PLAINTIFF'S EXHIBIT

CT-240

SUMMARY OF FINAL REPORT

STUDY OF THE CONTINUED USE OF ASBESTOS CEMENT PIPE

by

THE PIPE COMMITTEE OF THE
EAST BAY MUNICIPAL UTILITY DISTRICT

July 26, 1979

Background

The effect of the use of asbestos cement (AC) pipe on chrysotile asbestos levels in the distribution system was questioned in a letter to the District in September, 1978 from the California Department of Health Services (DHS). This letter prompted a study with the following four objectives:

1. Produce a study describing current District practices with AC pipe and the use of alternative pipe materials.

2. Determine the contribution of asbestos fibers to tap water by AC pipe.

3. Determine the corrosivity of District waters to AC pipe.

4. Determine alternatives to the use of AC pipe assuming the contribution of asbestos from AC pipe is shown to be significant from a health standpoint.

The letter from the DHS was the result of a University of California, Berkeley doctoral thesis entitled "Asbestos in Drinking Water and Cancer Incidence." The DHS commented in a press release September 22, 1978, that the thesis does "...suggest an apparent correlation between water supplies high in naturally occurring asbestos and higher-than-expected cancer of some body sites, including the stomach." The DHS also commented that the thesis "...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."

Asbestos Cement Pipe Usage

District installation of AC mains dates back to the 1930's. Most of these AC pipes, ranging from 4" to 12" in size, are still in service, and date back to 1935-1937.

Low cost, light weight, ease of assembly, and essential freedom from corrosion were factors which led to large scale usage of AC pipe up to the present time. In fiscal year 1978, the District added 33 miles of AC pipe to the system, which was 82% of the footage installed that year. At the end of fiscal year 1978, there were 990 miles of AC pipe mains in service, which is 30% of the total District footage.

CTD033742

Although diameters ranging from 4" through 12" were installed during the earlier years, the District now specifies AC pipe usage in 6" and 8" sizes only.

Asbestos Levels

Naturally occurring asbestos in the District's raw and treated waters is among the lowest in the Bay Area. Fiber counts in the distribution system range from 2 million fibers per liter to "Below Detectable Limits" (BDL), with typical counts of about 0.1 million fibers per liter. To put these counts in perspective, the aforementioned doctoral thesis that triggered the current review did not show any "apparent" relationship of asbestos fibers in drinking water to cancer until the fiber count was 10 million fibers per liter.

Even though asbestos fiber counts in District waters are far below the 10 million fibers per liter level, it was decided that it would be prudent to study the effect of AC pipe on asbestos levels in the distribution network and the use of alternative pipe materials.

Asbestos Cement Pipe Contribution to Asbestos Levels

The University of California data and samplings by the District did not demonstrate any statistically significant contribution to asbestos levels in tap water by asbestos cement pipe anywhere in the District's system. Typical data collected during the UC study are summarized in Table 1. Due to the inherent difficulties in conducting asbestos analyses, changes of less than an order of magnitude (i.e., a factor of 10) are not significant.

District "before" and "after" samplings of water passing through AC pipe were conducted at various locations in 1974 before the UC study and in 1978 after the UC study. Analyses were conducted in the same UC laboratory by the same person who conducted the analyses for the UC study. In all cases, no increase in asbestos levels upon passage through AC pipe was found in District samples. In fact, of the samples collected by and tested for the District, only one sample was at the detectable level and even this sample had an asbestos fiber count 150 times less than the 10 million fibers per liter level considered in the doctoral thesis to be potentially harmful. A summary of these analyses is presented in Table 2.

Tests were conducted to assess the contribution of AC pipe tapping to asbestos levels in treated waters. It was apparent from the tests that continuous, high velocity flushing of the tap machine during the tapping operation is essential in minimizing the asbestos added to the treated waters and would reduce the level of asbestos to negligible amounts. This flushing practice is now a requirement for all District-installed water service installations.

The Drinking Water Research Division of the U.S. Environmental Protection Agency (EPA) in Cincinnati, Ohio is conducting a national study on the use of asbestos cement in water systems. In a recent progress report presented at the National American Water Works Association Meeting in San Francisco in June, 1979, the EPA reached several conclusions which were identical to District findings. The two most significant of these were that water will not attack AC pipe if the "Aggressive Index" is above 11 (District waters are treated to maintain an Index of 12 or higher) and that continuous flushing of the tapping machine during pipe

CTD033743

tapping operations is very important (all District tapping machines have been modified to allow flushing). The complete list of EPA conclusions is contained in Appendix A.

