PLAINTIFF'S EXHIBIT

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Dear Editor:

The enclosed contains background and current information about asbestos-cement (A/C) pipe.

Asbestos-cement (A/C) pipe, the water lifeline of many U.S. and Canadian cities and towns, represents a classic example of perceived "guilt by association" because of its name, and one of its components, asbestos. It is that very component which, when combined with silica and cement, gives A/C pipe its structural strength, durability, and cost effectiveness. Moreover, there is substantial scientific evidence that the use of A/C pipe in water systems does not create a public health hazard.

This packet of source material about A/C pipe is offered in the sincere hope that you will retain it for your publication's "morgue" or for your personal reference file. We will forward updated information as it becomes available.

The Association welcomes any questions or comments you may have on this subject now, and in the future.

Sincerely,

John F. Welch

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A/C PIPE - ASSESSMENT OR ADVOCACY?
A reassessment and commentary
on the issue of asbestos in
drinking water.

by J. F. Welch
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For more than a century, the water works industry has been a remarkable engine of progress. The reliable and safe provision of drinking water came about with little fanfare. Yet, it is difficult to imagine a single engineering achievement that has contributed more to industrial progress and improvement of the human condition.

But in the past decade, the innovative spirit of the water works industry has been throttled by a new set of problems which are the product of a new kind of science administered by a new breed of advocate. Nowhere is this problem more evident than in the investigation of the potential health effects of trace substances in drinking water. These scientists, both the self-acclaimed environmentalists and those garbed in the lab coats of government bureaucracies, are motivated undoubtedly by an admirable concern over what they perceive should be the quality of drinking water. In the extreme, some are either misguided or mistaken in their judgments. Others skate perilously close to and sometimes cross the line between fact and fiction.

Such is the case with the article "Asbestos Cement Materials Used in Water Supply," (Water Engineering and Management, March, 1981) in which science takes a back seat to advocacy. The references cited in support of the "assessment" are selective and misleading. The article's hypotheses are unsubstantiated by an objective review of the literature and moreover, its conclusions have been rejected repeatedly by independent and government scientists and the water works industry in general.

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CORROSION OF A/C PIPE

The use of electron microscopy to evaluate the corrosion of asbestos cement (A/C) pipe epitomizes the scientific scrutiny to which the product has been subjected. But like the preoccupation with "part per billion" or "part per trillion" levels of substances in drinking water, what does it tell water utility managers? Or public health policy makers? Or the public?

That asbestos cement water pipe may corrode is not and never has been subject to question, only the degree and the relevance. Prior to development of the Aggressiveness Index (AI), discussed later, manufacturers recommended that the use of A/C pipe in waters with a Langlier Index of -2.0 (AI= 12.0) or less would be inconsistent with the expected design lifetime of water systems. Tests conducted by the U.S. Bureau of Standards[1] and the U.S. Bureau of Mines[2] established the excellent corrosion resistance and durability of A/C pipe in severe water and soil environments. On a more practical level, the increased use of A/C pipe in municipal water systems for the past fifty years in the United States, and nearly seventy years in Europe, attests to the long term retention of its structural and hydraulic integrity.

What then does a 30-40,000 magnification picture of a pipe area approximately 150 micrometers wide tell you about the C-factor or long term structural integrity of any pipe? Very little. As a matter of fact, the proverbial baby's bottom probably looks pretty rough under such magnification.

OBSERVANCE AND CONCENTRATIONS OF ASBESTOS IN DRINKING WATER

It is perplexing why dramatic "worst case" situations are portrayed as the rule rather than the exception. Case in point: The "12-year old, 4 in. asbestos-cement pipe system in Wisconsin" described in the article.

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The water entering the system in question was not only "corrosive" but highly corrosive by any standard. The source water was extremely soft (calcium hardness = 7) and very acidic (pH = 4.2). Thus, the Aggressive Index was approximately 5 or 100,000 times more aggressive than the lower limit of American Water Works Association guidelines for ensuring the long-term structural integrity of A/C pipe. "One example" to be sure but certainly not a representative one.

