



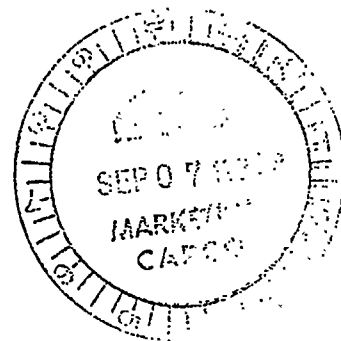
A/C Pipe
Producers Association

1600 Wilson Boulevard
Suite 1008
Arlington, Virginia 22209
(703) 841-1556

August 25, 1982

Mr. Lee Taylor
CAPCO Pipe Company, Inc.
1400 South 20th Street
P.O. Box 3435
Birmingham, AL 35205

S. J. Phibbs
Lee Taylor
Lee Taylor



Dear Lee:

As requested at the last Executive Committee Meeting, enclosed are the position papers on the control of worker exposures to asbestos fibers during A/C pipe manufacturing and installation. If you have any questions, please do not hesitate to call.

Very truly yours,

A/C PIPE PRODUCERS ASSOCIATION

J. F. Welch

J.F. Welch
Vice President

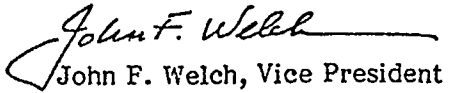
JFW/ccw

Enclosures

0172082506
Chrono

CAPCO JEN 0011938

Executive Committee


John F. Welch, Vice President

July 9, 1982

Kirkland & Ellis Information Request

REF: JFW correspondence, same title, April 21, 1982

ACTION REQUIRED: Review for completion by July 22, 1982

This is a reminder that the position papers, "The Control of Worker Exposure to Airborne Asbestos Fibers in the Asbestos Cement Manufacturing Industry" and "The Control of Worker Exposure to Airborne Asbestos Fibers in the Installation of Asbestos-Cement Pipe" were to have been reviewed and returned to AACPP no later than June 4, 1982. With the very real prospect of a Notice of Proposed Rulemaking on the OSHA asbestos standard scheduled for this Fall, Kirkland & Ellis would appreciate receiving the position papers by the July 22, 1982 Executive Committee meeting.

If you have any questions, please do not hesitate to call.

JFW/ajb

Enclosure

cc: A. Kahn, Esq.

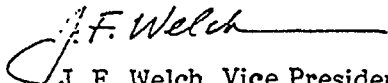
copies to: Executive Committee

L. Ambler
J. Cran
L. Taylor

H03EI20605
Chrono

CAPCO JEN 0011939

Executive Committee


J. F. Welch, Vice President

April 21, 1982

Kirkland & Ellis Information Request

REF: (1) Executive Committee meeting minutes, January 20-21, 1982
(2) Public Affairs Committee minutes, (Regulatory Affairs Program), October 13, 1981

ACTION REQUIRED: Review for comment by June 4, 1982

Background

On December 17, 1979, the Environmental Protection Agency (EPA) issued an Advanced Notice of Proposed Rulemaking (ANPRM) on Commercial and Industrial Uses of Asbestos Fibers. Kirkland & Ellis was retained as special regulatory counsel to AIA/NA and assumed responsibility for preparing industry's affirmative case for the rulemaking.

On April 17, 1980, AACPP Board of Directors passed a motion that AACPP should act as an independent industry subcommittee and prime coordinator for the collection of all information necessary to complete the product sector profile for A/C pipe. Since that time, AACPP has been operating in this capacity under the "umbrella" of AIA/NA and Kirkland & Ellis.

After the election of Ronald Reagan, the preparation of an affirmative case for the industry took a different approach. Taking advantage of a more favorable political climate, the industry engaged in "regulatory negotiations" with EPA to reach a cooperative agreement on the regulation of asbestos and asbestos-containing products.

Current Status

An important part of any negotiated settlement with EPA depends on industry's showing that substantial progress has been made in controlling worker exposures in A/C pipe manufacturing and installation. The enclosed drafts, prepared by Kirkland & Ellis and edited by AACPP Staff, address these two issues. Both rely heavily on the Research Triangle Institute report to the Occupational Safety and Health Administration (OSHA) because that document seems to enjoy the highest relative credibility by EPA and OSHA.

