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Publisher's version / Version de l'éditeur:

ASCE Pipeline Conference 2010: 28 August 2010, Keystone, Colorado, USA [Proceedings], pp. 1-10, 2010-08-28

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NRCC-52715

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September 2010

A version of this document is published in / Une version de ce document se trouve dans:
ASCE Pipeline Conference 2010, Keystone, Colorado, USA, August 28-September 1, 2010, pp. 1-10

SAFETY AND WASTE MANAGEMENT OF ASBESTOS CEMENT PIPES

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Abstract: Asbestos cement (AC) water mains, generally considered as non-friable asbestos-containing materials (ACMs), are not believed to represent a significant hazard to public health in normal use. However, repair, rehabilitation and removal of AC pipes involve cutting, polishing, and demolition can release asbestos fibers into the air, posing risks to public health. Many water utilities in North America currently have significant portions of their water mains composed of AC pipes. A comprehensive survey was conducted with 20 water utilities in the United States of America and Canada to understand the existing conditions of AC water mains in North America and to determine current management practices related to AC pipe repair, rehabilitation, and replacement. The survey was conducted through questionnaires that covered various areas: pipe inventory; environmental working conditions; current practices in pipe repair, rehabilitation and replacement; and safety/health protection practices used in working with, and disposing of AC pipe.

This paper focuses on the survey results related to safety and disposal issues, including existing regulations related to testing and concentrations of asbestos fibers in drinking water, AC pipe project management, worker protection measures, and existing disposal practices for broken AC pipes. Results indicate that some utilities do not have well-established procedures to provide suitable protection for workers and the general public during AC pipe projects. Some current practices can also lead to potential problems for future site development. For example, less than half of the utilities reported having a formal procedure specifically for dealing with AC pipe in water distribution systems. When replacing broken AC pipes, more than half of the utilities had abandoned broken pipes and buried them in place as their primary method of disposal. Standardized procedures, which can be critical for the safety of workers, the public and future site development, are needed by water utilities for handling AC pipes during the repair, rehabilitation, and replacement of AC water mains.

INTRODUCTION

AC pipes are considered non-friable asbestos-containing materials (ACM) when intact. They are unlikely to release large quantities of asbestos into drinking water during normal use. However, severe deterioration of the inner pipe surface, along with sudden changes in hydraulic conditions, may cause the release of asbestos fibers into drinking water. Although there are fewer health concerns about waterborne asbestos fibers, there are still concerns about the inhalation of airborne asbestos from showers, humidifiers, etc. There are also some concerns about the ingestion of fibers from drinking water as well as the clogging of filter systems. The United States Environmental Protection Agency (USEPA) has set the maximum contaminant level (MCL) for asbestos in drinking water at 7 million fibres per litre (MFL). All public water systems are required to monitor for asbestos in the distribution system for the first three years of each 9-year monitoring cycle. In Canada, the Guidelines for Canadian Drinking Water Quality do not provide an established maximum acceptable concentration (MAC) for asbestos fibers.

Compared to the low health hazard associated with the ingestion of asbestos released into drinking water, the repair, rehabilitation and replacement of AC water mains pose an increased health concern because they involve pipe cutting, polishing, demolition, transportation and disposal. These practices can release asbestos fibers into the air, particularly when pipes are mishandled or damaged (Von Aspern, 2008; DEQ, 2006; AWWA, 1995). Once the asbestos becomes airborne, it poses risks to project workers and the general public that are nearby the work area.

Replaced AC water mains are either abandoned in place or collected and disposed in designated sites. Abandonment-in-place may cause health risks related to future construction activities at these sites. However, this practice is still one of the preferred methods for many utilities. Some disposal practices can create current public health risks, and the hazard can also extend to future generations. For example, some trenchless replacement methods break the AC pipes into pieces and leave the AC material in a zone around the new pipe after replacement (Von Aspern, 2008). More water utilities have realized that disposal of broken AC water mains in designated sites (such as municipal hazardous waste disposal sites) provides better monitoring and control for future assessments and follow-ups. However, as there is no standard procedures to follow, plus limited financial resources, some utilities abandon the broken AC pipes in place.