Nor can the fiber concentrations in this system be considered representative. The 10 billion fibers per liter figure is almost certainly a spurious one. It was based on a single sampling from a fire hydrant, a method notorious for its inaccuracy. On single sampling, EPA's position is that collecting one sample from an A/C pipeline for an asbestos count is often insufficient to judge the actual behavior of the pipe[3]. Other EPA scientists[4] have rejected the validity of fiber counts taken from hydrants:

> Samples with high asbestos levels had been taken from fire hydrants which can cause abnormally high flow that will disturb the systems and easily pick up this material, thereby giving non-representative fiber counts.

Table 1 of the article lists asbestos concentrations in some A/C pipe systems. An unspecified number were taken at fire hydrants.

The finding of "wads" of asbestos fibers in faucet strainers also suggests the absence of routine main flushing, and possibly may be the result of disturbance, by the hydrant sampling, of sediment (including tapping residues) long quiescent in the system.

EXTENT OF A/C PIPE CORROSION AND PERSONS AFFECTED

Disregarding the gross underestimation of miles of A/C water pipe in use in the U.S, the article's estimate of the extent of corrosion of A/C pipe is flawed. This results from reasoning that the Aggressiveness Index was meant to quantify the corrosion of A/C

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pipe in the context of asbestos release. It was not, as other EPA scientists have observed:[5]

> The use of the AI as a predictor of the condition of the interior surface of the pipe ... and its tendency to retain or release asbestos fibers has come about in spite of the fact that the originial intention of the index was to outline water conditions that might cause structural failure of the pipe. The difference in application is very significant.

There is neither a quantifiable nor a predictive relationship between any corrosion index and levels of asbestos released from A/C pipe into drinking water. In fact, the author testified to that effect in public hearings in 1980, when he stated:[6]

> Further work has shown us that the aggressive index is not the perfect indicator of whether a water will corrode an asbestos-cement pipe and release fibers.
>
> * * * * * * * * * *
>
> The calculation of the aggressiveness index alone is not always sufficient to predict actual behavior of A/C pipe.

EPA researchers repeatedly have highlighted the imprecision of the AI as even a rough barometer of fiber release. The most recent EPA position, soon to be presented at the International Corrosion Forum, flatly rejects the AI - fiber release hypothesis:[7]

> Substantial field and pilot plant data, combined with comprehensive evaluation of many of the important chemical complexation and precipitation reactions occurring in drinking water, give compelling evidence that the AI has immense shortcomings with regard to use as a predictor of fiber release and interior surficial pipe condition that enjoin against its use under most circumstances.

The AI is a second generation technical guideline to govern the selection of the proper type of A/C pipe for use with waters of differing aggressiveness[8]. It is based on empirical observation and scientific tests of specimens from A/C pipe systems. Its sole purpose is to assure the long term structural integrity of the product. Based on field experience, it does just that. If anything, the AI is comfortably conservative. A recent analysis[9] of nearly forty pipe samples removed from A/C pipe systems after many years of service (including service in highly aggressive waters) shows this to be the case.

The article goes on to make a (very) "rough estimate" that 33,000 miles of A/C pipe may be exposed to highly aggressive water. This figure is rudimentary at best and again represents a "worst case" scenario because it is based on two incorrect assumptions. The first is that the hundreds of thousands of miles of A/C pipe in the U.S. are uniformly distributed throughout the continent. The second is that highly corrosive waters are similarly distributed. This makes for quick and easy estimates, but very weak science. The fact is that the use of A/C water pipe in the U.S. predominates in states west of the Mississippi River. Moreover, while highly corrosive waters occur in some parts of the western U.S., notably the Pacific Northwest, as Figure - shows they abound in New England, Mid-Atlantic and Southwestern areas of the U.S. It has been estimated that a very small percentage (7%) of the population of the western region of U.S. is exposed to soft water[10]. Thus, the estimates of the number of people which "may be affected" (if indeed there is an effect) are greatly inflated.

