemed to yield the most consistent results: BAT capital cost per employee and BAT capital cost per ton of asbestos (fiber) received per year. As shown on Table 5-4, these methods yield results which differed by approximately 20 percent. The BAT capital costs were expressed as $850 per employee and $400 per ton of asbestos (fiber) received per year.

TABLE 5-2

ECONOMIC IMPACT FOR BRAKE SERVICE/REPAIR SECTORS - SECONDARY INDUSTRIES

	Service Stations	Independent Repair Shops	New Car/Truck Dealer Shops	Self-Service Fleet Shops	Totals
Employee continuously exposed	340,000	190,000	145,000	225,000	900,000
Employee occasionally or infrequently exposed	325,000	470,000	140,000	135,000	1,070,000
Total employees exposed	665,000	660,000	285,000	360,000	1,970,000
Total establishments in U.S.	194,000	108,000	39,000	21,000	362,000
Establishments involved in Brake Service/Repair	136,000	70,000	25,000	15,000	246,000

Scientific (?)

Development of Basic Industrial Hygiene and Medical Program Costs

The industrial hygiene and medical program costs include the requirements for the following paragraphs of the proposed standard:

- Monitoring
- Respiratory Protection
- Personal Protective Clothing
- Hygiene Facilities and Practices
- Medical Surveillance
- Employee Information and Training
- Recordkeeping

To determine the methods industry would use to comply with the proposed standard, Weston used the costs developed in the primary industry sector as a basis. However, it was assumed that a basic program would have to be developed due to the proposed standard. It was also assumed that 40 percent of the process steps would be above the 0.5 fiber/cc level after implementation of BAT and that 40 percent of the employees are continuously or frequently in the work environment. The estimated costs per employee per year are summarized in Table 5-3.

Thus, by applying the figure of $835 per employee per year to each total employment figure in the secondary segments, a cost of compliance with the proposed regulation can be estimated.

Table 5-3

Basic Industrial Hygiene and Medical Program Costs
Secondary Industries

1.	Monitoring[1]	$120
2.	Respiratory Protection[2]	170
3.	Personal Protective Clothing[3]	200
4.	Hygiene Facilities and Practices[4]	180
5.	Medical Surveillance[5]	85
6.	Employee Information and Training[6]	50
7.	Recordkeeping[7]	30
	Total Per Employee Per Year	$835

1. Monitoring: 25 percent of the employees were estimated to require monitoring (from primary industries incremental cost estimate). It was assumed that a basic program monitoring was required 12 times a year.

   (.25) (12 samples/year) ($40/sample) = $120

2. Respiratory Protection: It was estimated 40 percent of the process steps would be above 0.5 fibers/cc after implementation of BAT based on data from primary process steps (65 percent). In addition, the material the secondary industries receive contain asbestos in a form more difficult to release to the work environment. However, in some cases the secondary industry, by sanding, cutting, drilling, etc., performs process steps identical to the primary industries. It was also estimated that 40 percent of the employees are continuously or frequently in the work environment. (Underlined figures represent information derived from the primary industries.)

   (.40) (.40) (<u>$2.80/filter</u>) (50 weeks/year) + (<u>0.1 hr</u>) (<u>$6.00/hr</u>) (250 days/yr) = $170.

3. Personal Protective Clothing: 40 percent of the employees are continuously or frequently in the work environment (from 2 above)

   (.40) (<u>$2.00/uniform</u>) (<u>250 days/year</u>) (<u>$6.00/hr</u>) = $200

Table 5-3
(continued)

4. Hygiene Facilities and Practices: secondary industries will be required to install change room/shower/lavatory facilities. These costs appear in the capital costs to achieve BAT. Forty percent of the employees are continuously or frequently in the work environment (from 2 above) and will require a daily shower.

(.40) (0.3 hr) ($6.00/hr) (250 days/year) = $180

5. Medical Surveillance: Annual examination to include chest roentgenograph, forced vital capacity, forced respiratory volume @ 1 sec. and sputum cytolgy. It was estimated 4.0 hrs of non-productive time would be required for the examination.

($60 examination) + (4.0 hr/yr) ($6.00/hr) = $85

6. Employee information and training:

(8.0 hr/year) ($6.00/hr) = $50

7. Recordkeeping: Based on one day clerk's time @ $30.

TABLE 5-4

ECONOMIC IMPACT - SECONDARY INDUSTRIES

	Primary Industry Segments		Secondary Industries					
						BAT Capital Cost Estimates (5)		
Industry Segment	% Asbestos Usage	Annual Tons of Asbestos Usage	% Asbestos Usage	Annual Tons of Asbestos Usage	Estimated Employment (production/total)	Based upon Employment (4)	Based Upon Tons of Asbestos Consumed / year(5)	Estimated Industrial Hygiene and Medical Costs, ($/year)
Asbestos Paper	38.0	342,000	66.0	342,000	158,400/198,000(3)	168,300,000	136,800,000	165,300,000
Asbestos Cement Pipe	16.0	144,000	-	-	-	-	-	-
Floor Tile	12.5	112,500	-	-	-	-	-	-
Friction Products	6.5	58,500	11.5	58,500	(900,000/1,970,000(7) (27,600/34,500(8)(3)	765,000,000(7) 29,300,000(8)	Not Applicable 23,400,000(8)	1,644,900,000(7) 28,800,000(8)
Paints, Coatings, & Sealants	7.5	67,500	-	-	-	-	-	-
Asbestos Cement Sheets	6.0	54,000	8.0	40,500	19,200/24,000(3)	20,400,000	16,200,000	20,000,000
Gaskets and Packings	3.0	27,000	5.0	27,000	12,000/15,000(3)	12,800,000	10,800,000	12,500,000
Asbestos Reinforced Plastics	2.0	18,000	3.5	18,000	8,400/10,500(3)	8,900,000	7,200,000	8,800,000
Asbestos Textiles	1.5	13,500	2.5	13,500	6,000/7,500 (3)	6,400,000	5,400,000	6,300,000
Miscellaneous	7.0	63,000	3.5	18,000	8,400/10,500(3)	8,900,000	7,200,000	8,800,000
TOTALS	100.0	900,000 (1)	100.0	517,500 (2)	1,140,000/2,270,000	1,020,000,000	Not Applicable	1,895,400,000(6)

