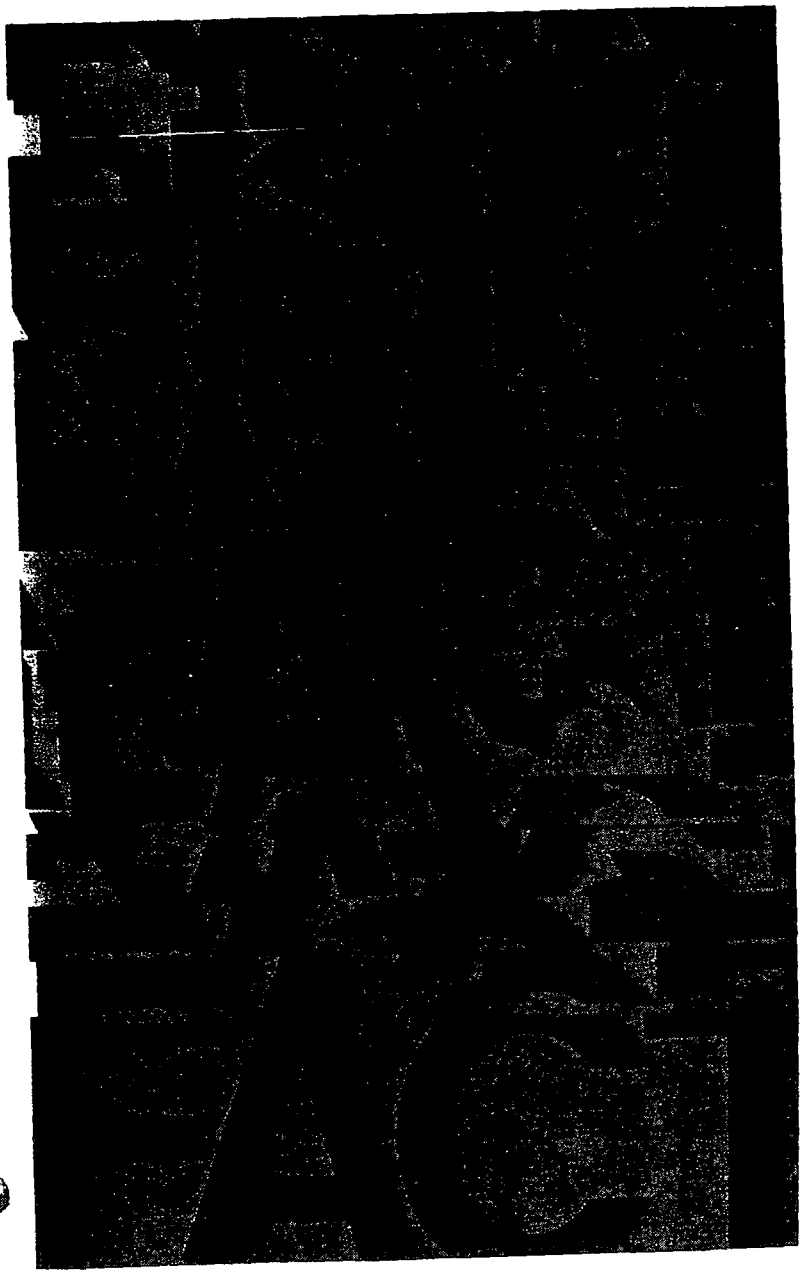
PLAINTIFF'S EXHIBIT

CT-288

A/C Pipe and Drinking Water



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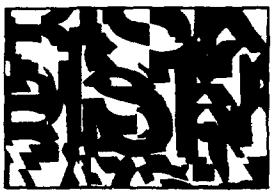

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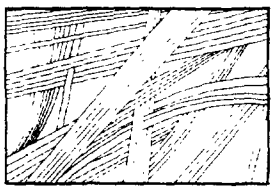

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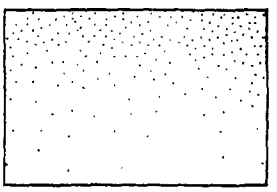

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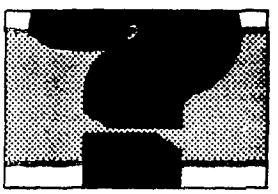

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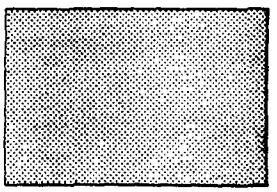

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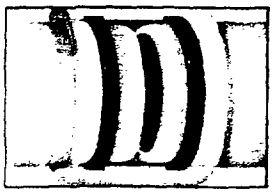

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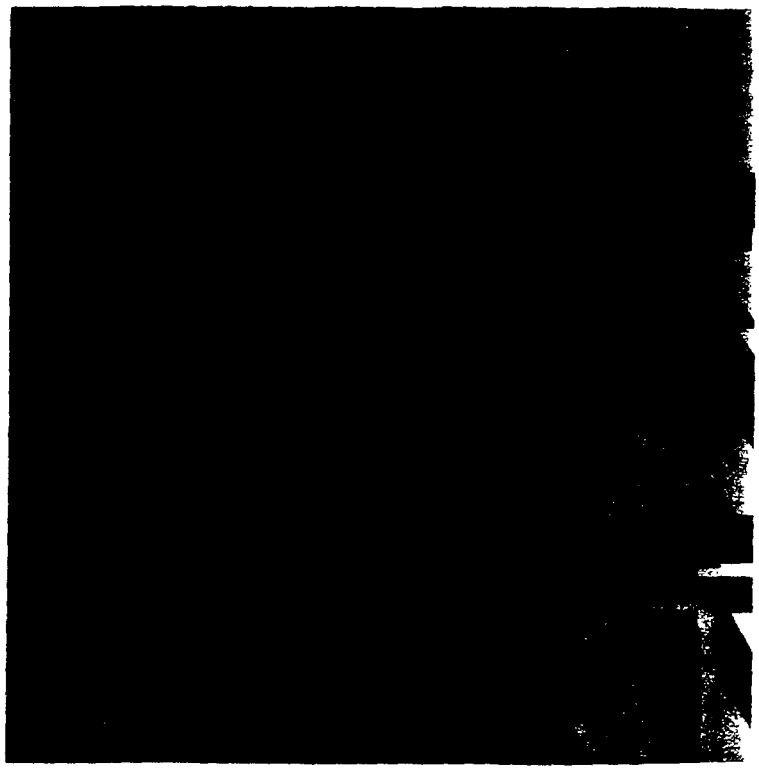
Perceptions of Risk

