Johns-Manville

ENVIRONMENTAL FACTS/Asbestos

PLAINTIFF'S EXHIBIT

SH-1624

Asbestos-Cement Water Pipe and Health

SUMMARY:

Questions have been raised about a possible health hazard associated with drinking water that has passed through asbestos-cement pipe.

The Public Health Service's position that there is a low probability of any health hazard associated with the use of A/C pipe is supported by prominent medical authorities. Additionally, the Advisory Committee on Asbestos Cancers of the IARC reports there is no indication of any increased cancer risk from asbestos fibers present in water, beverages, food, or in the fluids used to administer drugs.

Four types of evidence support the position that A/C pipe poses no health hazard: 1. Experiments have not shown any relationship between GI cancer and heavy concentrations of asbestos dust in the air or dust on food; 2. Large quantities of asbestos fiber fed to animals have not produced GI cancer; 3. There is no evidence to support the contention that A/C pipe releases asbestos fiber into water in amounts that can constitute a public health hazard; and 4. There has been a decrease, rather than an increase, in the incidence of GI cancer during the very years that the use of A/C pipe has increased in the U.S.

ASBESTOS-CEMENT DEFINED

Asbestos-cement (A/C) pipe for water supply and waste disposal systems was developed in Europe in 1913 and introduced to the United States in 1929. Asbestos fiber, added to Portland cement and silica, provides the structural strength required for durable, lightweight, rustproof, economical piping. Despite extensive research and experimentation, no satisfactory substitute for asbestos has ever been found as a replacement in asbestos-cement products.

These advantages have led to the use of great quantities of asbestos-cement pipe over the past half century, for water supply and sewer systems, irrigation projects, drainage systems, industrial processes, heating and cooling installations, and as conduit for electrical and telephone wires.

For water supply systems, A/C pipe meets the specifications of the American Water Works Association and of the U.S. Government. Under Federal Specification SS-P-351C, asbestos-cement water pipe is sold to the U.S. Public Health Service.

Because of the recognized occupational health hazards connected with the excessive and prolonged inhalation of asbestos dust, the question has been raised as to whether there might be a possible health hazard associated with drinking water that has passed through asbestos-cement pipe.

A QUESTION OF HEALTH

In late 1967, the U.S. Public Health Service was asked to look into this question, especially as it might be related to the risk of gastrointestinal (GI) cancer. Public Health Service officials discussed the matter with two prominent medical authorities in the field of asbestos and health. They were *Dr. George W. Wright,* Chairman of the Scientific Advisory Committee of the Institute for Occupational and Environmental Health, and head of the Medical Research Department, St. Luke's Hospital, Cleveland; and *Dr. Irving J. Selikoff,* Professor and Chairman, Division of Environmental Medicine, Mount Sinai School of Medicine, New York City.

Both *Dr. Wright* and *Dr. Selikoff* confirmed the Public Health Service's position **"that there is a low probability of any health hazard associated with the use of asbestos-cement pipe."**

Dr. Wright's position is summed up as:
"To my knowledge, there have been no reports in medical literature of a relationship between gastrointestinal (GI) cancer and the drinking of water supplied through an asbestos-cement pipe water system. There is no evidence that the ingestion of one, or a hundred, or a thousand asbestos fibers on one or more instances, is related to gastrointestinal cancer."

Dr. Selikoff's view is:
There is "no evidence at all at this time that the presumably very low level exposure by ingestion which might occur by intake of water supplied through asbestos-cement pipe has resulted in a recognized health hazard."

The Advisory Committee on Asbestos Cancers in its report to the Director of the International Agency for Research on Cancer, prepared October 6, 1972, considers the question: "Is there evidence of an increased risk of cancer resulting from asbestos fibers present in water, beverages, food or in the fluids used for the administration of drugs?" Their answer: *"Such evidence as there is does not indicate any risk."*

FOUR TYPES OF EVIDENCE SUPPORT POSITION

Four types of evidence support the position that A/C pipe poses no hazard:

1. Exposure of laboratory test animals to heavy concentrations of airborne asbestos dust, much of which was swallowed, has resulted in no observed cases of gastrointestinal cancer.