Footnotes:
1. Based upon Table 2-1
2. Estimate of tons of asbestos contained in primary industry products which are processed by secondary industries.
3. Approximately 80 percent of total employment are defined as production workers.
4. Based upon survey average of $850 per employee to install BAT on secondary industry level.
5. Based upon survey average of $400 per ton of asbestos processed per year on secondary industry level.
6. Based upon Table 5-3; Industrial Hygiene and Medical Costs of $835/employee/year.
7. Brake Service/Repair sectors only.
8. Secondary industries in Friction Products segment excluding Brake Service/Repair.

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General Profile

The Secondary Industries are highly diversified plants capable of producing an extremely wide variety of finished goods or intermediate products. In general, they are labor-intensive operations requiring significant use of hand-operated power tools. The process and control technology of the Secondary Industries has been shown to produce an employee exposure to airborne asbestos somewhat higher than for a similar operation in Primary Industries.

The plants are further typified as employing a small to medium-sized work force of varying levels of labor skills. A number of plants use a somewhat lower pay scale than others (producing the same product) but include a production incentive program ("piecework bonus") in their salary classifications or job descriptions. Large numbers of plants derive their sales from specialized or custom-made items ("jobshoppers") rather than term contracts for a specific item furnished over a period of time. It is important to note that a significant number of plants included in the secondary industries also produce materials not containing asbestos, and their level of control technology reflects generally accepted techniques for dust control not specific to reduction of airborne asbestos fibers.

With regard to the implementation of the proposed standards, the responses to Weston's survey indicate a wide diversity of opinions. Most of the plants indicated that they could not continue to manufacture certain products if the proposed standards were adopted. These plants are basically involved with production of asbestos cement sheet, friction products, and gasket and packing products and use such processes as drilling, grinding, sawing, and sanding. All produce significant quantities of asbestos-laden dusts and were unsure about what further approach was to be taken to reduce the exposure to the proposed standard levels.

Table 5-5 presents a summary of the economic impact attributable to compliance with the proposed regulations by the secondary asbestos industry as a whole and by individual segments. In developing these results, Weston used the same methodology as that described for the primary industries. In total, the secondary asbestos industries will be required to spend approximately $2,251,960,000 per year to comply with the proposed regulations. This expenditure may also be expressed as $995 per employee per year for the entire group of secondary industries, or

TABLE 5-5

Summary of Economic Impact - Secondary Industries

Industry Segment	Capital Cost to Achieve BAT (2)	Annual Costs to Achieve BAT			Total Estimated Employment	Total Estimated Number of Establishments
		Operating Costs	Industrial Hygiene and Medical (3) Programs	Total Annual Costs		
Asbestos Paper	168,300,000	6,600,000	165,300,000	213,980,000	198,000	
Asbestos Cement Pipe	-	-				
Floor Tile	-	-				
Friction Products	794,300,000	91,160,000	1,673,700,000	1,963,440,000	2,004,500	
Paints, Coatings, and Sealants	-					
Asbestos Cement Sheet	20,400,000	800,000	20,000,000	25,900,000	24,000	
Gaskets and Packings	12,800,000	880,000	12,500,000	16,580,000	15,000	
Asbestos Reinforced Plastics	8,900,000	890,000	8,800,000	11,920,000	10,500	
Asbestos Textiles	6,400,000	500,000	6,300,000	8,400,000	7,500	
Miscellaneous	8,900,000	710,000(1)	8,800,000	11,740,000	10,500	
TOTALS	1,020,000,000	101,540,000	1,895,400,000	2,251,960,000	2,270,000	258,000

(1) Estimated at 8% of capital cost.
(2) BAT capital costs on Table 5-4, based on employment.
(3) From Table 5-4.

approximately $8,725 per year per average work establishment. By comparison, the primary segments (refer to Table 1-1) are estimated to require a total of $66,440,000 per year, or $1,770 per employee per year and $350,000 per establishment.

Industrial hygiene and medical program costs make up about 51 percent of the cost of compliance for the primary segments; in the secondary industries, these costs increase to approximately 85 percent of the total. From data extracted from the 1972 Census of Manufactures, the weighted average of value of shipments added per employee is $20,682 (based upon SIC Codes 3292, 3293 and 2661). After adjusting this value to 1975, the value added per employee is approximately $21,200. Based upon an average of $995 per employee to comply with the proposed regulation in the secondary industries, a minimum average price increase of 4.7 percent for products exiting from these segments may be estimated, based upon the internal cost for compliance. The increase of 4.7 percent in product price by the secondary industries does not include the increased raw material costs passed on by the primaries as their cost of compliance.

The full impact of these economic changes on those who are required to install BAT may follow one of these avenues:

- If asbestos-containing materials are a mainstay of the plant's sales, the owner may choose to install BAT and pass all, or a portion of, his cost to the next secondary or directly to the final customer. The amount of the passed-on cost may have a ceiling above which he cannot raise prices because of competition from imported products, a competitor's similar product, or an asbestos-free substitute product. In these cases, the owner will suffer a loss in profit which may ultimately cause him to discontinue all or a portion of production and reduce his work force.