The world has never been . . . and never will be free from risk. It is inescapable. It is life itself. And since the dawn of time, man has accepted risk as a normal part of his daily activity.

The perception of risk varies . . . from situation to situation . . . from individual to individual. What one person considers safe, another may perceive as downright foolish. This simply illustrates that the perception of risk is subjective, emotional, and may have little basis in fact.

Safe vs. Zero Risk—All risks have one thing in common. They can be measured. There is a name for this measurement . . . *probability*. Something is judged "safe" if its probability of risk is acceptable. However, "safe" does not mean "free from risk". A seemingly "safe" 6 minute canoe ride, for example, carries the same risk of death as a 500 mph commuter flight



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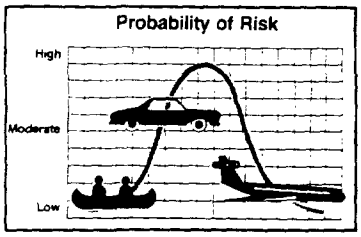
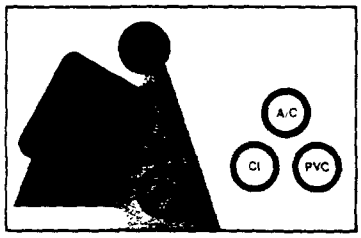
from Washington to New York City . . . traveling the same distance by automobile, the risk increases five-fold.[1]

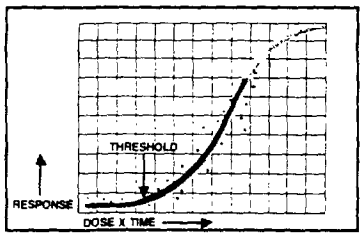


Nothing is absolutely free from risk . . . so nothing can be absolutely safe. But like electricity and your automobile, there *are* non-harmful ways to use potentially harmful things . . . it's simply a matter of probabilities.

Cancer and Carcinogens—Few risks are as well-publicized and frightening as the risk of cancer. While the fear of cancer may alter the *perception* of risk, it cannot . . . does not . . . alter the *probability* of risk.



Cancer, an unrestrained growth of cells, is not a single disease but many diseases caused by agents called *carcinogens*. Asbestos is a carcinogen . . . it is not alone. Over 300 chemicals, many known or potential carcinogens, have been identified in drinking water alone. This fact has prompted a close examination of common water pipe materials, since all contain potentially toxic substances.



Dose-Response and Threshold—The critical question with asbestos, as with any toxic material, is: *"at what exposure level is it hazardous?"* Medical science determines this by a principle known as *dose-response*. The principle is rather straightforward. For every *dose* . . . there is a proportionate biological *response*. Now let's add another wrinkle . . . *there is a dose small enough which will result in no measurable response*. This level is called a threshold. Threshold effects are common. We have thresholds for hearing, pain, heat . . . even martinis.

Whether or not we have a *theoretical* or *practical* threshold for carcinogens is a very controversial question. The answer is as philosophical as it is scientific. Like the perception of risk, opposing opinion simply reflects different value judgments on