These population estimates are confounded further by use of the AI to estimate fiber release. The serious shortcomings of this logic have been discussed previously. The EPA Drinking Water Research Division points out:[11]

> In most cases the dependence upon the AI has resulted in more pessimistic projections of the deteriorative nature of the water than actually exist, so the human exposure to released fibers and the number of utilities encountering large scale pipe degradation is less than it otherwise might be.

In citing the absence of correlation between fiber counts and reports of deteriorated pipe in forty-five out of forty-six towns in Connecticut, the article reaffirms in its own words the highly speculative nature of these population estimates. The 10 million person estimate is later supercharged by the guess that an additional 30 million "might be affected to a lesser extent if the utilities are distributing moderately aggressive water." This too is largely conjectural.

Lest the reader forget, asbestos is virtually everywhere in the United States and many parts of Canada and thus, is a naturally occuring substance in most water

supplies. Ironically, it is likely that the population exposed to asbestos in drinking water is much more than the 40 million persons which the article estimates. However, probably less than 1 percent of all of the asbestos consumed in drinking water comes from A/C pipe systems with the remaining 99 percent coming from naturally occurring sources.

Finally, it is difficult to reconcile the inconsistencies between this article and another[12] published a year ago by the same author in which the following conclusion is made:

> While it is estimated that some 200,000 miles of asbestos cement pipe are in use in the United States, reported analyses suggest that most asbestos cement pipe does not shed significant numbers of fibers into the water.

Skepticism is more than justified when scientific opinion on the same data blows like a weathervane in the wind.

POTENTIAL HEALTH HAZARD?

The article accurately states that the concerns about asbestos ingested in drinking water eminate from the observance of disease in occupational workers, principally asbestos miners and millers, insulation and factory workers. These worker groups were exposed to heavy and prolonged concentrations of airborne asbestos fibers, a large portion of which were cleared from the lungs and swallowed. The argument that the exposure of asbestos workers is directly relevant to the ingestion of asbestos in drinking water is a specious one.

In the estimation of risk from asbestos ingestion, the best source of information would be human ingestion studies, the next best would be animal ingestion studies, and the third best would be human or animal studies where the asbestos enters the body by some route other than ingestion. In the latter case, i.e., secondary route of entry, any cause and effect relationship inferred would be tenuous. So, it is extremely important that all of the available information be considered.

The Safe Drinking Water Committee of the National Academy of Sciences (NAS) expressed its views[13] on the problem of extrapolating from inhalation to ingestion

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stating:

> The fact that exposure to air heavily polluted with asbestos mineral fibers often leads to the diseases mentioned above does not necessarily indicate that drinking water contaminated with an equally large number of such fibers may lead to the same diseases or perhaps some other diseases.

NAS is not alone. Similar conclusions have been drawn by independent scientists[14] and an American Water Works Association Research Foundation select committee[15] which considered the question of the health hazard of asbestos in drinking water.

The selective presentation of studies in Table 4 of the article also would have readers believe that all workers occupationally exposed to airborne asbestos manifest increased incidence of gastrointestinal disease. This too is misleading and incorrect. Table 4 is only a small part of the available data on asbestos inhalation and disease. As the fine print shows, these worker groups were exposed to "severe" and "heavy" exposures. Although not labeled as such, the "insulation workers" category involved airborne exposures of similar magnitude. Other such studies, particularly those involving low-level occupational exposures have found no increase in the relative risks of gastrointestinal cancer.

These studies again represent "worst case" situations which have marvelous media value but which do little or nothing to illuminate the issue for water works managers and public health officials. The studies of asbestos inhalation have produced conflicting results concerning risks of GI cancer and in any event represent an exposure level and primary route of entry of no direct relevance to the consumption of drinking water.

The selective character of the article's studies is particularly striking when one considers the voluminous data pointing to much, much lower or no risk at all from asbestos ingestion. The article fails to note that other epidemiology studies by the same researchers cited in Table 4 (Selikoff and Newhouse[16]) find no increased risk in

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gastrointestinal cancer in certain worker groups exposed to asbestos. This is not an isolated instance as Table 1 shows.