- If asbestos-containing materials are a small portion of the plant's sales, the owner will be likely to discontinue processing the costly products. Similarly, in a plant which processes a variety of asbestos-containing products, the owner will likely discontinue that product line which causes his operation to exceed the standard rather than install costly BAT for a portion of his business.

- If asbestos-containing materials are a significant portion of the total plant's sales, the owner may not be able to afford installing BAT and must close his plant with resultant unemployment of his work force.

The competition among similar manufacturers in the secondary segments is keen, with many high-volume, low-profit-margin products. Recent increases in the costs of raw asbestos fiber to the primary segments, increased labor costs, capital expenditures to achieve the present asbestos standards, and the general inflationary trend of the past few years have caused asbestos-containing products to increase significantly in cost. As costs have risen, stronger market inroads have been made by imported asbestos products and by substitutes not containing asbestos. Additional research and development is continuing to supply new products which do not contain asbestos. All of these conditions serve to heighten the competition in the asbestos industry by shrinking the marketplace. The secondary industries are caught in the middle of a decreasing product demand and increased production costs.

A necessary result of this situation appears to be a reduction in the number of secondary industry plants. However, there may be no noticeable decrease in the total work force involved. This will be true only if product demand is relatively constant and can be supplied by a smaller number of secondary plants, each employing a larger average work force. Of necessity, there will be a consolidation of this segment into a fewer number of larger companies (whose economic situation allowed them to comply with the regulations and remain financially solvent); or more processing by the primary industries (which have a higher level of technology and the stronger financial base to expand their operations and sustain product demands) than had heretofore been the case. The extent to which this consolidation may occur in light of the proposed regulations and the effects upon the national economy are uncertain at this time and require in-depth study of the economic situation of the Secondary Asbestos Industries.

Conclusions

- The majority of the secondary industries are currently meeting the 5.0 fibers/cc TWA standard.

- BAT for the secondary industries is similar to that defined for the primary segments. However, equal employee exposure levels (vis à vis similar processes in both segments) are not considered likely.

- With the exception of a few industries in the gaskets and packings and reinforced plastic segments, all industries reported that efforts to decrease fiber exposure significantly below the current 2.0 fibers/cc TWA standard would require development of advanced technologies not as yet proven.

- Implementation of BAT in the secondary industry is estimated to cost approximately $2,251,960,000 per year, or $995 per employee per year.

- The estimated employment for the asbestos secondary industries is 2,270,000 employees, which includes approximately 258,000 locations throughout the U.S.

- Implementation of BAT is estimated to cause a product price average increase of approximately 4.7 percent exclusive of higher raw material costs passed-on by the primary segments.

- The brake (friction material) service/repair sector is estimated to bear approximately 85% of the costs to comply with the proposed standards.

Technological Feasibility

"Consumer Industries" are those industries that purchase a finished asbestos-containing product (from a primary or secondary industry) and apply, install, erect, or consume the asbestos-containing product without further modification of the product. The consumer industries are more diversified than the secondary industries with respect to both the number of plants involved and the variety of products sold to consumers. Furthermore, in many plants the asbestos-containing materials are a very small part of the total product. In an automobile, for example, asbestos-containing material can be found in the disc brake/shoe brake, automatic transmissions/clutch assemblies, mufflers, and the sound-deadening undercoating.

The major emphasis of this report involves the status of the primary industry segments producing asbestos products or intermediates (excluding construction activities). The total economic impact of the proposed asbestos standards cannot be fully assessed without a thorough investigation of the consumer industries (excluding construction activities).

To achieve this, Weston solicited data, information, and comments from a wide variety of sources: primary, secondary and consumer industry companies, trade associations, and economic specialists. The data, information, and comments are more varied than for the secondary industries.

Many companies and trade associations contacted were either unaware that asbestos-containing materials were in their products or felt assured that the proposed standard did not include their operations.

Once asbestos products leave the primary and secondary asbestos industry, they are absorbed by the domestic economy at large. This assimilation takes place in two major groups: construction and manufacturing. This portion of the report is concerned with outlining the diffusion of the products through the latter group and indicating the magnitude of the economic impact.

The consumer industries no longer modify the asbestos-containing material but simply install or apply these materials as a portion of the finished product. In some cases, asbestos-contining products are used by the consumer industry as maintenance or repair materials. For the asbestos fiber to be disassociated from the asbestos-containing material and to become airborne in sufficient quantities to exceed the ceiling or 8-hour TWA values of the proposed standard is improbable. Therefore, the technological feasibility discussion and the method of analysis used in the primary and secondary industries (process description, control equipment/work practices, existing fiber counts and BAT) are not applicable for the consumer industries.

Economic Impact

Method of Analysis

The basis for the economic impact analysis is a combination of information compiled from proprietary data contained in other economic studies, the National Input/Output Table, and the Census of Manufactures. The last two are published by the U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census.

The primary and secondary industries' products (excluding those going to the construction industry) are assumed to be supplied to the consumer by the asbestos manufacturing groups according to the following Standard Industrial Classification Codes: 2661 (Building Paper and Mill Boards), 3292 (Asbestos Products), and 3293 (Gaskets, Packing, and Sealing Devices).

Development of Effect of Price Increases in Primary and Secondary Industries

The products manufactured and fabricated by the primary and secondary industries (excluding those going to the construction industry) are assumed to be absorbed by the Consumer Manufacturing Group. The basis for this analysis and the development of the effect of price increases on the consumer industry are the data contained in Table 6-1. The data are organized by Asbestos Product Group (SIC 2661, 3292 and 3293) and show estimates of asbestos-containing materials as a percentage of the sales of the Consumer Manufacturing Groups. Therefore, each Consumer Manufacturing Group would be affected by price increases of asbestos products anticipated as a result of implementing the proposed standard. These price increases are estimates for the consumer industries only and do not represent the cumulative effects of price increases by the Primary and Secondary Industries as a result of implementing BAT.