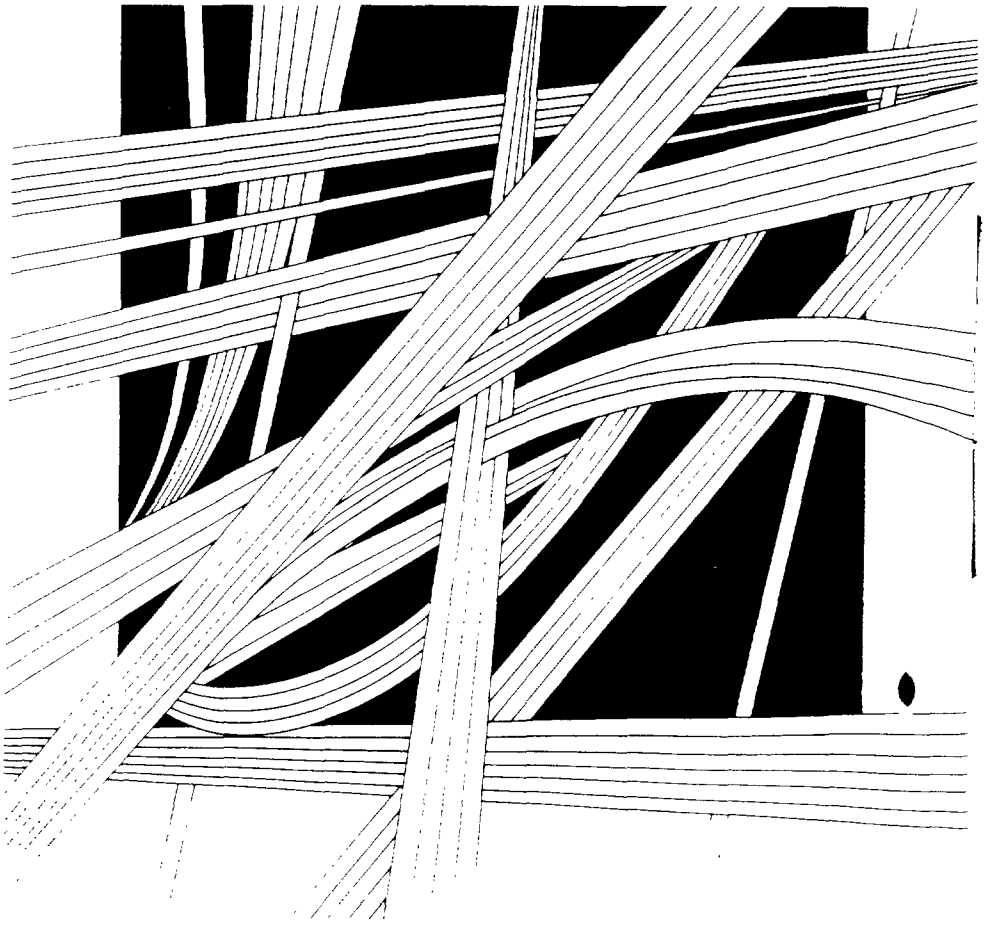
CTD031870

what constitutes an acceptable risk measured by "real world" doses . . . and "real world" probabilities.

Everything known about asbestos indicates it observes the rules of dose-response. Therefore, a practical threshold or safe level of exposure to asbestos must exist. If it did not, it would be difficult to reconcile the *prevalence* of asbestos in the environment with the *absence* of related disease in the general population.

Asbestos-The Unique Fiber—Asbestos is found throughout the world. 470 million years ago, hot, subterranean water dissolved rock layers containing iron, magnesium and silica, forming "veins" of liquid minerals. As the earth cooled, these minerals crystallized into the ore known today as asbestos.[2]

Pharoahs and ancient kings used this unique product of nature. Today, you don't have to be royalty to use asbestos,



Asbestos and A/C Pipe

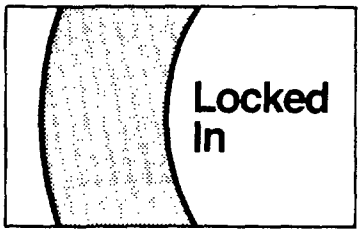
Micro-Reinforcement of Cement

	E Modulus	Strength	Fiber Surface	Corrosion	Critical Length	Age Resistance
Asbestos	+	+	+ +	+ +	+ +	+ +
Steel	+	+	+	+ +	+	+
Carbon	+	+	+	+	+	+ +
Glass	+	+	+	+	+	+
Organic Fibers	+	=	+	+	+	=

practically everyone does. Over 3,000 products use it, usually in combination with other materials. With properties unmatched by any other natural or man-made material,[3] asbestos is irreplaceable for the micro-reinforcement of high performance products like asbestos-cement (A/C) pipe.

Asbestos-cement pipe contains a blend of asbestos fibers. *Chrysotile* is used for reinforcement; *crocidolite* facilitates the pipe manufacturing process, as well as strengthening the cement matrix.

Free vs. Bound Asbestos— Asbestos comprises less than 20 percent of A/C pipe. Contrary to some perceptions, A/C pipe is not lined with asbestos. *The fibers are not free, but like reinforcing rods in concrete, they are bound . . . encapsulated . . . locked-in the cement binder.*



The distinction between *free* and *bound* asbestos is extremely important. Why? It determines the probability of fiber release, and in turn, the probability of exposure. More importantly, it explains *why* A/C pipe is a non-harmful use of asbestos.

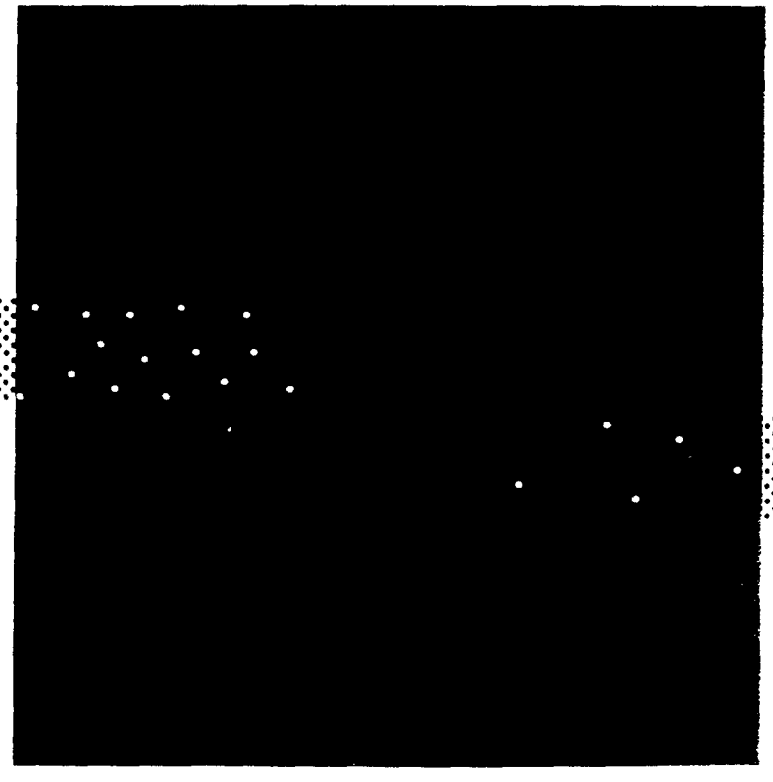
Dose and Routes of Entry— The ability of asbestos to subdivide into microscopically small fibers is the key to its ability to become airborne or waterborne, and thereby inhaled or ingested. The biological effects of asbestos depend on *dose* and *route of entry* into

CTD031872

the body . . . and are believed to be a function of fiber shape and size, rather than chemical composition. Generally, the longer and thinner the fiber, the greater the potential health risk.