This paper discusses current practices reported by the surveyed utilities in the following areas: (1) compliance with regulations governing the MCL for asbestos fibers in drinking water and testing protocols; (2) protection measures during repair, rehabilitation and replacement activities; and (3) current practices for the safe disposal of AC pipe materials. Based on utilities' current practices, health risks to the construction workers, the public and the environment, the authors provide recommendations related to safe practices and appropriate disposal methods for broken AC pipes. These recommendations provide a basic framework to assist water utilities in developing their own standard procedures for AC pipe repair, rehabilitation, replacement and disposal.

SURVEY OF WATER UTILITIES IN THE UNITED STATES AND CANADA

To understand current practices in safety and waste management of AC pipes in North America, a survey was conducted of twenty participating utilities from different regions of North America (Fig. 1). The twelve water utilities from the United States of America are located on the west coast (Washington, California, Nevada, Arizona and Idaho), east coast (New Jersey and Pennsylvania), and Alaska. The eight municipalities from Canada are located on the west coast (British Columbia) and Prairie Provinces (Alberta and Saskatchewan). The survey questionnaires included questions related to safety and waste disposal methods currently being practiced during operation and maintenance of AC pipes, as well as other questions concerning pipe inventory, and working and environmental conditions.

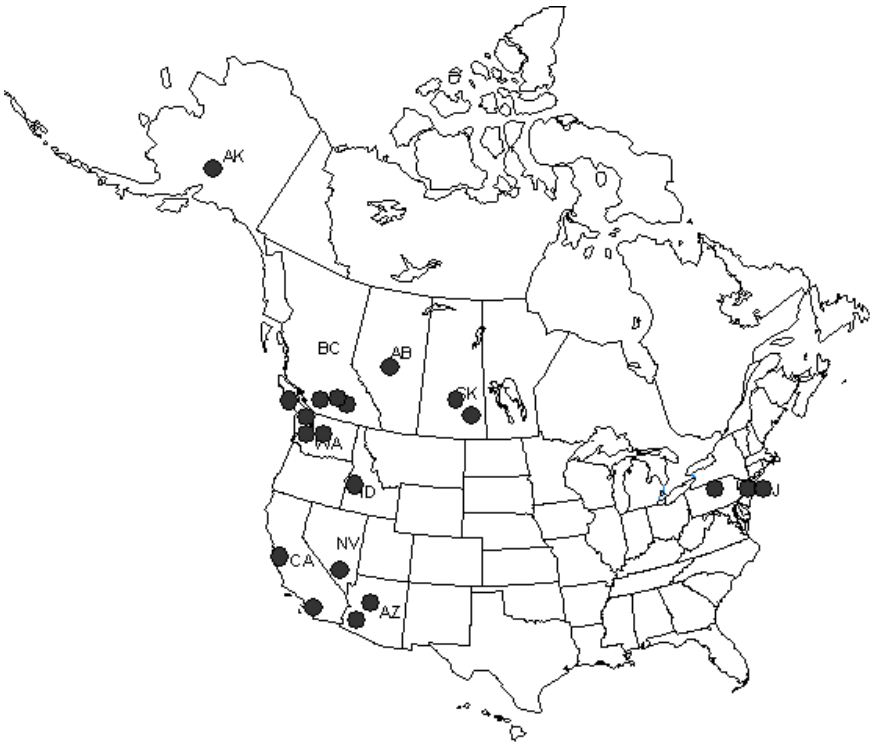

Fig. 1 Geographic locations of the participating utilities in USA and Canada

Asbestos fibers in drinking water

As expected, all 12 participating utilities in the United States followed the USEPA regulation regarding asbestos in drinking water (or the corresponding state regulations) and tested their drinking water for asbestos fiber concentration. The USEPA's regulation specifies the number and size of fibers that are allowed in public water systems. The MCL for asbestos fibers longer than 10 micrometers is established at 7 million fibers per liter (MFL). The MCL is established based on an assumption that some people who drink water that contains asbestos in excess of the MCL over many years may have an increased risk of developing benign intestinal polyps. Most States in the U.S. have adopted or enforce the regulations as prescribed by the federal agency. It should be noted that EPA set this MCL at this level because it believed, given present technology and resources, that this was the lowest level to which water system owners can reasonably be required to remove this contaminant should it occur in drinking water sources (USEPA, 2002).