Table 6-1

Summary of Economic Impact
Consumer Industries

Consumer Manufacturing Group (Industrial Product Group)	SIC Code	Sales Of Manufacturing Group millions of $	Number of Establishments	Estimate of Asbestos-Containing Materials as a Percentage of the Sales of Consumer Manufacturing Group: Building Paper & Board Mills SIC 2661	Asbestos Products SIC 3292	Gaskets, Packing, and Sealing Devices SIC 3293	Total Employment 1,000's	Number of Employees Continuously Exposed	Industrial Hygiene and Medical Program Costs $/year
Meat Products	201	31,477.9	N.D.	.02			307.7	720	100,800
Fluid Milk	2026	1,634.5	2,507	.07	0.000613		188.7	1,500	210,000
Narrow Fabric Mills	2241	566.2	376		.79		27.1	5,710	799,400
House Furnishings N.E.C.	2392	1,517.9	1,111		.01		50.0	4,820	674,800
Fabricated Textile Products N.E.C.	2393-9	182.2	208		.16		7.9	760	106,400
Canned Fruits and Vegetables	2033	11,478.6	1,038	.01			233.1	2,480	347,200
Frozen Fruits and Vegetables	2037	3,762.6	644	.03			83.8	6,750	945,000
Flour and Cereal Preparations	2041-43+45	2,308.0	457	.09			16.1	4,120	576,800
Prepared Feeds for Animals and Fowls	2042	12,162.2	47	.02			111.4	7,840	1,097,600
Bakery Products	2050	2,358.2	N.D.	.05	0.0042		68.7	12,450	1,743,000
Sugar	2060	6,620.1	N.D.	.01			107.1	7,590	1,062,600
Alcoholic Beverages	2082-5	4,054.4	167	.03			51.5	920	128,800
Bottled and Canned Soft Drinks	2086	5,486.4	2,687	.01			121.8	1,470	205,800
Soybean Oil Mills	2092	1,061.6	518	.03			24.7	590	82,600
Food Preparations N.E.C.	2099	3,647.9	2,099	.02			66.2	870	121,800
Paper Board Mills	2631	4,153.5	273	.01			68.5	860	120,400
Wallpaper & Building Paper & Board Mills	2661-2644	456.2	92	.02			11.6	830	116,200
Converted Paper, Product N.E.C. (No Boxes)	2641-43-45-46-49)	8,452.4	426	.11			189.1	12,460	1,744,400
Sanitary Paper Products	2647	9,315.7	108	0.0032			343.8	1,680	235,200
Industrial Inorganic & Organic Chemicals	2821	97,960.0	323	0.001	0.00204		161.9	11,470	1,605,800
Cleaning Preparations	2840	977.6	N.D.		.0.00204		111.6	1,950	273,000
Miscellaneous Chemical Products	2861	4,268.4	139		.06	.01	83.1	32,490	4,548,600
Prefabricated Wood Structures	2443	6,703.3	N.D.	.01	.01	0.007[illegible]	190.7	47,920	6,708,800
Logging Camps and Logging Contractors	2411	23,816.0	13,238		0.0039		691.0	N.D.	N.D.
Wood Products N.E.C.	2499	2,529.5	N.D.	0.78		0.00083	80.0	9,580	1,341,200
Saw Mills and Planing Mills General	2421	7,230.6	8,071			0.0013	204.4	13,420	1,878,800
Mill Work	2431	6,703.3	2,434	0.0030			190.7	12,200	1,708,000
Recalmed Rubber & Misc. Rubber Products	3069-31	29.7	1,103		2.45	5.5	0.9	54,760	7,666,400
Miscellaneous Plastics Products	3079	10,695.9	7,698		0.090	0.025	346.9	48,270	6,757,800
Glass Containers	3221	3,393.8	117		0.023		118.8	8,410	1,177,400
Leather Tanning & Indust. Leather Products	3121-11	1,059.5	N.D.			.019	25.7	7,540	1,055,600
Glass and Glass Products (Not Containers)	3211	937.1	31			0.95	20.9	6,980	977,200

N.D. = No Data
N.E.C. = Not Elsewhere Classified

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Table 6-1
(Continued)