Inhalation and Ingestion— Prolonged or heavy exposure to airborne asbestos can lead to *asbestosis*, a disease which impairs breathing, and an increased risk of *lung cancer*. To a much lesser degree, asbestos may cause *mesothelioma*, a rare cancer of the chest or abdominal cavity. *To date, all identified occurrences of these diseases attributed to asbestos, have involved exposures in or related to occupational settings.*

In contrast to inhalation, a clear "cause and effect" relationship between ingested asbestos and gastrointestinal (GI) cancer does not exist. In certain heavily exposed occupational groups, a higher than normal rate of GI cancers has



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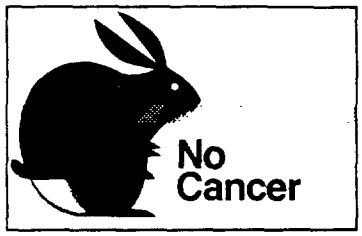
Asbestos Exposures from Field Operations

been reported.[4] Presumably, this is because the body's natural cleansing mechanisms catch and clear (by swallowing) over 90 percent of inhaled dust. Yet, a number of similarly exposed occupational groups [5, 6] have not shown



these increases. And everything from mice to baboons, has been watered, force-fed or dined at will on asbestos, as much as 6 percent of their food intake, without evidence of tumor production.[7, 8, 9, 10, 11, 12, 13]

These then are the risks for exposure to asbestos . . . "high" for heavy or prolonged inhalation exposure; solely "presumptive", with no proven risk for ingestion.

Regulatory agencies throughout the world set exposure levels to airborne asbestos based on the number of fibers longer than 5 micrometers.[14] Proposals to lower existing levels are under consideration. Let's take a look at fiber levels measured when installing A/C pipe by recommended work practices.

Loading, unloading and stringing out A/C pipe are basically dust-free operations. Even in the most confined working space, dust levels are barely measurable. A survey conducted by the Port of Tyne Authority in England measured dust levels in the hold of a ship loading A/C pipe.[15] The *highest* dust measurement was 0.01 fibers/cc . . . *one-fiftieth* of the proposed U.S. OSHA Occupational Standard.

OSHA Asbestos Exposure Standards

	Eight Hour Time Weighted Average	Ceiling Concentration
Occupational		
Existing	2.0 fibers cc	10 fibers cc
Proposed	0.5 fibers cc	5 fibers cc
Construction		
Existing*	2.0 fibers cc	10 fibers cc
Proposed*	—	—

*Identical with Existing Occupational Standard Pending

Source: Code of Federal Regulations 29 Part 1910.1001

The adaptability of A/C pipe, and the availability of a complete line of short lengths and standard fittings greatly minimize the need for field operations. When cutting, machining or finishing are necessary, independent industrial hygiene studies[16] have confirmed that *when recommended work practices are fol-*

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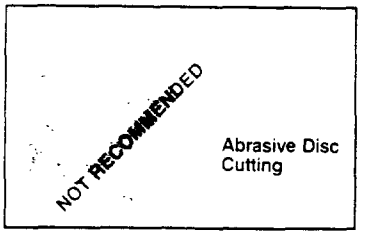
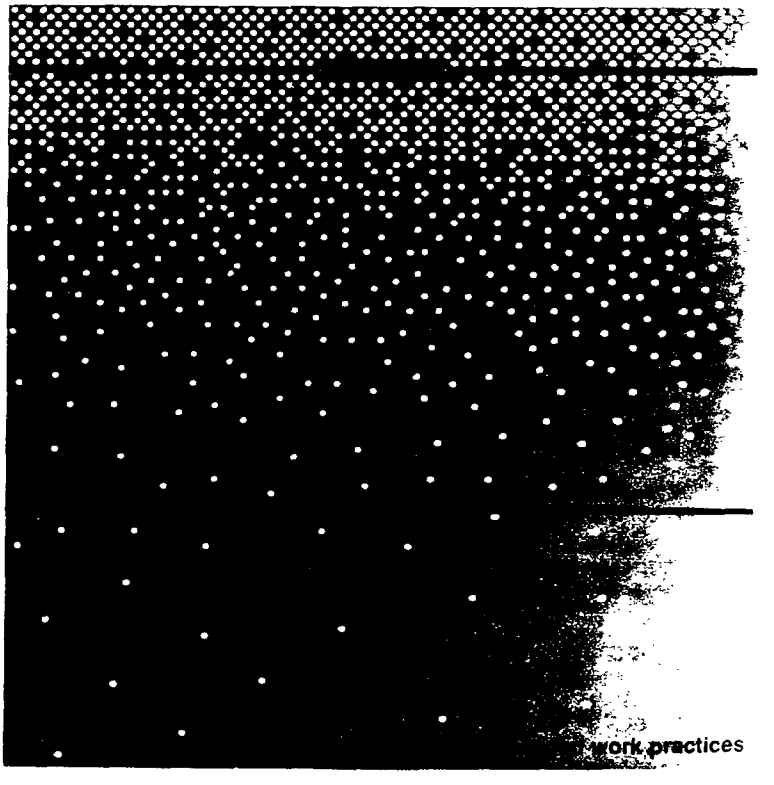
lowed, fiber levels are not only far below present standards, but also meet proposed standards (see Appendix A).