2. Experiments in which laboratory animals were deliberately fed a heavy dose of asbestos dust mixed with the regular food produced no tumors in animals.

3. Recent research indicates that only infinitesimal amounts of asbestos are released into drinking water that goes through asbestos-cement pipe.

4. In the face of the ever-increasing use of asbestos-cement pipe and of asbestos fiber, the death rate from gastrointestinal cancer in the United States has shown a steady *decline* over the last 20 years. This national trend also applies, in general, to those cities where A/C pipe has been used in water systems for long periods of time. Similarly, in European countries where A/C pipe has been used extensively (in many countries for more than half a century) the death rate from this type of cancer has also declined.

FURTHER DETAILS ON TYPES OF EVIDENCE

1. Animal experiments with airborne asbestos have not produced GI cancer.

Laboratory test animals are used extensively in cancer research to study their reactions to various substances that are suspected of having some relationship to cancer in humans. Tests of this nature, using asbestos dust in heavy concentrations in inhalation chambers, have been conducted on mice for as long as two years and on dogs for four or more years. The amount of fiber not only inhaled, but also swallowed, by these experimental animals is far in excess of any comparable human exposures.

Dr. Wright points out that in inhalation experiments, "the food, especially of the small animals, is covered by the settled-out asbestos fibers in the experimental chambers."

Inhalation experiments of this type have been conducted for many years in many laboratories *without a single report of GI cancer.* Dr. Arthur Vorwald and associates at the Saranac Laboratory of the Trudeau Foundation have issued two reports covering more than twenty years of investigation. Dr. J. C. Wagner conducted similar animal inhalation experiments in South Africa and in Britain. Neither Vorwald nor Wagner ever noted GI cancer in any animal.

In addition, experiments conducted by Dr. Selikoff on hamsters generally support the dog-and-mice findings.

"Yet," Dr. Selikoff commented, "the exposure to ingested asbestos in this experimental work was very much larger indeed than might be anticipated in water obtained from asbestos-cement pipes."

Summary: Animal inhalation experiments show no relationship between GI cancer and heavy concentrations of asbestos dust in the air, or the fallout of the dust on food.

2. Direct feeding of asbestos dust to experimental animals has failed to produce GI cancer.

In 1968 the British doctors, Bonser and Clayson, reported an experiment in which 40 rats were maintained on a diet which included approximately 2 grams of asbestos per week. No tumors of any kind resulted, they said, adding "nor were there any lesions in the intestinal wall which might have suggested a previous absorption of asbestos fibers."

Summary: Asbestos fibers, fed to animals in measured large quantities, have not produced GI cancer.

3. Municipal Water and Asbestos

A study was recently conducted of the drinking water in nine cities that have used asbestos-cement pipe for periods ranging from 8 to 17 years. *Not one of the water samples, either before or after passing through A/C pipe, contained fibers which were visible under a light microscope.* Only through use of the electron microscope was it possible to detect minute fibers of asbestos in any of the water samples. It is worthy of note that *all samples contained some asbestos fiber before passing through A/C pipe,* and in many cases the infinitesimal amount of fiber was essentially the same before and after exposure to the pipe.

One possible explanation for this is that natural waters, flowing through rock formations underground or through streams, appear to pick up trace amounts of asbestos, along with other minerals and naturally occurring chemicals. Thus, people for generations probably have been swallowing tiny amounts of asbestos in the water they drink.

The highest asbestos content per gallon of water tested was 6 micrograms, about one five-millionths of an ounce. In terms of human consumption this means that if a man were to drink eight glasses of water per day, he might swallow a total of twenty-seven ten-thousandths of an ounce (.0027) of asbestos in a lifetime of 70 years.

Summary: Present evidence does not support the contention that asbestos-cement water pipe releases asbestos into water in amounts that can constitute a health hazard to the general public.