The position paper entitled "The Control of Worker Exposure to Airborne Asbestos Fibers in the Asbestos Cement Manufacturing Industry" should be transmitted to appropriate industrial hygiene/manufacturing personnel for review and comment. Note that considerable information is needed for discussion of industry's position on the feasibility of proposals for more stringent exposure controls during fiber introduction, mixing and conveying, and pipe formation, curing and finishing.

The position paper entitled "The Control of Worker Exposure to Airborne Asbestos Fibers in the Installation of Asbestos Cement Pipe" should be transmitted to appropriate field engineering or marketing personnel with firsthand knowledge on potential asbestos exposures during A/C pipe installation. Note that input is needed on Member Company positions on the feasibility of engineering controls and work practices requirements during A/C pipe installation.

Comments on both position papers should be submitted to AACPP no later than June 4, 1982. If there are any questions about these documents, please do not hesitate to call.

JFW/ajb

Enclosures

cc: A. Kahn, Esq.
B. J. Pigg
T. S. Hardy (K&E)

copies to: Executive Committee

L. Ambler
J. Cran
L. Taylor

H03EI21903
Chrono

THE CONTROL OF WORKER EXPOSURE
TO AIRBORNE ASBESTOS FIBERS IN THE
ASBESTOS CEMENT PIPE MANUFACTURING INDUSTRY

The asbestos cement pipe manufacturing industry produces annually approximately \$200 million worth of pipe for sewer service and water supply systems in the United States.^{1/} At the present time, eight plants manufacture asbestos cement pipe, and these plants employ (____) workers. This industry consumes approximately 40% of the asbestos used in the United States.^{2/} This paper discusses the levels of worker exposure to asbestos fibers in the asbestos cement pipe manufacturing industry and the feasibility of improved control technologies.

I. ASBESTOS CEMENT PIPE PRODUCTION
AND ASSOCIATED EXPOSURE LEVELS

The production of asbestos cement pipe can be broken down into five discrete stages: (i) asbestos fiber receipt and storage, (ii) fiber introduction, (iii) conveying and mixing, (iv) pipe formation and curing, and (v) pipe and coupling finishing. Each stage has different levels of

^{1/} Unpublished data, Association of Asbestos Cement Pipe Producers (1981).

^{2/} United States Dep't of the Interior, Asbestos 3 (1980).

exposure and requires different control technology. This paper discusses these stages sequentially.

A. Fiber Receipt and Storage

The initial step in the production of asbestos cement pipe is the receipt of asbestos as a raw material packed in bags. Until the mid-1950's, asbestos was packed loosely and shipped in bags made of paper or jute. Since the fiber was air-conveyed, the bags were aerated during filling and tended to leak dust whenever they were handled.

In 1954, asbestos suppliers began to use hydraulic pressure in place of compressed air to fill the bags with asbestos. These "pressure-packed" bags are much cleaner when shipped, stored and opened.

Even these bags, however, may release asbestos fibers if broken during shipment and handling. To reduce exposure from this form of leakage, bags now are shipped on specially wrapped wooden pallets that reduce the likelihood of breakage when the bags are moved by forklift.^{3/} Asbestos suppliers also increasingly use shrinking film-wrapped or stretch-wrapped pallets and double-sealed bags to reduce further the

^{3/} Research Triangle Institute, Asbestos Dust: Technological Feasibility Assessment and Economic Impact Analysis of the Proposed Federal Occupational Standard IV-11 (September 1978) [hereinafter cited as "RTI Report"].

risk of breakage.^{4/} In addition, when bag damage does occur, the bags are taped, and spills are vacuumed promptly.^{5/}

The major supplier of crocidolite also has introduced fiber processing developments to improve dust control in asbestos cement pipe plants. The inherent physical characteristics of crocidolite make it more difficult to package and handle. Generally speaking, it is considered a "dustier" fiber than chrysotile. In 1979, some crocidolite suppliers began to wash the crocidolite-bearing ore to reduce fine dust and micro-fiber content. All ore is subjected to high pressure waterjets as it is sized prior to milling. The effect of water washing is a finished crocidolite with an (x) percent reduction in the micro-fiber content. This translates directly to reduced exposure levels during fiber introduction. [Insert data, if available, on reduction of crocidolite exposures in plants.]

These packaging and dust control measures have resulted in a steady decline in exposure levels during fiber receipt and storage. Various studies have estimated asbestos fiber concentrations at this process stage. The results, expressed as an eight-hour time-weighted averages (TWA) are reported as follows:

^{4/} Id. at IV-12.