This should come as no surprise. Remember . . . the asbestos fiber is *locked-in* the cement binder. The infrequency and short duration of field operations further reduce even these minimal exposures. *Conclusion: when recommended work practices are followed, the risk of working with A/C pipe is virtually non-existent.*



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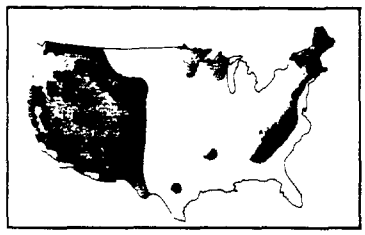
A/C Pipe and Waterborne Asbestos

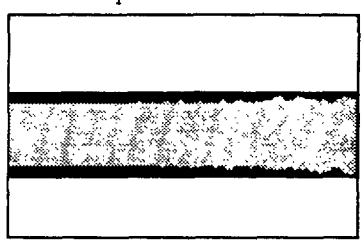
Source Waters—The prevalence of asbestos in soil results in its presence of most lake, river and well waters, and in many distribution systems regardless of the piping material utilized.[17]



Surveys by the United States Environmental Protection Agency showed that natural and treated waters in Montana, Washington, Pennsylvania, California, Massachusetts and Georgia had levels in the range of millions of fibers per liter.[18] There is asbestos in all surface waters of all habited areas of Ontario,[19] and many parts of Quebec and British Columbia. Natural weathering and erosion have in the past, and will, for generations to come, release asbestos to surface watersheds and underground aquifers around the world.

Soils—Another potential source of waterborne asbestos can be asbestos-bearing soil deposited in the pipe during installation or repair. This can occur whether the pipe is iron, plastic, or asbestos-cement. A thorough flushing easily eliminates any soil contamination.

Tapping A/C Pipe—Tapping A/C pipe to provide house connections also can contribute asbestos to drinking water. *The industry recommends when tapping A/C pipe while under pressure, that equipment with a positive purge be used.* This ejects 99 percent of the asbestos-cement chips, and downstream flushing takes care of the rest. Another alternative is the use of heavy-walled tapped couplings supplied directly from the factory.



Aggressive Waters—Now the critical question . . . *does A/C pipe contribute asbestos to drinking water conveyed through it?* The answer is not a simple one, but we do know this . . . it depends on the water. *As long as the cement binder remains intact, the release, if any, of the "locked-in" fiber is infinitesimal.*

A/C pipe is remarkably corrosion resistant . . . much more so than metallic pipe. However, certain corrosive or "aggressive" waters will attack even corrosion-resistant asbestos-cement. The most common are low hardness or "soft" waters and low pH or

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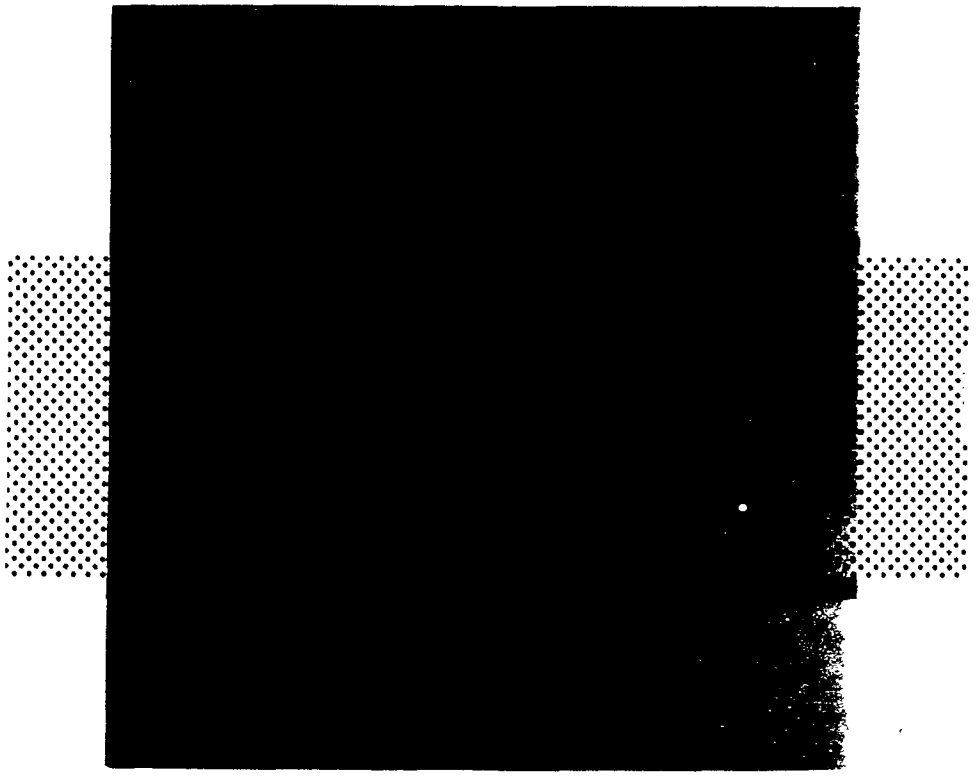
"acidic" waters. Aggressive waters are "hungry" waters . . . not only hungry for calcium and magnesium in cement . . . but hungry for iron, lead, copper, zinc, and cadmium in metallic pipe . . . organic residuals in plastic pipe . . . and polyaromatic hydrocarbons in organic coatings.

Corrosive waters take a staggering economic toll from the waterworks industry every year . . . an estimated $400 million in replacement costs for pipe alone[20] . . . perhaps as much as $1 billion, including other equipment and protective devices. But the heaviest toll of all may be the toll in human lives. More than fifty studies in nine countries reveal a consistently significant relationship between water hardness and cardiovascular disease, still the United States' number one killer. In one study,[21] cities with the softest water had *twice* the death rate from



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coronary disease as cities where the water was hardest. Economics *alone* argue strongly for treatment of corrosive waters . . . the potential loss of life punctuates the urgency.

Aggressive Water Guidelines—The A/C pipe industry is not the first to spotlight the need for stabilization, but it has been a leader in taking positive steps to include aggressive water guidelines in its national product specifications. *These guidelines do not recommend the use of asbestos-cement pipe with highly aggressive waters without consulting with the manufacturer.*

Aggressive Water Guidelines

Type of Water	Aggressive Index	A C Pipe Recommended
Non Aggressive	≥12.0	Types I & II
Moderately Aggressive	10.0-11.9	Type II
Highly Aggressive	≤10.0	*

*The serviceability of pipe for such applications should be established by the purchaser in conjunction with the manufacturer.