4. Decrease in frequency of GI cancer in the United States.

Figures from both the National Office of Vital Statistics of the United States Public Health Service and from the American Cancer Society show a steady decline in the frequency of GI cancer in the United States from 1947 to 1966. The death rate per 100,000 of population from GI cancer dropped from 55.2 in 1947 to 48.4 in 1966. Available United States figures also show GI cancer declining since 1960 as a percentage of total deaths.

TABLE I

DEATHS FROM SELECTED CAUSES FOR THE UNITED STATES

YEAR	TOTAL DEATHS ALL CAUSES	DEATHS FROM GI CANCER	GI CANCER AS % OF ALL DEATHS
1960	1,711,982	91,035	5.3
1962	1,756,720	92,047	5.2
1964	1,798,061	93,158	5.1
1966	1,863,149	95,079	5.1
1970	1,921,000	94,640	4.9

Similar trends can be found in cities all across the country.* Take for example the comparison between Nashville, Tennessee, where no A/C pipe has been used and Knoxville, Tennessee, where A/C pipe has been used since 1938—over 30 years. Here's how United States government figures apply to those two cities.

TABLE II

NASHVILLE-KNOXVILLE COMPARISON

	NASHVILLE (NO A/C PIPE)		KNOXVILLE (A/C PIPE SINCE 1938)	
	1960	**1966**	**1960**	**1966**
Deaths from All Causes	3,675	3,901	3,038	3,360
Deaths from GI Cancer	129	185	131	153
GI Cancer Deaths As Percent of Total	3.5%	4.7%	4.3%	4.5%

*In considering these figures, it is important to remember (a) that cities tend to have higher rates of cancer than rural areas, so some city figures will run higher than the U.S. average, and (b) that minor fluctuations from year to year in the percentage figures, whether up or down, are of little or no significance, especially if the numbers are small.

Similarly, in Europe, where asbestos-cement pipe has been in use for fifty years or more, the death rate from GI cancer is generally downward. For example, in Switzerland, where the use of A/C pipe is the highest per capita of any Western European country, the death rate for GI cancer has dropped from 81.9 per 100,000 of population in 1951 to 63.9 in 1962, according to the latest figures available from the World Health Organization.

Thus the actual frequency of gastrointestinal cancer does not support any suggestion that the use of asbestos-cement water pipe is causing an increase in this type of disease. In fact, *during the very years that the use of A/C pipe has increased in the United States, the rate of GI cancer has declined.* It is clear that no causal connection has been demonstrated between the use of A/C water pipe and GI cancer in human beings.

Summary: "Substantial and increasing amounts of asbestos fiber have been used in various ways from 1930 on in the United States, and one would anticipate that if this fiber was playing a role in the causation of gastrointestinal tumors, it might be expected to have led to an increase in tumors, rather than the observed decrease." (Dr. George W. Wright)

AN OVERVIEW

Four types of evidence have been examined: (1) results of experiments with test animals exposed to large quantities of inhaled and swallowed asbestos particles; (2) results of experiments in which animals were fed measured large quantities of asbestos; (3) results of tests to determine the amount of asbestos in municipal water supplies; and (4) the frequency of GI cancer in the United States and Europe, including those areas using asbestos-cement water pipe.

All of this evidence goes against suggestions that the use of A/C water pipe has any influence on the development of GI cancer.

Finally, it is important to view this situation in its proper perspective.

Asbestos is by no means unique in being investigated as a possible health hazard. Literally hundreds of substances—as common and everyday as fuel oil, charcoal broiled steaks, iron rust, and egg yolks—are known to be, or suspected of being, cancer-causing agents to test animals under certain experimental conditions.

Nearly everything we use and create in our increasingly complex society has been suspected, by someone, of being a potential hazard.

To forego the many benefits of these products of modern technology, simply on the basis of suspicions that are unsupported by medical proof, would be unwarranted.

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Asbestos
A Family of Minerals

SUMMARY:
This paper sets forth some of the reasons why the term "asbestos" should not be used loosely in discussing medical questions.