Consumer Manufacturing Group (Industrial Product Group)	SIC Code	Sales Manufacturing Group millions of $	Number of Establishments	Estimate of Asbestos-Containing Materials as a Percentage of the Sales of Consumer Manufacturing Group: Building Paper & Board Mills SIC 2661	Asbestos Products SIC 3292	Gaskets, Packing, and Sealing Devices SIC 3293	Total Employment 1,000's	Number of Employees Continuously Exposed	Industrial Hygiene and Medical Program Costs $/year
ment Hydraulic	3241	1,791.2	N.D.			0.33	30.0	9,810	1,373,400
rcelain Electrical Supplies	3264	834.8	N.D.			0.044	44.9	32,850	4,599,000
nferrous Wire Drawing and Insulating	3356	N.D.	N.D.		0.47	0.00787		114,580	16,041,200
pper Rolling and Drawing	3351	58,429.7	N.D.			0.318	1,142.8	7,580	1,061,200
luminum Rolling and Drawing	3352	2,446.2	N.D.			0.00955	50.8	10,020	1,402,800
per Industries Machinery	3554-51-52	12,867.6	218	.053			188.3	2,010	281,400
ating Equipment (Not Electric)	3433	2,136.8	432		0.49	0.0527	60.7	10,150	1,421,000
rm Machinery	3522	5,590.4	N.D.		0.055	0.827	125.3	43,210	6,049,400
dustrial Trucks and Tractors	3537	11,089.5	380		0.39		275.5	N.D.	N.D.
ecial Industry Machinery N.E.C.	3559	6,207.2	1,382		0.63	1.57	190.1	N.D.	N.D.
heet Metal Work	3444	14,179.6	3,116	1.3			394.8	1,402,160	196,302,400
tal Stampings	3461	9,956.9	N.D.			0.246	263.5	9,780	1,369,200
neral Industrial Machinery	3567	8,433.7	900			.1	262.0	11,240	1,573,600
chine Shop Products	3590	4,409.5	N.D.		1.0	.4	184.4	8,470	1,185,800
tor Vehicles and Parts	3711-14	63,921.4	2,347		0.604	.2	8,075.0	2,214,560	310,038,400
ipe, Valves and Pipe Fittings	3494-98	8,433.7	1,202			.63	262.0	84,300	11,802,000
bricated Metal Products N.E.C.	3499	7,784.8	2,342			.58	344.3	92,570	12,959,800
ternal Combustion Engines N.E.C.	3519	5,507.4	179			1.22	116.0	281,450	39,403,000
chine Tools, Metal Forming Types	3542	7,267.0	383			.29	268.1	8,650	1,211,000
rvice Industry Machines N.E.C.	3589	8,711.0	703			.2	197.9	15,870	2,221,800
ansformers	3612	3,585.4	216			.13	116.0	150,210	21,029,400
lectrical Industrial Appratus N.E.C.	3629	5,412.1	259			.2	188.3	154,780	21,669,200
lectric House Wares and Fans	3634	6,938.6	299			.3	162.8	118,790	16,630,600
ring Devices	3643-44	5,690.1	N.D.			.11	179.2	35,120	4,916,800
lectronic Components N.E.C.	3679	8,836.6	1,840			.01	335.6	87,490	12,248,600
gine Electrical Equipment	3694	4,297.3	290			.02	119.9	67,080	9,391,200
ailer Coaches	3791	2,268.9	N.D.	1.9			59.1	41,000	5,740,000
ansportation Equipment N.E.C.	3799	3,662.6	N.D.		.13		132.7	45,120	6,316,800
ip Building and Repairing	3731	4,329.2	455		.70	.2	185.2	323,010	45,221,400
rgical Appliances and Supplies	3842	2,824.5	N.D.		.33		90.8	21,890	3,064,600
r Craft Equipment N.E.C.	3729	15,451.4	N.D.		0.068	.3	438.7	43,000	6,030,000
nstruction Machinery	3531	11,089.5	748		.23	.275	305.3	93,000	13,020,000
N.E.C.		9,408.2	1,728				275.5	4,060	568,400
TOTALS		600,789	65,331				19,307.9(1)	5,873,320(1)	822,250,800

D. No Data
E.C. = Not Elsewhere Classified

) The employment shown may include employees from the primary and secondary industry groups

To derive the approximate percentage of a Consumer Manufacturing Group's sales that are related to asbestos or asbestos-containing materials, the following procedure was used. The sales to each Consumer Manufacturing Group by each of the three SIC groups of interest (2661, 3292, and 3293) were obtained by applying the Input/Output Table Coefficients (I/O) to data on the industry's shipments, taken from the 1972 Census of Manufactures. This procedure provides a rough estimate of the relationships between any two SIC groups (i.e., a Consumer Manufacturing Group and an asbestos-containing product group), assuming that the I/O coefficients are still an approximate relection of the economic transfers involved. (Since more recent data are not available, there is no factual alternative to this assumption.) In prior work, data had been derived as a percent allocation by four-digit SIC of labor/materials/ other costs for outputs for each Consumer Manufacturing Group. (This allocation was based on 1971 survey data previously collected.) The approximate effect of the asbestos cost increase was obtained by combining these two sets of data. Thus, a matrix of data was formed between a given Consumer Manufacturing Group and an asbestos-containing product group to show the relationship of the portion of sales (Consumer Manufacturing Group outputs) which reflect the value of asbestos-containing materials in consumer outputs. Absolute error in this procedure is obviously present, if for no other reason than the data used are at least five years old. However, this does not present an insurmountable problem since the orders of magnitude, if not the actual numbers, are probably correct.

This procedure was applied only to first order sales; further inter-industry transfers were not explored but would probable not alter the overall picture.

The data range from thousandths of a percent to 5.5 percent for reclaimed rubber and miscellaneous rubber production (Table 6-1).

Development of Estimated Plant Employment Data

From the data in Table 6-1, approximately 19,300,000 civilian employees in the United States are employed in the Consumer Manufacturing Group. To ascertain the employee exposure levels of asbestos for the consumer industries, it was not possible to use the data available or that developed from primary and secondary industries. (Number of employees and percent exposed were obtained from questionnaires sent by the primary industries.) In order to determine the estimated number of employees exposed to asbestos-containing material in the consumer industries, the following procedure was used. The asbestos content of raw material input to the Consumer Manufacturing Group was expressed as a ratio of the total raw material input. (This ratio was derived from the Input/Output Table of Coefficients and data developed from previous economic surveys.) This ratio was then multiplied by the total production labor force for the Consumer Manufacturing Group to approximate the consumer employment exposed to asbestos-containing materials. As a further refinement of this estimate, the employment for each Consumer Manufacturing Group was adjusted by two additional factors: a "productivity" factor (obtained from publications by the Department of Labor and Survey of Current Business from the Department of Commerce) and a "turnover" factor (to account for total yearly plant employment). The net effect of these steps was an estimate of the Consumer Manufacturing Group employment directly involved with handling asbestos-containing materials from each of the three major asbestos product classifications (SIC numbers 2261, 3292, and 3293). These estimates are presented in Table 6-1 as Number of Employees Continuously Exposed.