^{5/} Id.

	<u>Range (fibers/cc)</u>	<u>TWA (fibers/cc)</u>
Weston (1976) ^{6/}	0.25 - 2.5	1.0
RTI (1978) ^{7/}	0.1 - 2.5	---
AIA Survey (1980) ^{8/}	<0.1 - 0.23	0.1

B. Fiber Introduction

Asbestos fiber is introduced into the production process in two steps. First, the bags of raw asbestos must be opened and dumped onto an enclosed conveyor belt. Second, the fiber must be "fluffed" to transform it into a relatively uncompacted state suitable for the manufacturing process.

Bag opening and dumping may be performed manually or with automated, completely enclosed equipment. The manual process involves moving bags of asbestos from a pallet to a hooded dump station where the bags are opened and emptied. The station is equipped with a receptacle (usually a heavy plastic bag) to dispose of empty asbestos bags.^{9/} Both the

^{6/} Weston Environmental Consultants-Designers, Technological Feasibility and Economic Impact of OSHA Proposed Revision to the Asbestos Standard 4-23 (March 29, 1976). [hereinafter cited as "Weston Report"].

^{7/} RTI Report at IV-13.

^{8/} The results of this survey of all nine currently operating asbestos cement pipe plants are not yet published. It also should be noted that due to limitations in the accuracy of monitoring equipment at these low levels, these measurements should not be considered precise.

^{9/} RTI Report at IV-14.

dump station and bag receptacle are kept under negative pressure to prevent air outflow and control worker exposure to asbestos fibers.^{10/}

The automatic asbestos bag opener is a completely automated and environmentally isolated asbestos processing system. The opener automatically opens, dumps, compacts and fluffs all asbestos materials. The automatic bag opener also compacts the empty bag and places it in a sealed container for subsequent disposal. This type of equipment is used in (_____) A/C pipe plants.

Two studies have reported worker exposures from fiber introduction:

	<u>Range (Fibers/cc)</u>
Weston (1976) ^{11/}	0.5 - 3.5
RTI (1978) ^{12/}	0.1 - 4.8

C. Conveying and Mixing

After fiber introduction, the asbestos is conveyed to a dry mixing step. Here the various fiber types are agitated and blended into a homogenous fiber mix. The fiber mix is conveyed to a milling step where the Portland cement and silica flour are then added at a mixing station. The blend

^{10/} Id. at IV-14 to IV-15.

^{11/} Weston Report at 4-23.

^{12/} RTI Report at C1-2.

is then conveyed pneumatically to the next production stage (wet mix) in which water is added to form the asbestos-cement-mortar-silica slurry.

In the past, conveying fiber or fiber-containing mixes was an extremely dusty operation. More recently, however, the use of closed pneumatic conveying systems kept under constant negative pressure has minimized leakage. For example, negative pressure is maintained inside the dry mixer by connection with a local-exhaust dust-control system.^{13/} The mixer is generally a totally enclosed unit, and regular maintenance is conducted to restrict leaks from seals or loose-fitting equipment.^{14/}

As the dry blend is wet mixed, local exhaust is employed to prevent worker exposure.^{15/} Once the mixture becomes wet, little asbestos fiber becomes airborne.^{16/}

Steps to control airborne concentrations of asbestos fibers from mixing operations have dramatically reduced exposure levels. Concentrations due to mixing have been measured as follows:

^{13/} RTI Report at IV-17 to IV-18.

^{14/} Weston Report at C-21.

^{15/} Id.

^{16/} RTI Report at IV-18.

	<u>Range (fibers/cc)</u>	<u>TWA (fibers/cc)</u>
NIOSH (1967) ^{17/}	---	6.2
NIOSH (1971) ^{18/}	0.2 - 7.0	2.3
Weston (1976) ^{19/}	0.8 - 3.0	1.2 or 1.8
RTI (1978) ^{20/}	0.4 - 3.0	---
AIA Survey (1980)	<0.1 - 1.62	0.32

D. Pipe Formation and Curing

After wet-mixing is complete, the slurry is conveyed to the pipe-forming machine. Here, it is first filtered through rotating screens to form a cement-fiber ply. Then, it is picked up by a continuous felt, vacuum dewatered and wrapped, under pressure, on a rotating mandrel until the desired wall thickness is reached. The newly formed pipe is electrolytically stripped from the mandrel, "pre-cured" under controlled temperature and humidity and "final cured" in an autoclave using saturated steam.