The AWWA Research Foundation study of asbestos in drinking water compared quantitatively the types of exposure from ingestion of asbestos in an occupational environment with exposure from asbestos cement pipe. The report concludes that the asbestos which can be expected to be consumed in a 60-year lifetime from an asbestos cement system with high fiber release levels is on the order of .005 grams, which is approximately two ten-thousandths of an ounce in a lifetime. The report goes on to compute that the occupational exposures in the studies that found an increase in gastrointestinal cancer resulted in lifetime exposures to ingested asbestos of as much as 336 grams, or over four orders of magnitude greater than the exposure from an A/C pipe system with high fiber levels.

THE PENETRATION QUESTION

Whether or not asbestos fibers cross the intestinal tract is indeed a matter of interest. If, after all, clay fibers and latex spheres can cross the intestinal wall, why not asbestos fibers? The important questions, as far as drinking water is concerned, should be "How much?" and "Does that crossing result in risk of disease?" In none of the studies cited in the article has there been even the suggestion that disease resulted in humans or animals so exposed. As a yardstick of exposure, the baboon study involved a total dose of 3.0×10^{13} fibers (per kilogram body weight) fed to the test animal. Given this heroic level, the finding of asbestos in baboon kidneys is no more a surprising phenomenon than the observance that asbestos in humans, like other body wastes, may be eliminated by the kidneys.

TABLE 1

Gastrointestinal Cancer in Workers

Occupationally Exposed to Asbestos

Study	Observed Deaths	Expected Deaths
Selikoff and Newhouse (1979)	3	3.1
	3	2.8
Newhouse and Rubino (1979)	4	4.8
	15	14.5
Peto (1977)	No increased incidence	
Meurman (1974)	No increased incidence	
Weill (1979)	No increased incidence	

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ANIMAL STUDIES

The premise that health effects in animals, properly qualified, are applicable to man underlies all of experimental biology and medicine. Likewise, the exposure of experimental animals to agents in high doses is a valid method of assessing possible hazards in man. These facts are no less true for asbestos than any other exogenous agent.

Like the data on occupational groups exposed to airborne asbestos, the article, without any qualification, presents only a small portion of the many animal studies conducted. As a matter of fact, the article improperly denigrates the consistency of negative findings in animal studies, stating that such studies are not "truly conclusive." A much more reasonable conclusion would be that these findings, based on no less than 10 animal studies, provide strong and consistent evidence that ingestion of asbestos in drinking water does not result in disease.

In the past six months, two important findings have been made in animal studies. In the only experiment in which animals were actually exposed to asbestos fibers via drinking water (as opposed to through the diet), the authors reported that no malignant tumors were found in hamsters maintained on drinking water containing 13,000 million amosite fibers per liter of drinking water for a lifetime.[17]

The large scale asbestos feeding study referenced in the article also recently reported its preliminary findings. These studies, which are being conducted by the National Institute of Environmental Health Sciences (NIEHS) and partially funded by EPA, reported that after a lifetime oral exposure to a 1% dose level of asbestos:[18]

> There was no indication of major differences in the mortality rate between the hamsters receiving the asbestos diet or the control diet.

* * * * * * * * * * * *

Histopathological examine of tissues from female hamsters has been completed. The contractors reported that a preliminary analysis of the hamster data indicates that no carcinogenic or cocarcinogenic effect was observed.

EPIDEMIOLOGICAL STUDIES

Substantial epidemiologic evidence exists that the ingestion of asbestos in drinking water does not cause cancer. Studies of populations exposed to asbestos in drinking water supplies have been conducted in Connecticut[19,20], Duluth[21,22], Canada[23], and the Pacific Northwest[24] where millions and in some cases billions of asbestos fibers per liter are present in the drinking water. These studies have been conducted for at least ten years, some using data bases extending for up to 35-40 years — well beyond the latency period for cancer. All such studies have failed to show a carcinogenic risk from ingesting asbestos in drinking water.