In Canada, it is believed that exposure to high concentrations of asbestos in drinking water is unlikely. In addition, regulatory officials have taken the position that there is no consistent and convincing evidence that ingesting asbestos via drinking water is hazardous to health. Therefore, Health Canada has not established a MAC for asbestos in drinking water. Following the Guidelines for Canadian Drinking Water Quality, all provinces do not have regulated maximum asbestos concentrations.

Among the 11 utilities that responded, only one reported an asbestos concentration greater than 1 MFL (from Canada). The other 10 utilities had test results <0.2 MFL and 4 of these utilities had

no detectable levels in their drinking water samples. This is consistent with the results of earlier surveys which found that most of the American population consumes drinking water containing asbestos in concentrations far less than 1 MFL (Millette et al., 1983). However, when AC pipes are severely deteriorated, there can be a large flux of asbestos into the drinking water; the concentrations could reach 100 to 200 MFL (Chatfild and Dillon, 1979; Toft et al., 1984).

Established procedures for AC pipe projects and site preparation

Survey results showed that 90% of the 19 utilities that responded to the survey had established formal procedures to deal with AC pipe related activities. Some of them had adopted procedures used for the management of other ACMs to their work when AC pipe was involved. Only 2 utilities responded that they did not have a formal procedure specifically for AC pipe projects, although one of them indicated that a respirator and proper eye protection were required when cutting or drilling AC pipes. Properly established procedures can assist water utilities in managing AC pipe projects to ensure the protection of public health and safety. Based on this survey, it appears that most utilities with significant proportions of AC pipes in their distribution systems are aware of the related health concerns and have established formal procedures to address these hazards. However, these procedures can vary significantly from one utility to another, based on the responses to questions regarding preparation of excavation sites, protection of workers' health, and the disposal of broken AC pipes.

The majority of surveyed water utilities undertook preparatory work prior to AC pipe repair, rehabilitation or replacement projects (Table 1). The preparatory work included informing project staff about the nature of the project (17 of the 19 responding utilities), identifying existing asbestos hazards (11 utilities), preparing the excavation site according to established procedures (15 utilities) and conducting initial exposure assessment testing for a baseline report (4 utilities). Excavation site preparation can include: a) posting a warning sign at the entrance to the excavation area; b) restricting access to the site, restricting the work area using barricades; or c) providing hand/face washing facilities at the site. Eleven out of the 19 utilities prepared their excavation sites by establishing regulated work areas using barricade tape and six posted asbestos warning signs at the entry points of their work areas. Five utilities established waste loading areas adjacent to the excavation areas and restricted public access to the work areas once excavation started. One utility also conducted a negative exposure assessment (OSHA, 2002) for their asbestos projects. Two utilities indicated that they did not treat AC pipe excavation differently from other pipe excavations; therefore no specific preparation was performed.

The established procedures used by water utilities differed significantly from one to another. Most utilities responded that they laid the groundwork for AC projects by informing workers of the nature of the projects, identifying existing asbestos hazards, and preparing excavation sites. It should be noted that although more than half of the utilities stated they performed excavation site preparation, few gave details of the preparatory work that was done (such as providing washing stations, posting asbestos warning signs, establishing work areas with barricades, and not allowing public access to the work sites). It was evident that utilities employed different measures to manage the operation of AC pipe projects and to protect the health of the general public.