Throughout pipe forming and curing stages, the asbestos is in aqueous solution, wet or cement ply or hardening into pipe, and generally special equipment to control fiber

^{17/} National Institute for Occupational Health and Safety, Occupational Exposure to Asbestos Table XV (1972) [hereinafter cited as "NIOSH Report"].

^{18/} Id. at Table I, Table XV.

^{19/} Weston Report at 4-23.

^{20/} RTI Report at C1-2.

release is not required.^{21/} Good housekeeping measures are conducted to clean up slurry splashes, bits of ply or fragments of pipe that could dry and become a source of fiber emissions.

Good housekeeping practices during pipe formation and curing have progressively reduced concentrations of asbestos fibers. Exposures at this stage (measured in TWA f/cc) have been estimated as follows:

	<u>Range (fibers/cc)</u>	<u>TWA (fibers/cc)</u>
NIOSH (1967) ^{22/}	---	1.8
NIOSH (1971) ^{23/}	<0.1 - 3.7	1.1
Weston (1976) ^{24/}	0.5 - 1.1	0.75
RTI (1978) ^{25/}	0.1 - 1.4	---
AIA Survey (1980)	<0.1 - 2.5	0.32

E. Pipe Finishing

In the finishing process, the pipe is cut into uniform lengths. The pipe ends are machined on a lathe to ensure a

^{21/} Id. at IV-18.

^{22/} Id. at Table XV. The NIOSH averages cited here are weighted means of the averages reported for pipe formation and pipe curing.

^{23/} Id. at Table I, Table XV.

^{24/} Weston Report at 4-23.

^{25/} RTI Report at C1-2.

tightly fitting joint, and the finished pipe tested. In addition, pipe couplings and other special lengths or fittings (tees, elbows, reducers, etc.) are produced. Defective sections and scrap are crushed and recycled.

To capture and control fiber emissions during pipe finishing, the industry uses local exhaust systems and partial hooding near the working point of the tool. In addition, single-point cutting and chipping tools are used in place of diamond or carborundum abrasion wheels, thereby substantially reducing fiber levels. When practicable, wet sawing is used to reduce fiber emissions of certain finishing stations. Local exhaust systems also are used in the vicinity of the rework saw and scrap crusher.^{26/}

Reductions in exposure levels in pipe finishing operations have been reported over the years:

	<u>TWA (fibers/cc)</u>
NIOSH (1967) ^{27/}	5.0 (pipe finishing) 12.8 (coupling finishing)
NIOSH (1971) ^{28/}	1.7 (pipe finishing) 5.3 (coupling finishing)
Weston (1976) ^{29/}	2.0 (pipe finishing)

^{26/} Weston at 2-24.

^{27/} NIOSH Report at Table XV.

^{28/} Id.

^{29/} Id. at 4-23.

RTI (1978)^{30/}

0.1 to 1.9 (sawing)
 0.1 to 0.7 (lathes)
 0.2 to 2.3 (coupling cutoff)
 1.5 to 2.1 (fitting and special-
 ties)
 0.1 to 0.5 (drilling)
 2.0 to 2.9 (rework saw and
 crushing)

AIA Survey (1980)

0.1 to 1.41 (average of 0.22)

II. OVERALL EXPOSURE LEVELS IN THE PRODUCTION OF ASBESTOS CEMENT PIPE

Due to the installation of increasingly effective dust control measures, asbestos concentrations throughout the industry have declined steadily. Data from the Johns-Manville asbestos cement pipe plants in Long Beach and Stockton illustrate the dramatic reduction that has taken place over the last decade.^{31/}

<u>Measurements</u>	<u>1969-79</u>	<u>1978-79</u>
less than .5 f/cc TWA	3%	72%
.5 to 1.0 f/cc TWA	14%	21%
1.0 to 2.0 f/cc TWA	33%	6%
more than 2.0 f/cc TWA	52%	<1%

^{30/} RTI Report at C1-2.

^{31/} See Johns-Manville Canada, Submission to the Royal Commission on Matters of Health and Safety Arising from the Asbestos in Ontario (January 14, 1981).