Source: American Water Works Association Standards C 400-75, C 402-75
American Society for Testing & Materials Standard C 500-75

Asbestos in A/C Pipe Systems—In "moderately" and "non-aggressive" waters, field measurements confirm EPA laboratory results that A/C pipe does not contribute significant or in many cases even measurable amounts of asbestos to drinking water conveyed through it.

Northeast Illinois . . . an analysis of 15 public water systems containing A/C pipe of various ages, lengths and diameters . . .*Conclusion: No significant release of asbestos from A/C pipe.*[22]

California . . . an analysis of water from a distribution system with nearly 1,000 miles of A/C pipe . . . *Conclusion: Asbestos levels below detectable limits.*[23]



New Mexico . . . an analysis of asbestos fiber concentrations in water systems containing 548 miles of A/C pipe . . . *Conclusion: No evidence of asbestos pick-up from A/C pipe.*[24]

Texas, Ohio and Connecticut . . . EPA studies of A/C pipe systems . . . *Conclusion: Fiber levels "not statistically significant" or "below detectable limits."*[25]

Common sense tells us that "real world" risk must relate to "real world" exposure. That's why these results are so important . . . they measure actual asbestos levels in A/C pipe systems. *Clearly, the amount of asbestos, if any, contributed to drinking water supplied through A/C pipe was infinitesimal . . . certainly far less than was found in many natural source waters.*

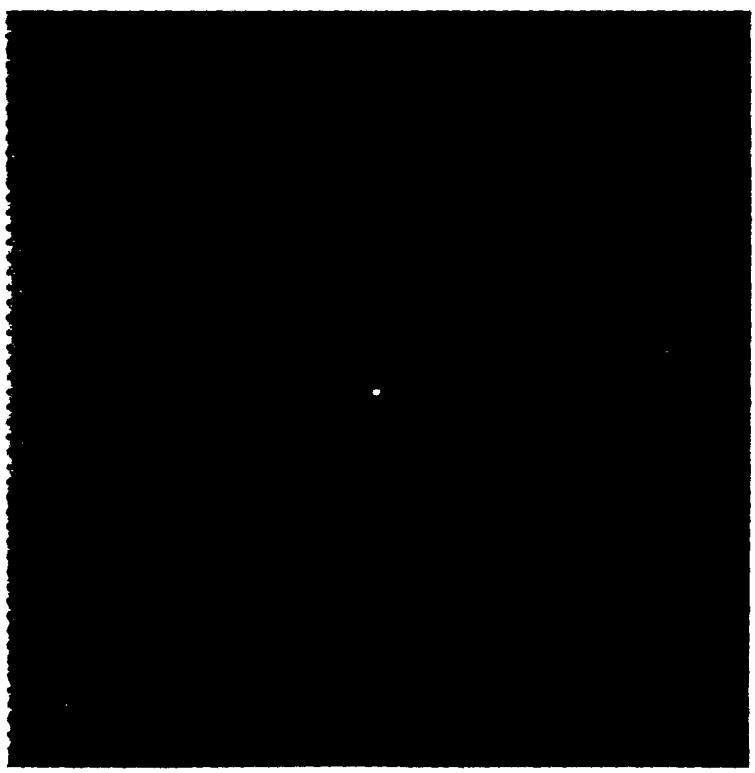
CTD031878

Asbestos in Water... The Risks

What about water systems which have measurable quantities of asbestos fiber . . . what's the risk of contracting cancer?

There is no evidence that anyone in the general public has ever contracted any disease from naturally-occurring asbestos . . . or the minute amounts of fiber released from A/C pipe. This is not a judgment of safety . . . it is a statement of fact.

Ingested Asbestos and Cancer—In 1978, University of California researchers reported a statistical association between certain cancers and water supplies high in naturally-occurring asbestos. While the study[26] stirred up a storm of questions, it did not pinpoint a "cause and effect" relationship between ingested asbestos and cancer. As the researchers themselves noted, important factors such as smoking, alcohol consump-



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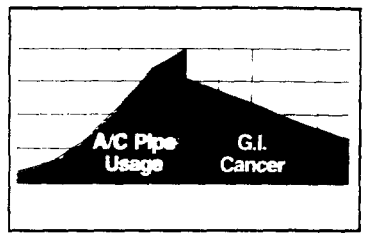
tion, and dietary habits, as well as occupational history, population mobility, and the presence of other carcinogens in the drinking water were *not* included in the study.

In response to the study, the California Department of Health Services took the position: "The UC doctoral thesis abstract contains no new or original evidence of a medical nature about cancer or asbestos, nor does it establish any causal link between asbestos in Bay Area drinking water and the incidence of cancer."[27] A similar position was also taken by the U.S. Environmental Protection Agency.[28]

Further, a preliminary report on an EPA-funded study in Washington State directly contradicts the University of California findings. Researchers in the Puget Sound region, where waters also are high in naturally-occurring asbestos, did not show any association between fibers in the drinking water and cancer of the colon, stomach, kidney, or total alimentary tract.[29]

Whether it's the extremely small fiber size or the "subthreshold" dose, if there is a "cause and effect" relationship between gastrointestinal cancers, ingested asbestos, or the use of A/C pipe, it does not show in state, national, or world cancer statistics.

