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Technological Feasibility and Economic Impact of OSHA Proposed Revision to the Asbestos Standard

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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.

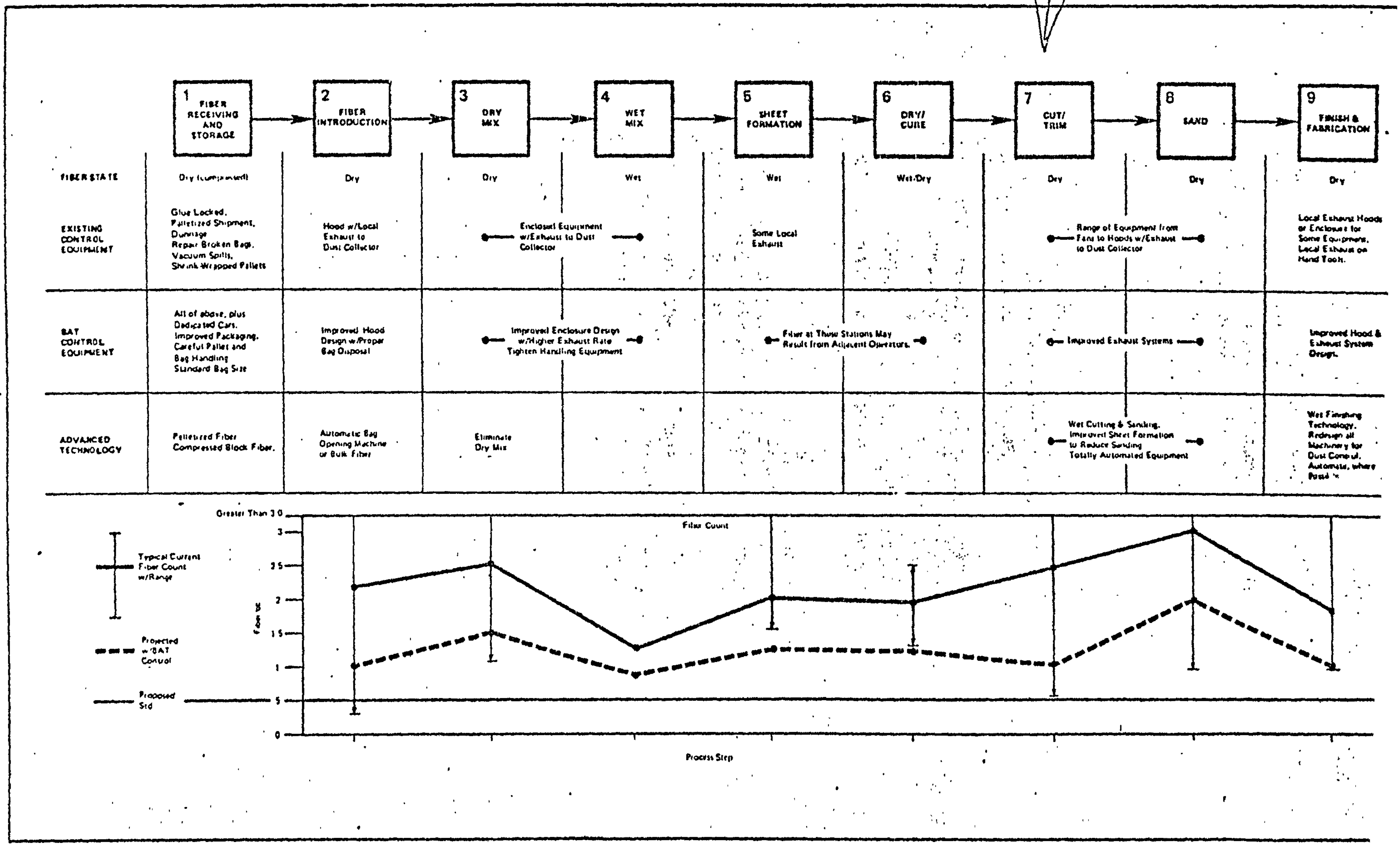

FIGURE 4-6 DIAGRAM OF PROCESS FLOW AND FIBER COUNT
— ASBESTOS CEMENT SHEET

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		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	2.3	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.