Most employees are exposed for only part of their workday; however, as a standard a production-line employee whose function involves the repeated placement or handling or an asbestos-containing product is assumed to be continuously exposed.

The total number of employees continuously exposed, therefore, is approximately 5,900,000 in the manufacturing group.

The total number of employees continuously exposed in the consumer industries (manufacturing, wholesale/retail trade and services) was estimated as a ratio of the 5,900,000 employees in the manufacturing group. These ratios were based upon the 1970 Census of Population (occupation by industry) of the civilian labor force working in the following industry groups:

Industry Group	Percentage of Total Employment
Manufacturing	25.9
Wholesale and Retail Trade	20.1
Services	7.7

The total number employed at the time of the census (April 70) in the labor force was approximately 76,600,000. This information is based upon responses to employment questions included in the 1970 census, the last complete inventory of population and economic data.

The previous total employees in the manufacturing group indicated 19,300,000 were employed (Table 6-1). Using the 25.9 percent of employees engaged in manufacturing, multiplied by 76,600,000 total employment, equals 19,800,000 employees included in the manufacturing group. Therefore, the total employment in the manufacturing group is in the range of 19-20 million. It was assumed that the number of employees continuously exposed in the wholesale and retail trade and services industry groups was at a minimum equal to the number in the manufacturing group (5,900,000). Therefore, the minimum total employment in the consumer industry becomes 11,800,000 employees.

Development of Estimated Number of Establishments

From the data in Table 6-1 the minimum number of establishments is 65,300. Several manufacturing group SIC Codes did not report data; therefore we assumed that 70,000 establishments are contained in the consumer manufacturing industries handling asbestos-containing products.

Additionally, the same rationale used for developing the total employees exposed was adopted to determine the number of establishments in the wholesale and retail trade and services groups. The total number of establishments in the consumer industries becomes 140,000.

Development of Partial Industrial Hygiene and Medical Program Costs

Weston assumed that it was very improbable that the ceiling or 8-hour TWA values will be exceeded for the consumer industries. However, some consumer industries may decide to monitor to insure that this is in fact the case. These monitoring costs will be a one-time (two consecutive sets of data) cost and therefore is not considered as part of annual industrial hygiene and medical program costs.

Table 6-2

Partial Industrial Hygiene and Medical Program Costs to the Consumer Industries

1. Monitoring	Not required
2. Respiratory Protection	Not required
3. Personal Protective Clothing	Not required
4. Hygiene Facilities and Practices	Not required
5. Medical Surveillance	$ 85
6. Employee Information and Training	25
7. Recordkeeping	30
Total per employee per year	$140

Note: Labor costs per hour were estimated at $5.00/hr direct + 20% overhead, or $6.00/hr.

For Items 1, 2, 3 and 4, it was assumed that the levels of asbestos available to be released to the work environment are very small. Therefore, since by definition the consumer industries do not change the form or process the asbestos containing material, these items are not required.

For medical surveillance, $85 is chosen, based on secondary industries information which is applicable to consumer industries.

Employee information and training is estimated at 4.0 hrs/year to provide medical information and training;

(40 hr/year) ($6.00/hr) = $25

For recordkeeping, $20 is assumed, based on information from the secondary industries which is applicable to consumer industries.

Recently (14 November 1975), the Occupational Safety and Health Review Commission handed down a decision on:

- Secretary of Labor, complainant vs. GAF Corp., Respondent. OSAHRC Docket Nos. 3203 and 4008.
- Secretary of Labor, complainant vs. United Engineers and Constructors Inc., Respondent. OSAHRC Docket No. 7355.

The issue involved in these cases was the interpretation of 1910.93a(j) (later renumbered 1910.1001(j), medical examination. Judge Robert D. Moran, Commissioner OSAHRC, in his dissenting opinion, states:

> "The rule of this case is that whenever employees are exposed to ANY trace of asbestos no matter how temporary or insignificant -- their employer must furnish (and employees must undergo) annual physical examinations and tests as prescribed Sec. 1910.93a)j). This will apply to a rather significant portion of the entire workforce of the United States -- from this day forth, the Commission decision requires annual physicals for millions of employees who, this decision concedes, are not exposed to any hazard whatsoever. The consequences of this upon the employees and the employers of America will be astonishing. Its impact on the medical profession -- and even the economy -- could be considerable. In my view, such a construction of the standard is uptopian and clearly unreasonable."

Resulting from Judge Moran's dissenting opinion, it appears that the entire work force would be required to have an annual medical examination. However, Weston assumed that the medical surveillance costs should apply only to those employees in the consumer industries who could reasonably be assumed to be in contact with or involved in handling products which have asbestos-containing materials.

Foreign Trade Impact

Assuming a widening gap between U.S. prices and those of the rest of the world, it can generally be assumed that increased foreign competition and further loss of business can be expected as prices for U.S.-produced asbestos materials increase.

The specific question is whether the cost impact associated with the implementation of BAT in the primary and secondary asbestos industries will be of sufficient magnitude, in and of itself, to cause any displacement in the current import/export balance or trends.

Market Overview

As published in Asbestos (12/75), the U.S. Bureau of Mines calculated that in 1974 asbestos consumption in the United States had dropped about 8 percent (816,964 tons consumed in 1974 versus 876,000 tons in 1973), but that consumption was still ahead of 1972 (809,000 tons) and would rise to about 2 million tons by the year 2000. This is equal to an average growth rate of about 4 percent -- approximately the anticipated GNP growth rate. Asbestos use will thus remain proportionately stable. From a different perspective, a separate source quoted by the magazine stated that the United States is now accounting for some 16 percent of the total world use/consumption. The current usage profiles of the U.S. and the rest of the world are shown in Table 6-3.