A similar study by CertainTeed Corporation found that current exposure levels were one to two orders of magnitude lower than 1961 concentrations.^{32/}

The 1980 AIA survey of nine asbestos cement pipe facilities also confirms the progress made in reducing worker asbestos exposures. The study found that of the 917 workers exposed to asbestos fibers in asbestos cement pipe plants, 881 (96.1%) were exposed only to concentrations of 0.5 f/cc TWA and below. Only 11 workers (1.2%) were exposed to concentrations in excess of 1.0 f/cc TWA.

This study also considered the worker-hours of exposure at various concentrations. Broken down by concentration level, the relative worker-hours of exposure were as follows:

less than 0.1 f/cc TWA.....	40.1%	(635,804)
0.1 to 0.5 f/cc TWA.....	55.1%	(873,385)
0.5 to 1.0 f/cc TWA.....	3.2%	(50,000)
1.0 to 2.0 f/cc TWA.....	1.4%	(22,600)
more than 2.0 f/cc TWA.....	0.3%	(4,000)

III. POTENTIAL ADDITIONAL CONTROL TECHNOLOGIES

Despite the great progress that has been made in reducing asbestos exposures in asbestos cement pipe manufacture and the generally very low levels now achieved, suggestions have been advanced for further improvements. These suggestions

^{32/} See CertainTeed Corporation Answers to Questions of John Dekany (EPA) Concerning Asbestos Rulemaking 2 (July 8, 1980).

will be discussed on a production stage by production stage basis.

A. Fiber Receiving and Storage

The Research Triangle Institute reports that consistent application of good housekeeping measures (such as power-vacuuming at least once per shift) could keep fiber levels consistently below 0.3 f/cc TWA.^{33/} In addition, RTI suggests that new control measures might be used, including high-density fiber blocks, improved packaging, stronger pallets, standardized sizes for bags, and improved transportation practices. Use of these practices, according to RTI, could reduce exposure levels to less than 0.2 f/cc TWA within two years.^{34/}

[Insert discussion of industry position on feasibility of RTI proposals for more stringent control of exposure during fiber receiving and storage]

B. Fiber Introduction

RTI proposes greater use of the following practices to reduce worker exposure to asbestos during fiber introductions:

^{33/} RTI Report at IV-13.

^{34/} Id.

- maximum use of local exhaust systems and empty bag receptacles;
- regular performance checks and preventive maintenance;
- vacuuming at least once per shift and immediately following spillage; and
- mechanically supplied contaminant-free makeup air to balance the local exhaust capacity.

RTI estimates that these procedures would achieve average exposure levels consistently below 0.4 f/cc TWA.^{35/} In addition, RTI believes that within two years exposures can be maintained at a level below 0.2 f/cc through the maximum use of hooded dumping stations with integrated bag collection, high-density fiber blocks, and process-recyclable containers.^{36/}

[Insert discussion of industry position on feasibility of RTI proposals for more stringent control of exposure during fiber introduction]

C. Mixing and Conveying

RTI suggests the maximum use of continuous exhaust of hoods and maintenance of negative pressure throughout the mixing and conveying stages.^{37/} RTI also notes that the dry mix stage might be bypassed completely, with wet mixing conducted immediately after fiber introduction.^{38/}

^{35/} Id. at IV-16.

^{36/} Id.

^{37/} Id. at IV-18.

^{38/} Id. at IV-19.

[Insert discussion of industry position on feasibility of RTI proposals for more stringent control of exposure during mixing and conveying. Since many of RTI's recommended additional controls are currently in place, it would be appropriate to assess the validity of RTI's 1978 projections.]

D. Pipe Formation, Curing and Finishing

In addition to maximum use of local exhaust systems, RTI proposes increased use of a number of advanced control technologies. These include the redesigning of machinery with integrated local exhaust and increased automation, wet dust suppression for pipe lathes, and wet finishing.^{39/}

[Insert discussion of industry position on feasibility of RTI proposals for more stringent control of exposure during pipe formation, curing and finishing]

^{39/} Id.

