section of the wet machine where it is continuously wrapped around a long steel cylinder until the proper size of pipe is formed. This continuous wrapping process is carried out under high pressure which forces each new lamination to bind with the previously wrapped layer.

After the wrapping process is complete, the formed pipe is removed from the press section of the wet machine and processed through primary curing ovens to allow the cement to attain an initial set. Later, the semi-hardened pipe is placed in an autoclave where it is subjected to a high-pressure steam environment which forces the cement and silica in the pipe to undergo an accelerated cure. At this stage of the process, the asbestos fibers in the pipe become bound in a cement mixture [Exhibit 91-16, Section H].

After autoclaving, cured pipe sections are cut to uniform lengths, machined in a variety of ways (sawing, lathing, drilling), and outfitted with a coupling. The finished pipe is inspected and each section of pipe to be used for conveying water under pressure is tested hydrostatically.

A/C pipe coupling is also produced in these plants. The coupling is manufactured and then cut into smaller sections for use in pipe connection. The repetitious cutting of the coupling lengths causes high asbestos exposures. For this cutoff operation and other finishing processes like lathing and drilling, the use of custom-engineered hoods, local exhaust systems, wet sawing, and special single-point cutting tools has reduced exposure levels. Exhaust air is filtered into baghouses and the collected dust is typically removed in closed containers for recycling or disposal.

As a good housekeeping practice, measures are taken during the pipe formation process to clean up spills of slurry that could dry and become a source of emissions. These housekeeping practices include the use of wet vacuum machines and squeegees instead of brooms for cleaning floors.

The exposure data for A/C pipe used in OSHA's feasibility determination are summarized in Table 13. The average exposures at all of the processes are less than 0.15 f/cc. Among the highest exposures are those for dry mechanical operations; however, these also average less than 0.15 f/cc. Other data submitted show that some dry material operations may have difficulty achieving the new PEL some of the time. For example, the data presented by Dr. Bragg show that exposures at coupling cutoff operations in an A/C pipe plant are the highest, averaging 0.369 f/cc [Exhibit 312-A, Section H, Table II]. The high exposures during the coupling cutoff operation are also consistent with data submitted by the International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers and Helpers (AFL-CIO). These data show that out of 82 exposure readings taken at a CertainTeed Corporation plant, only 2 (both for coupling cutoff operations) exceeded 0.2 f/cc [Exhibit 225]. OSHA believes, however, that most dry mechanical operations can achieve the new PEL.

TABLE 13.—EXPOSURES FOR A/C PIPE MANUFACTURERS

Job classification/process	Mean 8-hr TWA exposure (f/cc)	Standard deviation	No. of observations	Source of data
Fiber introduction	0.136	0.089	83	OSHA MIS [1]
Wet mechanical	.097	.094	87	Do.[1]
Dry mechanical	.134	.145	124	Do.[1]
Other operations	.077	.100	240	Do.[1]

[1] Unpublished compliance data from the Management Information System data base for 1979-1984.

Source: U.S. Department of Labor, OSHA, Office of Regulatory Analysis.

Based on these data, OSHA concludes that the 0.2 f/cc PEL is feasible for all operations at A/C pipe plants using current technology except for coupling cutoff where respirators will have to be used to supplement engineering controls. OSHA, therefore, considers is feasible for the other operations, particularly mixing and conveying of materials within the plant, to reach exposures below 0.2 f/cc.

A/C Sheet

The manufacturing process of A/C sheet is similar in many aspects to that of A/C pipe. Unlike A/C pipe manufacturing, however, OSHA was unable to find data to indicate that exposures at even the "best controlled" A/C sheet plants are below 0.2 f/cc. The mean exposures at most stations, for which OSHA has data, are approximately 0.5 f/cc. Based on the analysis by Dr. Bragg, however, OSHA believes that A/C sheet manufacturers are not using the best available techniques to control asbestos dust.

> The data indicate that fiber is less well-controlled in the sheet manufacturing environment than the cement pipe operation. For example, we would expect that it is possible to control exposures at the fiber introduction stage to values similar to those found in asbestos cement pipe. As a result, the data . . . does not represent the best available technology in our opinion and the improved use of local exhaust ventilation, wet processing and good housekeeping should be capable of reducing exposure levels to values typical of the A/C pipe industry. However, the sanding operation is unique to sheet and there may be a serious control problem for this operation at a PEL of 0.5 "f/c.c." or lower. [Exhibit 235-A, pp. 65-69.]

In addition, the AFL-CIO attributed the higher exposure levels in the asbestos-sheet industry to the failure of this industry to use available controls to reduce exposures [Exhibit 335, p. 39]. Thus, OSHA has determined that by using the same control technology that is currently being used in the A/C pipe sector, it will be feasible for the A/C sheet sector to comply with a 0.2 f/cc PEL. However, in sanding, which is unique to A/C sheet, achieving the new PEL will require the use of respirators.

As previously described, OSHA has determined that fiber introduction for all primary manufacturing processes, including A/C sheet, can be performed with exposures below the PEL of 0.2 f/cc. The dry and wet mixing stages of A/C sheet production are virtually the same as the mixing steps of A/C pipe production. With the use of conveying systems kept under negative pressure, local exhaust systems, and fully enclosed exhaust mixers, it is possible for exposures to be kept under 0.2 f/cc during this phase of production.

The advanced processing steps of A/C sheet manufacture are also similar to those of A/C pipe. Following wet mixing, the slurry flows into vats and is deposited on rotating cylinder molds where the appropriate thickness is formed. The sheet is passed under embossing rolls or hydraulic presses and is then removed from the press for curing by heated air or steam-heated autoclaves. After curing, the A/C sheet undergoes a variety of finishing operations. The highest and most difficult exposures to control occur during these mechanical finishing operations, which is also true for A/C pipe manufacturing. It is possible to reduce worker exposures to below 0.2 f/cc in finishing operations with the use of local exhaust ventilation and tools equipped with exhaust systems or wet spray devices. OSHA, however, has found no evidence indicating it is feasible to lower exposure levels to below 0.2 f/cc during the sanding of A/C sheet without the use of respirators.