There is no single mineral known as asbestos. "Asbestos" is a name given to a family of minerals. It includes two major groups, containing a total of six varieties of asbestos. Each of these six differs from the others, physically, chemically and in biological effect. Any study of the effects of asbestos is complicated by this diversity.

Studies of both people and animals show differing types of reaction to the various types of asbestos. Animal studies of excessive exposure made with three of the major commercial types of asbestos indicate that commonly-used chrysotile is least likely to produce a reaction.

Because different varieties of asbestos produce different reactions, scientists are working on better methods for identifying the types of asbestos involved in their studies on human health. Other complications arise because trace amounts of mineral impurities are often found in samples of raw asbestos ore and refined fiber.

TYPES OF ASBESTOS

Any attempt to assess the effect of asbestos on health is complicated by the fact that asbestos is not a single chemical or physical entity. "Asbestos" is a generic name given to a group of hydrated silicate minerals that have one common attribute – namely, the ability to be separated into relatively soft, silky fibers.

The known varieties of these minerals can be divided into two main classes on the basis of their crystalline structures: **serpentine** asbestos and **amphibole** asbestos. The lone member of the serpentine class is **chrysotile** asbestos, which is by far the most common of the asbestos minerals. About 95 per cent of the asbestos used in this country is chrysotile, principally from mines in Canada.

There are five recognized varieties of amphibole asbestos: **crocidolite, amosite, anthophyllite, tremolite and actinolite.** Of these, crocidolite and amosite have the greatest commercial significance, although the use of anthophyllite is increasing.

Each of the six types of asbestos differs from the others, chemically and physically. To add to the complexity, chrysotile asbestos from one Canadian mine, for example, will differ in chemical impurities and physical properties from the chrysotile taken from another Canadian mine.

CHARACTERISTICS OF THE FOUR MAJOR TYPES

Each of the four types of asbestos that are most important commercially – chrysotile, crocidolite, amosite and anthophyllite – exhibits distinguishing characteristics.

Chrysotile

By far the leading producers are Canada and the Soviet Union. Smaller deposits are found in South Africa, Rhodesia, China, the United States and Italy. Chrysotile is a *white* serpentine asbestos and occurs in areas where serpentine rock was cracked by earth movement thousands of years ago and subjected to intense pressure and the flow of volcanic waters. This action transformed some of the granular serpentine into fibrous chrysotile. Chemically, chrysotile is hydrous magnesium silicate with a magnesium hydroxide surface. It has a positive electrical charge. It can be attacked by acids. It is a flexible fiber and does not pulverize readily. Commercial chrysotile contains small and varying amounts of iron and calcium compounds, depending upon its origin.

Crocidolite
The bulk of the world's supply comes from South Africa; there are also small deposits in Australia, but they are no longer mined commercially. Crocidolite is an amphibole asbestos occurring in iron-rich sedimentary rock. Chemically, it is a ferrous sodium silicate with a silica surface. It has a negative electrical charge. It is acid-resistant. It is characterized by a deep *blue* color. Crocidolite is less flexible than chrysotile.

Amosite
The Transvaal district of South Africa is the only place in the world where amosite is mined commercially. It is a member of the amphibole asbestos family, occurs in the same type of rock as does crocidolite, has the same negative electrical charge, but is brown in color. Chemically, amosite is a ferrous magnesium silicate with a silica surface. It is acid-resistant, but less so than crocidolite. It is brittle and pulverizes easily.

Anthophyllite
The least used of the commercial fibers, it comes primarily from Finland but small amounts are mined in the United States. It is an amphibole asbestos, has a negative electrical charge, and is white in color. Chemically, anthophyllite is a magnesium silicate with a silica surface. It is acid resistant like the other amphiboles. It is brittle and pulverizes easily.

Because of the basic chemical and physical differences among chrysotile, crocidolite, amosite and anthophyllite, it would be expected that over-exposure to the four varieties would show varying biological effects. And scientific observation confirms this expectation. There seems to be broad agreement that chrysotile, the type of asbestos most widely used in the United States, is least likely of the three most commercially significant fibers (chrysotile, crocidolite, amosite) to produce asbestosis, a non-malignant lung disease brought on after inhalation of excessive concentrations of asbestos dust over a period of many years.