PRIVILEGED & CONFIDENTIAL DRAFT

4/6/82

THE CONTROL OF WORKER EXPOSURE
TO AIRBORNE ASBESTOS FIBERS IN
THE INSTALLATION OF ASBESTOS CEMENT PIPE

Approximately 90 million linear feet of asbestos cement pipe are installed annually in sewer service and water supply systems in the United States.^{1/} This pipe is manufactured in standard lengths of ten and thirteen feet and is also produced in half and quarter lengths.^{2/} In addition, special fittings such as couplings, elbows and reducers are available for most pipe sizes.^{3/} Occasionally, however, asbestos cement pipe must be cut or machined during field installation. These operations generally are brief and infrequent, and when proper work practices are used they produce minimal worker exposure to asbestos fibers.

I. PIPE INSTALLATION PROCEDURES

The installation of asbestos cement pipe initially involves the unloading of the pipe. This may be done with a

1/ Research Triangle Institute, Asbestos Dust: Techno-logical Feasibility Assessment and Economic Impact Analysis of the Proposed Federal Occupational Standard III-23 (September 1978) [hereinafter cited as "RTI Report"].

2/ Id.

3/ Id.

forklift, a sling, or a special boom. Smaller diameter pipe may be hand-passed or lowered with ropes and skids. The pipe usually is laid alongside the trench prior to lowering and laying it in the trenches and bottom. During these operations the pipe remains intact, and virtually no asbestos is released into the air.^{4/}

A major advantage of asbestos cement pipe is its ease of installation and the quality and variety of available joints and fittings.^{5/} Consequently, little field fabrication is necessary for installation of this pipe.^{6/} Sometimes, however, pipe must be cut, drilled or machined during installation, and workers may be exposed to asbestos fibers released during these processes.

A variety of tools are available for cutting asbestos cement pipe. Cutting may be performed manually with a bow saw or hack saw or with special equipment fitted with carbide-tipped blades. Pneumatic or electrically-driven blade cutters also are available but not commonly

4/ A study by Equitable Environmental Health, Inc. measured exposure levels during this stage of installation at less than 0.1 fibers/cc. See Equitable Environmental Health, Inc., Dust Exposures During the Cutting and Machining of Asbestos/Cement Pipe: Additional Studies 16 (December 15, 1977).

5/ Cogley, et al., Life Cycle of Asbestos in Commercial and Industrial Use Including Estimates of Releases to Air, Water and Land 36 (October 1979) (draft).

6/ Id. See also RTI Report at III-23.

used. Snap cutting equipment is a relatively recent innovation in which cutting discs mounted on a chain are wrapped around and squeezed into the pipe until a cut is made. The cutting is controlled hydraulically by an operator standing 10 to 15 feet from the pipe. This procedure can be completed in less than three minutes.

Another procedure used to cut pipe is the gasoline-powered abrasive disc saw. This method produces particularly high asbestos exposure levels. Sometimes a hose or special blade shrouds are used to deliver water to the cutting area in an effort to reduce exposure levels.

Finally, cutting may be done with a Doty tool, which also has a station for machining pipe. Doty tool cutting may be used with a shroud and with water applied to the cutting area in order to reduce fiber levels.

After cutting, the pipe is machined. This may be performed with a manual or a power lathe. Hole cutting is occasionally required and may be performed with a drill and rasp or a powered hole cutter. Likewise, when the pipe is drilled or "tapped" to provide customer service connections, manual or power equipment may be used. If couplings must be removed from pre-assembled pipe, a hammer and chisel may be used.

The frequency of field operations depends largely on the type of A/C pipe (water or sewer) being laid, installation locale (urban or rural area) and the experience of

the contractor. For example, there may be a relatively higher frequency of tapping operations in urban or suburban installations than in rural projects where homes are further apart. The duration of field operations depends on the type of operation, type of equipment (manual or power driven) and the skills of the equipment operator.

On any given day a crew may perform none, any one, or all of these operations. This, of course, depends on the individual job and its requirement.

-- As noted above, little fabrication is necessary in the field.^{7/} The Research Triangle Institute has estimated that one cutting or machining operation is required for each 1,300 feet of installed asbestos pipe.^{8/} Dividing the annual production of asbestos cement pipe by this figure yields an estimate of 69,230 cutting or machining operations annually.

II. WORKER EXPOSURE LEVELS FROM THE INSTALLATION OF ASBESTOS CEMENT PIPE

A typical work crew for installation of asbestos cement pipe is three to four people (the estimated average crew size is 3.41 people) and a crew can install an average of 222.5 feet of pipe per day.^{9/} If one assumes that 225

^{7/} RTI Report at III-23.

^{8/} Id.