Table 6-3

Comparative Consumption Patterns[1]

Product Category	Percentage of U.S. Consumption	Percentage of World Consumption
Asbestos Cement Pipes/ Sheets/Siding/Shingles	21.8	69.0
Friction Materials	6.3	2.2
Asbestos Paper	37.7	7.4
Floor Tile	12.6	3.9
Paints/Roof Coatings/Cauks/ Sealants/Adhesives/Undercoatings	7.4	1.6
Asbestos Textiles	1.4	.7
Asbestos-Reinforced Plastics	2.0	.5
Joint Cements	1.5	.3
Gaskets and Packings	3.3	1.0
Miscellaneous	6.0	13.4
	100.0	100.0

(1) Source: Asbestos Magazine (1/76) and the U.S. Department of Commerce

Table 6-3 illustrates the markedly different demand/consumption patterns that emerge when the U.S. is compared with the rest of the world. It is this pattern, or changes in this pattern, that form the basis for an analysis of possible production shifts that could result from the application of asbestos standards in the domestic market.

The United States is generally not an export nation in that its industries seldom set out to produce products domestically for the export market, nor does the U.S. economy tend to encourage industries whose sole orientation is an export market. The more typical case is that an industry, already enjoying a strong domestic market, will expand its production of one or more products, to meet market opportunities abroad. Depending on the size and configuration of the industry and the technology required, the actual production site could be either in the continental United States or in or near the foreign market area. The asbestos industry seems to follow this general pattern.

Method of Analysis

Evidence of the potential impact of cost increases resulting from the implementation of regulations on the primary and secondary production sectors of the asbestos industry can be shown through a consideration of the importance of price as an absolute factor in foreign trade in asbestos. Two general relationships are of particular importance: the changes in the raw asbestos export market and the relationships of price and quantity in the U.S. imports of manufactured asbestos products.

The first of these relationships is illustrated by the export data presented in Table 6-4.

Table 6-4

U.S. Exports of Unmanufactured Asbestos[1]

Year	Short Tons	Est. Value	Average Price Per Short Ton
9/74 - 8/75	33,785	$9,308,660	$275.53
9/73 - 8/74	71,784	9,752,917	135.86
9/72 - 8/73	54,992	7,923,575	144.09
9/71 - 8/72	56,216	8,084,003	143.80

(1) Source: U.S. Department of Commerce and Asbestos Magazine.

Although these data are not unambiguous, there is evidence of a rough but expected trend that relates rising cost per short ton with declining export volume. In this case, a price/value increase of about 92 percent per short ton is matched with a volume decline of about 39 percent. Even so, caution is in order since several factors affect any such clear-cut exposition, and, by implication, affect any straightforward assessment of the impact of the cost increases attributable to the implementation of regulations.

The first of these is the evident volatility of raw asbestos prices, as illustrated in Table 6-5, which presents the recent price trends for Vermont production. Raw-material price fluctuations of the magnitudes evident here, if at all typical of the market, make the estimation of the impact of the smaller perturbations on the import/export balance (such as those that might result from BAT implementation in the primary and secondary asbestos industries) quite uncertain in a quantitative framework, but not impossible in more general terms.

Table 6-5

Vermont Production Prices[(1)]

Product Type	Date of Quotation May 1, 1974	June 16, 1975	Jan. 1, 1976
Grades 3T & 3Z Fiber	$158-490		
Grades 4A through 4T Fiber	$250-424	$360-608	
Grade 4T Fiber			$418
Grades 5D through 5R Fiber	$180-212	$238-280	$275-324
Grade 6D Waste	$131	$173	$200
Grades 7D through 7T - Shorts	$ 57-114	$ 77-150	$ 83-160
Grade 7TF - Floats (Shorts)	$ 50	$ 66	$ 72
Grade 8S - Shorts	$ 53	$ 53	$ 54
Hooker No. 1	$524	$850	$970
Hooker No. 2	$262	$425	$485

(1) Source: Asbestos Magazine.

The second factor in the case of the example of the raw asbestos exports/price relationship is in the evident non-linearity of the trend. A consideration of the second general relationship (i.e., price/quality in the importing of manufactured asbestos products) provides a better perspective. In this case, a general analysis (see Table 6-6 for the results of the regression analysis) confirms the importance of price as a central factor in import volume, and therefore in the penetration of the domestic market by foreign producers. In addition, the extremely high R^2's, which indicate a strong association between price and volume, remove the confusion caused by the non-linearity of the raw asbestos price/volume trend, while also implying that the volatility of the raw asbestos prices is somehow stabilized in the manufacturing sector so that its influence is less erratic.

Table 6-6

Analysis of Import Price/Volume Data[(1)]

Product Class	Results of Regression Analysis
Asbestos Yarn/Textiles	\$ = 0.81746155(Net.Q) - 4996.218632 R^2 = .873
Asbestos Pipes and Tubes	\$ = -3.96522563(Net.Q) + 107723827.6 R^2 = .008
Asbestos and Hydraulic Cement Articles, N.E.C.	\$ = 0.10020622(Net.Q) + 34771.4513 R^2 = .638

(1) Source: U.S. Department of Commerce

Q = Net Quantity of Product Class
R^2 = Regression Coefficient

Although imports have never constituted a large share of the domestic market for manufactured asbestos products (see Table 6-7), their value relative to domestic production has been increasing at a slow but steady rate, while their value considered by itself has shown dramatic growth (see Table 6-8). However, this latter trend reflects the world economic picture more than anything peculiar to the asbestos product market. For example, radical changes in product value (Table 6-8) have resulted in only a 4 percent increase in the physical quantity of products imported (Table 6-9, column 5).