Table 1 Participating utility responses to preparation for AC pipe projects and site excavations

Preparation for AC Pipe Projects	# Utilities	Preparation of Excavation Sites	# Utilities
Conduct initial exposure assessment	4	Provide wash station at site	4
Identify existing asbestos hazards	11	Post asbestos warning sign	6
Prepare the site for excavation	15	Establish work area with barricade	11
Inform workers about the nature of the project	17	Establish a waste load-out area	5
Collect air samples for asbestos testing	3	No access to the regulated work area	6
No Preparation	2	No Preparation	2
Total participating utilities	19	Total participating utilities	19

Similarly, for staff protection, each utility had its own standards. Most personal protective equipment (PPE) used for AC pipe projects were also typically required for other construction activities (e.g., steel-toed boots, hard hats, safety glasses and rubber/leather gloves). Some utilities believed that hard hats, steel-toed boots, safety glasses and rubber/leather gloves were enough to provide worker safety. Other utilities added respirators and protective clothing as required PPE for projects related to AC pipes. All utilities responded that their staff wore hard hats; 94% wore steel-toed boots and safety glasses, and 75% wore rubber gloves when working on AC pipe projects. Slightly more than half of the responding utilities required their staff to wear protective clothing, and only half indicated that their staff used a respirator apparatus.

In summary, most utilities realized that repair and replacement of AC pipes involved ACMs. However, in practice many treated AC pipe projects similar to any other pipe excavation activity, therefore, no additional PPE was used.

Disposal of broken AC pipes

After the excavation and exposure of AC pipes, the condition of the pipes can be visually inspected. An on-site decision is then typically made to fix or replace the pipes. Some pipe breaks can be repaired using clamps. In other cases repairing pipes does not make economic sense and the pipes must be replaced. Once the replacement decision is made, the original AC water mains should be treated as ACM and proper abandonment or waste disposal should be considered. In some states regulations allow the broken AC water mains to be left and buried in place. In other states the asbestos rules prohibit in place abandonment of AC water mains once they are exposed. Even under the strictest regulatory regimes, AC pipe materials were allowed to be left in the ground in certain circumstances, such as for AC pipe located under a building.

Leaving broken AC pipes in place or burying them on site are the most convenient and cost effective means of disposal. Seven of the 19 utilities (37%) currently employ these practices. The other 12 utilities (63%) remove the broken pipes and dispose of them in designated locations, if possible. Among these 12 utilities, five indicated that off-site disposal in designated

locations was their only approach, and the other seven utilities used both on-site disposal and off-site disposal, depending on the specific site situation. In addition, one utility chose to remove AC pipes, cut the pipes into 1 to 2 m (3 to 5 foot) lengths, and place them in plastic bags for shipping to specified sites as their only disposal method. Two of the utilities chosen on-site disposal also indicated that they marked these disposal sites on maps after the pipes were buried (Table 2).

Table 2 AC pipe disposal measures chosen by participating utilities

Pipe Disposal	US	Canada	Total
Burial on site only	4	3	7
designated site disposal	4	1	5
Combination - burial and removal	4	3	7
Number of responses	12	7	19

Utilities chose to bury AC pipes on-site for three major reasons: (1) cost (69%); (2) no regulatory requirement (69%); and (3) no perceived public health concerns (54%). One Canadian and four US utilities that adopted off-site disposal of all broken AC pipes were not eligible to answer this question. The three reasons mentioned above basically dictated the 10 utilities' decisions to leave the broken AC pipe in place, particularly for those utilities that had practiced both abandonment on site and disposal in designated areas. Only one utility indicated that busy work schedules were also a reason for choosing on-site disposal. In contrast, 10 utilities that practiced disposal of broken pipes at designated locations indicated that the main reasons for their choice were: (1) regulatory requirements; (2) perceived public health concerns if abandonment in place was practiced; and (3) conflict with future construction activities or pipe installation and repair. In the responses to these questions, it was hinted that many water utilities do believe the best management practice for AC pipe wastes was off-site disposal at designated locations. However, they are not doing it this way because of cost pressures and the lack of policy requiring them to do so.

For disposal site selection, utilities have the following choices: (1) using an existing municipal landfill; (2) sharing a site used for the disposal of other municipal hazardous materials; or (3) creating a new site specifically for AC pipe waste. Among the 12 utilities that responded to this question, eight chose to send broken AC pipes to existing hazardous waste disposal sites and three used municipal landfills for disposal. The remaining one utility had used both designated locations and municipal landfills. When detailing safety measures used during the transportation of broken AC pipes from excavation sites to disposal locations, all 12 utilities indicated that they wrapped pipe pieces with plastic and labeled them as asbestos-containing materials.