^{9/} Id.

days per year of labor are expended installing asbestos cement pipe, approximately 6,130 man-years are devoted to this installation.^{10/}

The estimated 69,230 cutting or machining operations take an average of 15 minutes each to perform.^{11/} Thus, about 17,307 hours will be spent annually on cutting and machining operations that have the potential to produce exposure to asbestos fibers. If an average of 3.41 workers are exposed to these operations, the result will be 59,016 man-hours of exposure (0.53% of total work hours). This is a liberal estimate because not all workers will actually perform field operations. The operations usually involve only an equipment operator and a helper while remaining workers perform other tasks which may or may not be in the immediate vicinity of the fabrication operation.

If one makes the extreme assumption that a discrete group of workers installs asbestos cement pipe and no other type of pipe, these workers perform 9.5 hours per year of operations that may result in asbestos exposure. (1800 hours x 0.53%).^{12/}

^{10/} Id.

^{11/} Id.

^{12/} Asbestos cement pipe, however, only accounts for one-third of all distribution piping installed in the United States. Id. Furthermore, installation of other types of pipe is estimated to take three times as many man-years as installation of asbestos cement pipe. Id. Based on these figures, approximately 42,900 man-years annually are devoted to pipe installation.

If one adopts the more realistic assumption that the workers who install asbestos cement pipe also install other types of pipe, and vice versa, the frequency of an individual worker's exposure to asbestos fibers is much lower. Under this scenario, the typical worker will have 1.38 hours per year in which he may be exposed to asbestos.^{13/}

Not only are the frequency and duration of exposure to asbestos very brief, but the concentrations to which workers are exposed also are generally quite low. A study by Equitable Environmental Health, Inc. measured peak exposures for various operations on different types of asbestos cement pipe.^{14/} Their results are summarized in Table 1 on the next page.

^{13/} Id. at III-24.

^{14/} Equitable Environmental Health, Inc., Dust Exposures During the Cutting and Machining of Asbestos/Cement Pipe: Additional Studies (December 15, 1977).

TABLE 1
PEAK EXPOSURE LEVELS^{15/}

<u>Operation</u>	<u>Sewer Pipe</u>		<u>Pressure Pipe</u>	
	<u>Operator</u>	<u>Helper</u>	<u>Operator</u>	<u>Helper</u>
<u>Cutting Operations</u>				
Hack saw	0.18	0.1	<0.1	0.11
Snap cutting	<0.1	<0.1	<0.1	<0.1
Abrasive disc, wet	42.1	10.2	65.0	49.2
Abrasive disc, dry	35.5	64.0	20.3	59.7
Chisel, hammer and rasp	0.30	0.25	1.99	0.87
<u>Machining Operations</u>				
Manual lathe	0.15	0.13	0.51	0.22
Power lathe	<0.1	0.10	0.29	0.18
Doty Machine, dry	3.83	0.29	1.90	2.23
dry, shroud	0.23	0.10	1.29	0.18
wet, shroud	0.20	0.10	0.21	0.27
Tapering tool	0.18	<0.1		
<u>Hole Cutting</u>				
Power hole cutter	0.44	0.23	1.65	0.38
Drill, hammer and rasp	0.23	0.13	0.22	<0.1
Dry tap with Mueller				
J tool	<0.1	<0.1	<0.1	<0.1
Tapping with Mueller				
B-100	<0.1	<0.1	<0.11	<0.13
<u>Coupling Removal</u>				
Hammer and chisel	<0.1	<0.1	0.30	<0.1

^{15/} Data in this table are taken from the Equitable Environmental Health, Inc. Study. Id. at 16-22.

As Table 1 demonstrates, most cutting, machining and tapping operations produce very low concentrations of fibers. Only cutting with an abrasive disc saw and frequent machining with a Doty tool result in peak concentrations in excess of 1.0 f/cc. Fortunately, these peak exposure levels are brief and infrequent. Table 2 gives the time weighted average exposures over a year for various operations. These estimates are based on two very conservative assumptions: (i) that every cutting, machining or tapping operation performed during the year was of the type listed and (ii) that the affected workers installed asbestos cement pipe exclusively.