Duluth, Minnesota . . . Millions of asbestos-like fibers in its drinking water supply, and Minneapolis-St. Paul, with none. *A comparison showed no statistical difference in the incidence of gastrointestinal cancer.*[30]



Switzerland . . . The highest per capita use of A/C pipe in Western Europe. From 1951, more than 20 years after A/C pipe was introduced, to 1976, *the death rate from GI cancer dropped a significant 32 percent.*[31]

Canada . . . A study of 22 municipalities with high concentrations of naturally-occurring asbestos in the water supplies *failed to reveal any excess cancer mortality which could be attributed to asbestos consumed in drinking water.*[32]

The United States . . . During 50 years of rapidly increasing A/C pipe usage, gastrointestinal cancer rates for the period 1949-1976 declined 39 percent.[33]

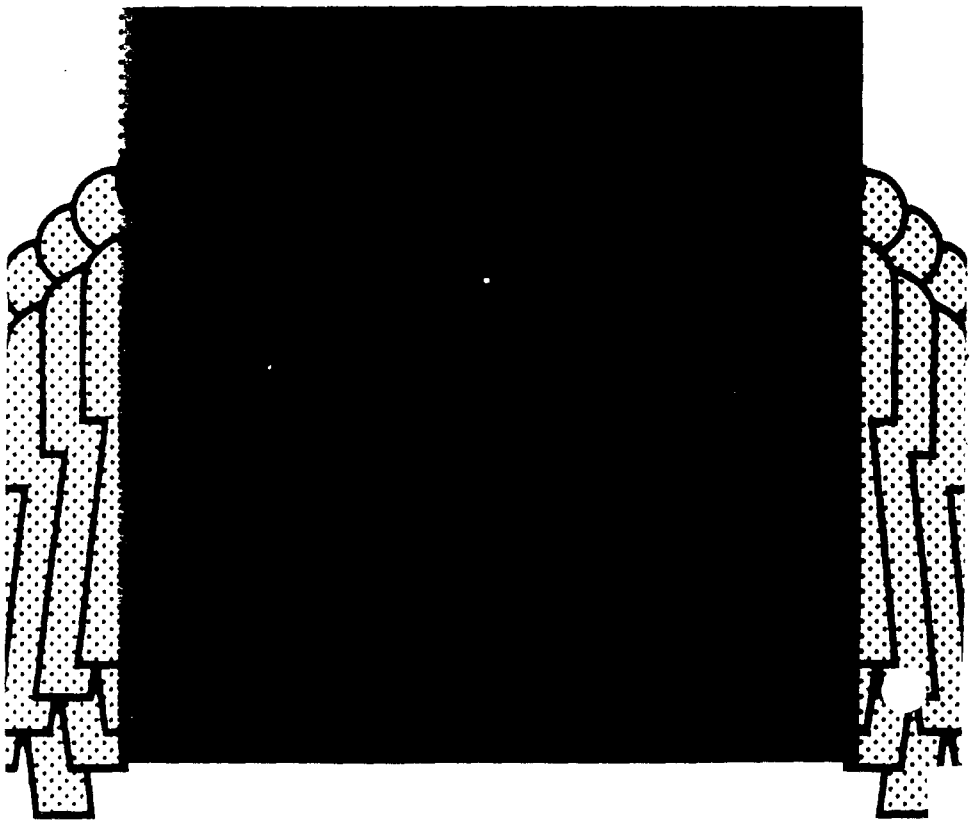
Connecticut . . . An extensive Environmental Protection Agency study showed *no correlation between the incidence of GI cancer and the use of asbestos-cement water pipe.*[34]

CTD031880

This inability to relate a "real world" response with a "real world" dose again says that like the amount of asbestos contributed to drinking water by A/C pipe, the risk from ingesting that asbestos must be infinitely small. How small? Let's try to put it in perspective.

Measuring the Risks— Imagine a man . . . and a mouse. 0.27 percent of their diet will be asbestos . . . not very much, but for the mouse, a magnified dose which in an actual feeding experiment failed to establish a cancer risk. For the man, it amounts to about 5 pounds of asbestos, roughly the amount of butter he eats in a year.

Using the *highest* fiber levels found in drinking water, the man would have to drink *3.8 million quarts of water per day to consume five pounds of asbestos in a year . . . or over 50,000 quarts per day for a lifetime.*



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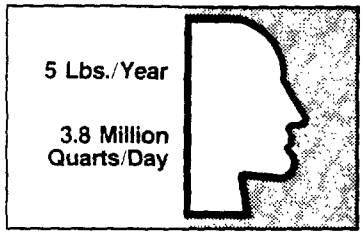
This is, of course preposterous. But it does place in perspective the probability of risk from a "real world" dose of ingested asbestos from A/C pipe



. . . a dose which is not uncommonly a billion times less than asbestos levels proven to be non-carcinogenic in animal feeding studies.

One in a billion! That figure probably doesn't register with most people. In terms of volume, it's a very, very dry martini . . . one drop of vermouth in 15,750 gallons of gin.[35] In terms of risk . . . it's a thousand times safer than smoking one and one half cigarettes or drinking a half bottle of your favorite wine.[36]

Perceptions of Risk—In spite of perceptions and publicity to the contrary, these incredibly low probabilities of risk tell us that the use of A/C pipe is not a risk to the public . . . a judgment confirmed again and again by some of the most respected authorities in the world.

Dr. Irving J. Selikoff, Director of the Environmental Sciences Laboratory, Mount Sinai School of Medicine . . . "Insofar as asbestos-cement pipe for public water supplies is concerned . . . we have no data demonstrating hazard."[37]

National Cancer Institute . . . "NCI scientists . . . have found no unusual cancer mortality patterns so far among persons residing where drinking water is contaminated by asbestos . . :"[38]

Selected Study Committee of the American Water Works Association Research Foundation . . . "No firm evidence shows that the proper use of asbestos-cement pipe poses a hazard to health by reason of ingestion of asbestos fibers . . . the probability of risk to health from the use of such systems is small . . . approaching zero."[39]

False accusations and "guilt by association" have created a perception of risk about A/C pipe; scientific measurements and common sense show this distorted perception has no basis in fact.