ANIMAL EXPERIMENTS SHOW DIFFERENT EFFECTS

Dr. J. C. Wagner experimented with three types of asbestos (chrysotile, crocidolite and amosite) on various laboratory animals, and found that –

crocidolite produced the most severe asbestosis, and

amosite was more than five times as likely to produce a reaction as chrysotile. He reported[1] in 1963:

"With chrysotile dust it was possible to produce severe lesions in the lungs of guinea pigs, slight fibrosis in monkeys, while no significant effect was observed in two rabbits. Amosite dust causes marked asbestosis in all three kinds of animals. Lesions occur more rapidly in guinea pigs exposed to this dust than in those exposed to chrysotile. There is an indication that the disease is progressive in monkeys and rabbits. Similar pathology to that which occurred in a monkey exposed to chrysotile for 22 months was observed in a monkey exposed to amosite for four months. The impure crocidolite dust caused severe disease in guinea pigs, and the rate of respiratory infection among animals exposed to this dust was more marked than with the other types. It is possible that this may be due to the high quartz content of the dust.

"Finally, asbestos bodies could be demonstrated in the lungs of animals exposed to all three types of asbestos dust. These were scanty in the animals exposed to chrysotile and usually segmented. Only occasional fibers were observed. In contrast to this, the asbestos bodies in the animals that were dusted with amosite were plentiful, and segmentation was rare: fibers were extremely numerous and far outnumbered the bodies."

Following further investigation, Dr. Wagner offered an explanation[2] for this observation at a medical symposium in 1965:

> **"A method of producing asbestos dust clouds has been devised and an animal inhalation experiment carried out to test it... The elimination rate of Rhodesian chrysotile has been found to be three times greater than that of the amosite and crocidolite, which suggests an explanation for the previously observed reduced fibrogenicity of this dust. The reason for the difference in the elimination rate remains to be determined."**

COMMERCIAL ASBESTOS CONTAINS OTHER MATERIALS

Asbestos ore and refined asbestos fiber contain mineral impurities, trace elements, and trace quantities of organics, which vary from type to type and from mine to mine. In addition, the ore may pick up additional trace organic impurities when in transit.

These trace materials are also the subject of medical study to see if they may have a role in any of the health effects observed in animals. Trace impurities of nickel, chromium and manganese, for example, were found by Cralley, et al.[3] in samples of chrysotile used in the asbestos textile industry. Other impurities in commercial asbestos fiber include iron, aluminum, calcium, sodium and potassium.

WORLD ASBESTOS BANK

Much scientific research has focused on studying the varying biological effects of different types of asbestos and on developing techniques for identifying asbestos fibers of unknown origin. In 1967, a "World Asbestos Bank" was established in Johannesburg, South Africa, under the direction of the British Medical Research Council. The purpose of the "bank" is to provide standardized samples of asbestos from regions all over the world to be supplied to medical researchers for chemical, physical and biological investigation and for comparison purposes in clinical studies.

CHARACTERISTICS OF MAJOR COMMERCIAL TYPES OF ASBESTOS

NAME	**Chrysotile**	**Crocidolite**	**Amosite**	**Anthophyllite**
CLASS	Serpentine	Amphibole	Amphibole	Amphibole
COLOR	White	Blue	Brown	White
CHEMICAL COMPOSITION	Hydrous Magnesium Silicate	Ferrous Sodium Silicate	Ferrous Magnesium Silicate	Magnesium Silicate
SURFACE COMPOSITION	Magnesium Hydroxide	Silica	Silica	Silica
ELECTRICAL CHARGE	Positive	Negative	Negative	Negative
REACTION TO ACID	Susceptible	Resistant	Resistant	Resistant
TEXTURE	Flexible	Medium Flexibility	Brittle	Brittle

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