Corrosion Control Practices

It has been a standard District practice to add lime or sodium hydroxide to eliminate the natural acidity in treated waters to make them non-corrosive. This practice was already established by the time asbestos cement pipe installations began in the late 1930's.

Chemical analyses conducted on District waters indicated that water in the distribution system is not corrosive to AC pipe. This conclusion was confirmed by observing several sections of pipe removed from throughout the system. Sections of pipe, which were in the system up to 41 years, were removed and found to have a thin protective coating and showed no erosion of the original pipe wall.

An "Aggressive Index" is used by the pipe industry to describe the corrosivity of water to AC pipe. Waters with an Aggressivity Index of 11 or above are considered non-corrosive to AC or other pipe materials. Treatment of all District waters with lime or sodium hydroxide results in water in the distribution system with an aggressive index of 12 or above.

Asbestos Cement Pipe Alternatives

Table 3 summarizes total installation costs of various alternative pipe materials. Data are based on actual installations within the District. AC and PVC pipe total installation costs are comparable and are significantly lower than the total installation costs for ductile iron and steel pipe. Note that pipe costs represent only 6 to 11% of the total installed cost. Costs have been brought up to date and made directly comparable by applying factors for length and difficulty of installation using a common cost index for the year of installation.

In the remote event a decision were made to discontinue the use of AC pipe, the best alternative based upon total installed cost would likely prove to be polyvinyl chloride (PVC) pipe. PVC pipe, however, has not been in use long enough to determine accurately its life expectancy. Recent PVC pipe field tests posed no major installation problems for District pipe crews.

PVC pipe is not totally free from concern since very low levels of vinyl chloride monomer, a cancer causing chemical, can be contributed to water through the use of this type of pipe. Vinyl chloride levels found thus far by Environmental Protection Agency researchers, however, are well below those that have been associated with adverse effects in test animals.

A test installation was also made using mortar-lined ductile iron pipe to supplement the District's extensive experience with mortar-lined steel pipe. During the installation no major problems were encountered by District pipe crews. There are no known health concerns in the use of either ductile iron or steel pipe; however, the total installed cost is roughly a fourth higher than that of AC or PVC pipe.

CTD033744

Conclusions

All data collected to date, including U.C. Berkeley laboratory tests, indicate that District water is not corrosive to AC pipe and that the use of this pipe material contributes no significantly measurable quantity of asbestos fibers to water in the distribution network. The contribution of asbestos to tap water by AC main tapping operations is reduced to insignificant levels by continuous, high velocity flushing of the tapping machine while in operation. These conclusions are consistent with recent EPA findings.

Additional test installations of PVC pipe should be conducted to more fully evaluate its installation costs relative to those for AC pipe. Mortar-lined ductile iron and steel pipe are available but are significantly more expensive.

Recommendation

Based on a study by the District's Pipe Committee, summarized in this report, it is recommended that the District continue using 6-inch and 8-inch asbestos cement pipe in the distribution system.

CTD033745

TABLE 1

UNIVERSITY OF CALIFORNIA ASBESTOS TESTING

Typical Data from 1974-77

Source/ Location	Chrysotile Asbestos Fibers/L	Lowest Detectable Limit Fibers/L	AC Pipe Length ft	AC Pipe Age yrs
Orinda FP (1976)				
before AC pipe	2×10^5	5×10^4		
after AC pipe	1.5×10^5	5×10^4	1800	15
Orinda FP (1977)				
before AC pipe	1×10^5	1×10^5		
after AC pipe	3×10^5	1×10^5	1800	16
Sobrante FP (1976)				
before AC pipe	6×10^4	2×10^4		
after AC pipe	BDL	2×10^4	1900	17
Sobrante FP (1977)				
before AC pipe	BDL	-		
after AC pipe	BDL	-	1900	18
Upper San Leandro FP (1976)				
before AC pipe	1.4×10^5	1.6×10^4		
after AC pipe	BDL	2×10^4	2200	17
Upper San Leandro FP (1977)				
before AC pipe	2×10^6	2×10^5		
after AC pipe	1×10^5	5×10^4	2200	18