TABLE 2
TIME WEIGHTED AVERAGE EXPOSURES^{16/}

<u>Operation</u>	<u>Sewer Pipe</u>		<u>Pressure Pipe</u>	
	<u>Operator</u>	<u>Helper</u>	<u>Operator</u>	<u>Helper</u>
<u>Cutting Operations</u>				
Hack saw	<0.1	<0.1	<0.1	<0.1
Snap cutting	<0.1	<0.1	<0.1	<0.1
Abrasive disc, wet	0.22	0.1	0.34	0.26
Abrasive disc, dry	0.19	0.34	0.11	0.32
Chisel, hammer and rasp	<0.1	<0.1	<0.1	<0.1
<u>Machining Operations</u>				
Manual lathe	<0.1	<0.1	<0.1	<0.1
Power lathe	<0.1	<0.1	<0.1	<0.1
Doty Machine, dry	<0.1	<0.1	<0.1	<0.1
dry, shroud	<0.1	<0.1	<0.1	<0.1
wet, shroud	<0.1	<0.1	<0.1	<0.1
Tapering tool	<0.1	<0.1		
<u>Hole Cutting</u>				
Powerhole cutter	<0.1	<0.1	<0.1	<0.1
Drill, hammer and rasp	<0.1	<0.1	<0.1	<0.1
Dry tap with Mueller				
J tool	<0.1	<0.1	<0.1	<0.1
Tapping with Mueller				
B-100	<0.1	<0.1	<0.1	<0.1
<u>Coupling Removal</u>				
Hammer and chisel	<0.1	<0.1	<0.1	<0.1

^{16/} These figures are derived from the peak exposure levels in Table 1, adjusted for duration of exposure.

Even using assumptions that tend to dramatically overstate the exposure level attributable to a specific operation, only cutting with an abrasive disc saw produces concentrations in excess of 0.1 f/cc as a time weighted average exposure. And, even a worker who installed only asbestos cement pipe and who used an abrasive disc saw for every operation would have a maximum time weighted average exposure of only 0.34 f/cc.

If it is assumed that half the field operations performed are machining rather than cutting operations, a worker who cuts pipe only with an abrasive disc saw would receive a time weighted exposure of less than 0.2 f/cc. Furthermore, if these workers also install other types of pipe, even exclusive use of the abrasive disc saw for cutting operations will not produce time weighted average exposure levels in excess of 0.1 f/cc.

III. STEPS TAKEN TO REDUCE EXPOSURE LEVELS

Although exposure levels in the installation of asbestos cement pipe are already quite low, the industry has taken a number of steps to reduce them still further. Since 1973, the Association of Asbestos Cement Pipe Producers (AACPP) has recommended against the use of abrasive disc saws for cutting A/C pipe. At least one pipe manufacturer maintains a supply of tools that produce low exposure levels,

which it makes available at no charge to contractors who purchase its pipe.^{17/}

The AACPP also commissioned studies by Equitable Environmental Health, Inc. of exposure levels in pipe installation. Upon receiving the data from the first study, the Association published and distributed nearly 85,000 copies of a field manual entitled "Recommended Work Practices for A/C Pipe." As a result of the widespread acceptance of this manual, the American Water Works Association adopted these same recommendations in its manual entitled "Work Practices for Asbestos-Cement Pipe." All A/C pipe manufacturers in the U.S. have incorporated the work practices into their pipe installation guides. Two manufacturers label A/C products with a bilingual warning that recommended work practices should be followed.

The AACPP manual covers shipping, receiving, handling, assembling, cutting, machining, hole cutting, tapping, and coupling removal for all asbestos cement pipe products. The manual also discusses appropriate procedures for good housekeeping at the work site and waste disposal. AACPP is convinced that when these recommended work practices are followed, no adverse health effects attributable to asbestos will result from normal employment in a construction environment where asbestos cement pipe is used.

^{17/} RTI Report at IV-59.

[INSERT DISCUSSION OF INDUSTRY POSITION
ON ENGINEERING CONTROLS]

B) Work Practice Requirements

The Research Triangle Institute has also suggested that a variety of work practice requirements might be used to reduce peak airborne fiber concentrations. These practices include: (i) vacuuming dust generated during cutting and machining; (ii) burying chips that accumulate on the work site; and (iii) catching the chips produced during cutting and machining in a bag or sheet spread beneath the operation.^{22/} Standards also would be set for disposal of the materials gathered.^{23/}

[INSERT DISCUSSION OF INDUSTRY POSITION
ON WORK PRACTICE REQUIREMENTS]

^{22/} Id. at IV-62.

^{23/} Id.