Asbestos disposal sites must be protected with cover materials in order not to disturb the ACM on a place and prevent opportunities for human exposure. US federal regulation (40 CFR 61.151) prohibits the disturbance of any asbestos-containing waste material at the disposal site unless prior notice is supplied to the USEPA and the work procedures are tightly controlled to prevent asbestos emissions into the air. To help assure that these requirements are met, and to limit the potential for human exposure, a regular inspection of the surface of the ground in and around the disposal area is required to assess the condition of the cover materials and look for

exposed asbestos. In addition, inspection after each significant weather event, including high intensity rainfalls, floods and windstorms are effective ways to find deterioration or damage of the cover layer. Inspectors look for problems like erosion, settlement, cracking, stressed and dying vegetation, burrowing activity by rodents and vandalism. Inspectors should take immediate action to eliminate any identified exposure risks for workers and the general public.

Among the 12 utilities that responded to the site monitoring questions, four indicated that they inspected the disposal sites annually or whenever there was a concern. The remaining eight utilities pointed out that this monitoring was the responsibility of other departments, e.g. solid waste management division. In most cases, water utilities shared the designated disposal sites with other municipal departments for urban hazardous materials and asbestos wastes. It is likely the monitoring and inspection responsibilities reside with those who deal with the friable asbestos waste, such as asbestos-containing building materials. One utility also indicated the monitoring and follow-up actions were done by the operator of the disposal site.

RECOMMENDATIONS FOR AC PIPE PROJECTS AND WASTE DISPOSAL

These recommendations are proposed for the reference of project managers as they develop standard operating procedures for AC pipe repair, rehabilitation and replacement. They cover the excavation of water mains; repair, rehabilitation and replacement of the pipes; as well as the removal, transportation and on-site and off-site disposal of asbestos containing materials. The recommendations should be read in conjunction with related federal and state or provincial regulations for the management of asbestos containing materials.
These recommendations aim to ensure that:

1. Project staff are properly trained to enable them to identify asbestos and ensure that they are competent to safely conduct asbestos cement pipe related projects;
2. Active AC project sites are clearly labeled and appropriate public access restrictions are in place;
3. Project workers working on AC related projects are properly protected;
4. Broken AC pipes are properly disposed of, including either on-site disposal or proper transportation and disposal at a designated location; and
5. Disposal sites are monitored and cover materials remain in a functional condition.

Staff training

Suitable training is required to enable project staff to identify asbestos and to ensure that they are competent to conduct AC pipe projects, including waste disposal, in a safe and effective manner. The training should ensure that they understand the relevant aspects of working with asbestos, the health hazards associated with asbestos, safe work procedures, and the need for employing the right protective clothing and equipment. Specifically, staff must learn about:

- The recognition of ACM;
- Regulations and rules in dealing with asbestos containing materials;
- Health hazards associated with asbestos;
- Required personal protective equipment and its appropriate use;
- Appropriate procedures for handling ACM;
- AC pipe project management procedures;

- Appropriate options for pipe waste disposal.

Staff should be consulted regarding the health and safety of work practices. Safety representatives should be able to provide support to site staff to ensure that safe working conditions are maintained at all times.

Secure active project site

Before trenching commences, the AC pipe project site should be properly secured to limit access by automobiles and pedestrians. The designated work area boundary should be clearly marked by placing barricades, fencing or similar structures around the work area.

- Signs should be placed around the work area warning people not to enter the area unless authorized to do so;
- Public traffic should be diverted around the work area to avoid disturbance of and exposure to hazardous materials.

Protect project staff

All employees involved in AC pipe project work, such as pipeline repair, removal and waste disposal, should be provided with suitable and appropriate PPE and thoroughly understand the proper use of the PPE, which could include:

- Steel-toed boots;
- Hard hats;
- Safety glasses;
- Rubber or leather gloves.