*Below Detectable Limit

CTD033746

TABLE 2

EBMUD ASBESTOS TESTING

Typical Data, 1974 and 1978

Source/ Location	Chrysotile Asbestos Fibers/L	Lowest Detectable Limit Fibers/L	AC Pipe Length ft	AC Pipe Age yrs
Orinda FP (1974)				
before AC pipe	BDL*	2×10^4		
after AC pipe	BDL	2×10^4	1800	13
Sobrante FP (1974)				
before AC pipe	BDL	1×10^4		
after AC pipe	BDL	2×10^4	1900	15
Upper San Leandro FP (1974)				
before AC pipe	BDL	4×10^4		
after AC pipe	BDL	2×10^4	2200	15
Upper San Leandro FP (1978)				
before AC pipe	6.7×10^4	6.7×10^4		
after AC pipe	BDL	3.4×10^4	1300	12
Walnut Creek FP (1978)				
before AC pipe	BDL	8.6×10^4		
after AC pipe	BDL	6.7×10^4	1700	18

*Below Detectable Limit

CTD033747

TABLE 3

INSTALLATION COSTS OF AC PIPE ALTERNATIVES

Pipe Size and Material	Pipe Cost $/ft	Total Installed Cost $/ft
6" Asbestos Cement	2.20	38
6" Polyvinyl Chloride	3.00	38*
6" Mortar Lined and Plastic Wrapped Ductile Iron	4.09	43*
6" Mortar Lined and Plastic Coated Steel	4.02	53
8" Asbestos Cement	3.20	45
8" Polyvinyl Chloride	4.75	40*
8" Mortar Lined and Plastic Coated Steel	5.19	56
8" Mortar Lined and Plastic Wrapped Ductile Iron	5.55	58*

* Costs per foot for PVC and ductile iron pipe should be considered preliminary since relatively few installations have been made.

CTD033748

APPENDIX A

CONCLUSIONS OF THE EPA PROGRESS REPORT ON AC PIPE*

1. Calculation of the Aggressive Index alone is not sufficient to predict the behavior of asbestos-cement pipe.

2. Collecting a single sample for an asbestos fiber count is often insufficient to judge the behavior of asbestos-cement pipe in a given situation.

3. Drilling and tapping of asbestos-cement pipe, if not performed with a flushing device on the tapping machine, can cause a major release of fibers into the water.

4. Metals such as zinc, iron, or manganese in the water can change asbestos-cement pipe behavior.

5. The following conditions are indicative of situations in which the water <u>is not attacking</u> A/C pipe:

   a. An initial Aggressive Index above about 11 and,

   b. No significant change in the pH or the concentration of calcium occurring as the water flows through the pipe and,

   c. No asbestos fibers consistently found in representative water samples or,

   d. Significant asbestos fiber counts being found in representative water samples at one time, but not another at a location where water flow is sufficient to clean the pipe of tapping debris (recent tapping can cause high fiber counts not related to pipe attack) or,

   e. Significant asbestos fiber counts only being found in water samples collected from low-flow deadends or from fire hydrants (non-representative samples) and nowhere else in the system.

6. The following are conditions indicative of situations in which the water is <u>most likely attacking</u> A/C pipe:

   a. An initial Aggressive Index below about 11 and,

   b. A significant increase in pH and the concentration of calcium occurring as the water flows through the pipe and,

   c. Water not containing iron, or manganese, or possibly similar metals and,

* EPA Drinking Water Research Division Progress Report, "The Behavior of Asbestos-Cement Pipe Under Various Water Quality Conditions", Ralph W. Buelow, et. al., pgs. 52 and 53.

CTD033749

d. Significant asbestos fiber counts being consistently found in representative water samples collected from locations where: 1) the flow is sufficient to clean the pipe of debris and 2) drilling and tapping of the pipe has not been performed near or during the sampling period and,

e. Inlet water screens at coin operated laundries becoming plugged with fibers.

7. Although inspection of pipe sections removed from the ground is the best method of assessing the condition of asbestos-cement pipe, reviewing the above factors in addition to the determination of asbestos fiber counts by transmission electron microscopy (repeated sampling if possible) will aid in determining pipe conditions, if inspection is not possible.