The latest Connecticut study used particularly refined and sensitive methods and concluded that " ... the lack of coherent evidence of cancer risks from use of A/C pipe is reassuring." The researchers stated " The results reported here provide no evidence for changing current water distribution policies for Connecticut water supplies because of A/C pipe use." Under oath, the principle investigator testified that it could be stated unequivocally on the basis of this study that there is no health hazard associated with A/C pipe.

The only epidemiological study[25] ever to suggest a positive correlation between asbestos ingestion and gastrointestinal cancer is discussed in the article. This was done under contract to EPA and was an indirect incidence study in which census tracts with different amounts of asbestos in drinking water were compared for cancer incidence after attempting to account for relevant variables.

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This study does not establish any cause and effect relationship between asbestos and drinking water and disease. It has been reputiated by the California Department of Health Services[26] and is not considered "definitive" by the Environmental Protection Agency[27]. The study's authors also have recognized the limited predictive value of this one study, stating in their report that studies such as this can only suggest associations and can not pinpoint definite causation. A peer view of the San Francisco study concluded that, beyond the lack of control for ethnicity, occupational exposure to asbestos, dietary or smoking habits, alcohol consumption, or exposure to other potential carcinogens in drinking water, the study did not adjust for population density. (People who live in more crowded areas where the population density is higher consistently manifest higher cancer rates). This serious experimental flaw led two independent epidemiologists to conclude that the findings of the study simply are not valid.

The article goes on to attempt to establish a link between findings in the San Francisco study and the finding of increased rates of stomach and pancreatic cancer in areas of Canada. This is a misrepresentation of the facts. The principal investigators of the Canadian study refute this supposition:[28]

> The present study does not support an association between pancreatic cancer and exposure to asbestos fibers in drinking water, because there was not excess among males. The excess stomach cancer among males may reflect occupational exposure to asbestos; the absence of an excess among females argues against a role for waterborne asbestos.

WATER QUALITY CRITERIA FOR ASBESTOS

The EPA water quality criteria for asbestos, published in late 1980, do not accurately reflect either the latest or the best scientific knowledge on the subject. The Agency was compelled under a consent decree with the National Resources Defense Council to issue criteria for asbestos along with 64 other toxic pollutants. The conclusions supporting the risk estimates were drawn almost exclusively from inhalation studies, despite the fact that a substantial amount of ingestion research was available, including scientific findings specific to asbestos in drinking water.

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Water quality criteria are not rules, have no regulatory effect, are not "maximum contaminant levels" for asbestos in drinking water, and by EPA's own admission, are not expected to be the same as standards or guidelines issued by EPA under the Safe Drinking Water Act. The asbestos industry is reviewing various options for challenging the action of the Agency in this matter.

To put the 300,000 fiber per liter figure "risk value" in perspective, remember that 300,000 asbestos fibers per liter of drinking water is approximately three parts per trillion.

CONCLUSIONS

When will the evidence on asbestos in drinking water be conclusive? That questions nags the water works industry and the water consuming public as much as it nags the A/C pipe industry. Is data inconclusive because it is "not conclusive enough to support a drinking water standard?" No. In the face of substantial evidence to the contrary, is it appropriate to respond with paralytic prudence to an advocacy position and not use A/C materials in water supply construction? No again. This action is not only unwarranted scientifically, but inconsistent with the latest statement[29] on the matter by the EPA Office of Drinking Water:

> The EPA has not yet reached a definite position on the ingestion risks and hazards of asbestos cement pipe, but research is continuing both with animal feeding studies and epidemiologic studies of human populations exposed to asbestos through drinking water.

The Environmental Protection Agency and the scientific community have been studying asbestos in drinking water for nearly eight years. Millions and millions of taxpayer dollars have been spent to confirm the hypothesis that the ingestion of asbestos in drinking water is hazardous. The findings of all studies conducted to date have rejected that hypothesis.

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For every substance, there comes a point in history when available scientific knowledge supports reasoned decisions. That time has come for asbestos in drinking water. It is time to put aside the preconceived hypothesis about asbestos in drinking water. It is time to look at the scientific evidence in its totality ... not through the oculars of an electron microscope. It is time for advocacy to yield to science.

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