When on-site assessment by project managers or safety representatives indicates that there is a possibility of asbestos release from activities such as pipe cutting, pipe polishing, and pipe cracking, the following PPE should be used to protect workers from exposure to asbestos.

- Disposable overalls with fitted hood or waterproof overalls may be required outside in some weather conditions;
- Waterproof boots without laces (laced boots can be difficult to decontaminate);
- Disposable particulate respirator (FFP3), worn according to manufacturer's instruction.

Only where the level of risk is established and controlled, e.g. the broken AC pipe waste is double-bagged and sealed in approved-type plastic, should a less stringent PPE standard be considered.

All PPE should be inspected before use, and any defects should be reported and rectified. No work should be carried out without the appropriate PPE.

Handling AC pipes on site

- Machine excavates to expose AC pipe. Excavation operations should be carefully executed so that pipe damage does not occur;
- Hand excavate areas under the pipe where cuts/breaks are planned;
- Ensure that the pipe is wet; or spray water to keep the pipe surface wet during the cutting;

- Use low-pressure water to suppress dust and clean up waste. When using a vacuum cleaner make sure it is equipped with HEPA filtered exhaust, or preferably incorporate wet-sweeping or mopping;
- Do not use compressed air to clean up or remove dust or materials from work surfaces and clothing;
- All pipe cutting or breaking operations require adequate wetting with water to prevent the asbestos becoming airborne;
- When removing pipes from the site, place the broken AC pipes in sealed bag or container.

AC pipe abandonment and disposal

Utilities should make every effort to dispose of broken AC pipes properly. Abandoning the pipe sections or burying them in place is not a recommended practice. This practice creates potential ACM waste exposure zones in the urban environment, which can require costly reclamation prior to future development. Since many jurisdictions currently do not have regulations prohibiting the on-site abandonment of AC pipe waste, the authors recommend that if the AC pipes must be left underground, the following measures should be taken to keep records for future use:

- Record detail information of the AC pipes abandoned at the site, including precise coordinates and elevation, plus the original age, diameter, length, reasons for abandonment and the physical state;
- Do not crush pipe into pieces before on-site burial; leave the abandoned pipe in a consistent location in relation to the newly installed pipeline (e.g., on the south and east sides of the existing piping);
- Pipe bursting practice should be avoided;
- Mark the ACM abandonment site on all relevant maps for future reference.

Appropriate disposal involves double bagging the AC pipe sections, labeling it clearly, carefully transporting the wastes to the designated site and burying them securely underground.

- Place waste materials in impervious containers or poly bags at least 0.15 mm thick; seal the containers or bags and mark them as ACM;
- Pack the sealed impervious containers so that they will not be punctured during handling and transportation to the disposal site;
- Before removing the sealed containers, clean the outside of the containers or bags with a vacuum equipped with HEPA-filtered exhaust or clean them by damp wiping;
- Make prior arrangements with appropriate authorities to deliver ACM waste to designated locations;
- Inform transport drivers of precautions; transport vehicles may be required to display signs or placards specifying the nature of the cargo;
- Ensure the disposal sites conform to federal, state/provincial and municipal requirements;
- Ensure disposed material is completely covered by non-asbestos containing materials to a depth of at least 15 cm (6 inches).

Monitoring the disposal site

Regularly inspect the surface of the ground in and around the disposal area to assess the condition of the cover materials and look for exposed AC pipe material. Repeated inspection is needed after major environmental events (such as heavy storm, floods, extreme winds or earthquakes). Damage and deterioration of the cover materials or the surface layer should be remediated immediately. At the disposal sites, look for exposed ACM and pay close attention to the area around the base of tree trunks and growing root areas for asbestos to resurface.

If any cover deterioration or disturbance problems are noted, implement cover repairs and address cover maintenance needs as required. Always seek advice and assistance from occupational health and safety professionals, local health officers, and other qualified professionals whenever there is question about the site.

Acknowledgments: The authors wish to acknowledge the financial support from National Research Council and Water Research Foundation. We also greatly appreciate the time and effort of the 20 participating utilities from the United States and Canada for submitting detailed AC pipe information.

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