Table 6-7

Value of Imports as a Function of Domestic Production

Time Period	Value Ratio
1965	13.39×10^{-3}
1966	11.67×10^{-3}
1967	11.30×10^{-3}
1968	12.55×10^{-3}
1969	13.35×10^{-3}
1970	18.28×10^{-3}
1971	17.23×10^{-3}
1972	15.14×10^{-3}

Table 6-8

Changes in Value of Imports: 1971 - 1975

Time Period	Total Value of Imports	Percent Change
9/74-8/75	$24,227,826	+32
9/73-8/74	$18,354,414	+35
9/72-8/73	$13,611,138	+35
9/71-8/72	$10,094,928	---

Table 6-9

U.S. Imports of Manufactured Asbestos Products (in tons)

Product Type	Term				
	9/74-8/75	9/73-8/74	9/72-8/73	9/71-8/72	Change in %
Yarn/Cloth/Tape	4,173	4,114	2,833	1,411	+196
Asbestos Cement Pipes Tubes and Fittings	8,063	6,622	10,844	22,180	- 64%
Other Asbestos-Containing Products	21,713	24,416	13,130	8,898	+144%
Total	33,949	35,152	26,807	32,639	+ 4%

Nonetheless, these changes in gross values mask quite specular changes in the import product mix (Table 6-9). These changes, when viewed in conjunction with the changes in our exports of manufactured asbestos products (Table 6-10), show a definite, if as yet minor, weaking in our import position. The product group that is obviously being affected most radically is the asbestos yarn/textile sector.

The number of countries that are competing in this market segment has risen from five to 18. The other product sectors show a much less decisive and clear cut change, although reflecting the data in Table 6-9, the imports in asbestos cement pipe/tube sector have shrunk significantly.

Conclusions

As a result of these analyses, the following conclusions can be drawn:

- Since it is highly improbable that asbestos fibers will be released in the consumer industries--
  - All consumer industries are assumed to be meeting the proposed standards for TWA and ceiling exposures.
  - BAT is not applicable
  - The only costs are for the industrial hygiene and medical program
- Implementation of the proposed standard is estimated to be $1,652,000,000 annually (Table 6-11), or $140 per employee per year exposed or handling asbestos-containing products.
- The direct effects of the primary/secondary asbestos industry's price increases will be negligible in almost all particular industrial product groups. The only exception might be SIC 3069 (reclaimed rubber & misc. rubber products), which has a 5.5 percent sales/price ratio. Asbestos and manufactured asbestos products, while widespread throughout the economy, constitute a very minor part of most products' prices. Indeed, in many cases this diffusion could cause the price increases to be absorbed by various industrial producer groups.

Table 6-10

U.S. Export of Manufactured Asbestos Products

Product	9/74-8/75	9/73-8/74	9/72-8/73	9/71-8/72	% Change
Asbestos-Cement Products (tons)	36,768 (tons)	35,980	23,173	20,243	+82%
Gaskets/ Packing (tons)	3,027	3,308	2,859	2,321	+30%
Textiles/ Yarn (tons)	6,173	9,013	10,331	8,098	-24%
Clutch facings/ linings, (units)	1,947,989	2,426,821	2,459,818	2,843,583	-31%
Brake linings (tons)	5,197	6,026	5,171	4,965	5%
Value	$62,478,339	$52,947,745	$38,330,269	$31,239,170	
Yearly Change in Value of Exports	+18%	+38%	+23%	----	

(1) Base Year 1971-1972, Compared to 1974-1975.

Table 6-11

Summary of Economic Impact —
Consumer Industries

Industry Group	No. of Exposed Employees	Total Number of Establishments	Total Industrial Hygiene and Medical Program Cc
Manufacturing	5,900,000	70,000	$826,000,000
Wholesale and Retail Trade + Services	5,900,000	70,000	826,000,000
TOTAL	11,800,000	140,000	$1,652,000,000

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- The greatest impact on the consumer industries will result from the industrial hygiene and medical programs that would be required for employees if the standards are strictly adhered to. While the cost per employee per year is generally low ($140), the number of employees handling asbestos-containing materials is quite high in many cases (11,800,000).

- The estimates' employment for the consumer industries is 11,800,000 employees, which includes over 140,000 establishments in the U.S.

- The product cost increase that will probably result from the implementation of the proposed standards will tend to have several specific but no general effects on our import/export balance.

  - Barring major productivity increases, the textile/yarn product sector can be expected to decline even more rapidly than at present.

  - The estimated cost increase could possibly have an adverse impact on our exports in the brake lining/clutch facing/friction materials products group. Imports would probably not be stimulated.

- Given the consumption patterns shown in Table 6-3, the U.S. will continue to be a net exporter of manufactured asbestos products, and until world consumption more closely mirrors that of the U.S., foreign production capacity (i.e., capacity other than that of U.S. multnational corporations) will not be sufficiently well-developed to present a threat to U.S. producers in most product groups.

- To the extent that foreign competition is concentrated in specific countries, Canada, Mexico, Belgium and the United Kingdom are the major competitors; of these, only one, Canada, unites a significant supply of raw asbestos (Table 6-12) with a mature production capacity.

Table 6-12

Summary of World Asbestos Production: 1975[1]

Country	Production in Short Tons
USSR	2,500,000
Canada	1,200,000
South Africa	374,000
Rhodesia	264,000
Italy	165,000
China	130,000
West Germany	110,000
U.S.	99,000
Brazil	77,000
Australia	49,500
Switzerland	44,000
Cyprus	27,500
Japan	22,000
Yugoslavia	11,000
India	11,000
Misc.	11,000
	5,095,000

(1)Source: U.S. Department of the Interior and U.S. State Department.

APPENDIX A