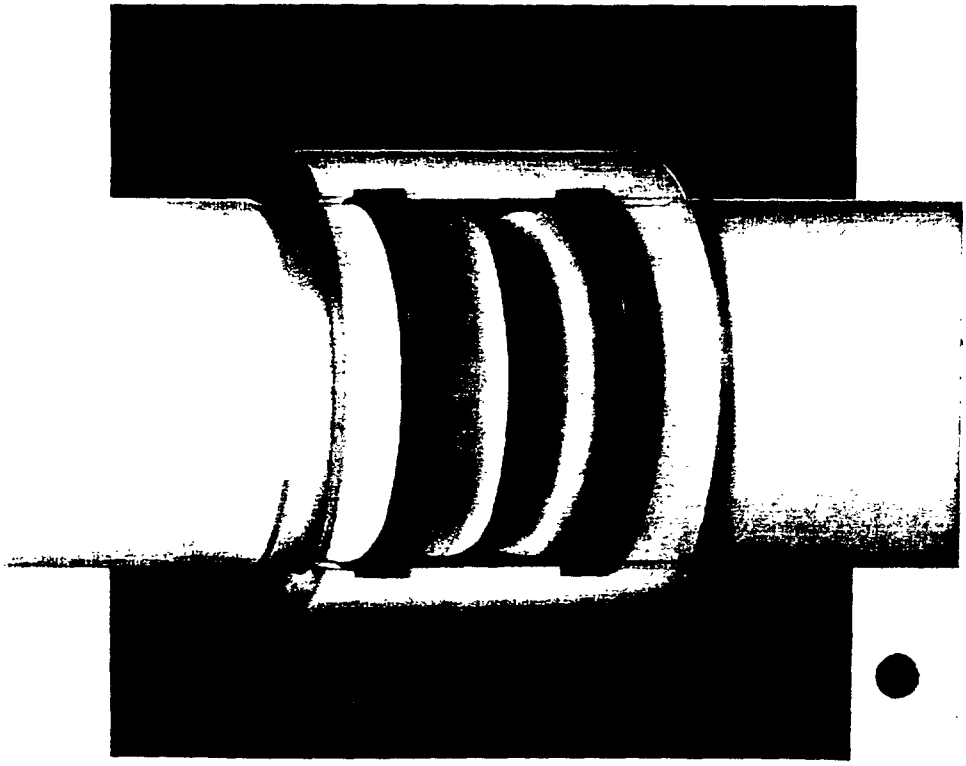
CTD031882

A Commitment to Quality

The A/C pipe industry has a commitment . . . a commitment to quality water. Quality water demands conservation in use, diligence in treatment, and economical reliability in distribution.

Designed for value . . . engineered for performance . . . scrutinized for safety . . . A/C pipe is as cost-effective, reliable, *and safe* as any water pipe in common use today.

Continuing to provide products of integrity, which the public can use with confidence, will remain the commitment of the A/C pipe industry . . . today . . . tomorrow . . . and in the future.



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Appendix A

Ceiling Concentrations of Airborne Asbestos Fiber from A/C Pipe Field Operations

Field Operation	*Type of Pipe*	*Operation Time (Min.)*	*Exposure (Fibers/cc)* Operator	Helper
Recommended Work Practices				
Manual Lathe	Pressure	12-13	0.51	0.22
Manual Lathe	Sewer	4-5	0.15	0.13
Power Lathe	Pressure	5-6	0.33	0.56
Power Lathe	Sewer	6-8	0.08	0.09
Power Hole Cutting	Pressure	1.5-2	0.44	0.23
Power Hole Cutting	Sewer	1	1.65	0.38
Cutting w/Chisel & Rasp	Pressure	10-11	1.99	0.90
Cutting w/Chisel & Rasp	Sewer	4-6	0.30	0.25
Chain-type Cutter	Pressure	2-3	0.85	0.87
Chain-type Cutter	Sewer	2-3	<0.06	<0.06
Pilot®-type Cutter	Sewer	2-3	0.09	—
Non-Recommended Work Practices				
Abrasive Disc Cutting*	Pressure	<1	20.30	59.70
Abrasive Disc Cutting*	Sewer	<1	35.50	64.00

*Workers should be provided with respiratory protection approved by the United States Department of the Interior, Bureau of Mines, Schedule 21C or Department of Health, Education and Welfare, National Institute of Occupational Safety and Health, under the provisions of the Code of Federal Regulations, 30, Part 11.

Note: OSHA Standard for Occupational Exposure to Asbestos Dust (Ceiling Concentration): Ten (10) fibers per cubic centimeter of air.

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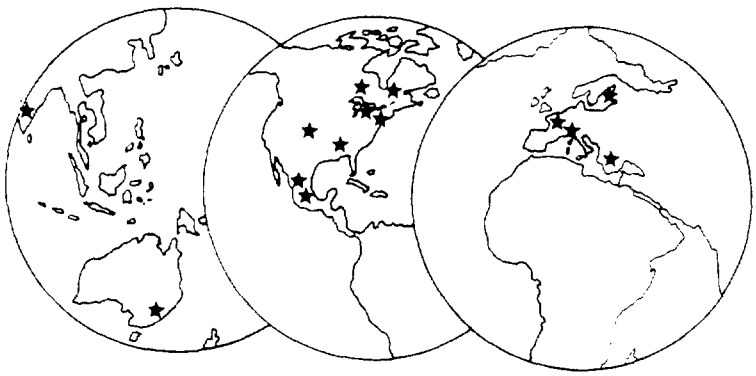

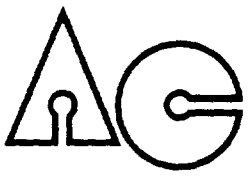

A/C Pipe
Producers
Association
1600 Wilson Boulevard
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