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Standard Practice for Maintenance, Renovation, and Repair of Installed Asbestos Cement Products[1]

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1. Scope

1.1 This practice describes work practices for asbestos-cement products when maintenance, renovation, and repair are required. This includes common tasks such as drilling and cutting holes in roofing, siding, pipes, etc. that can result in exposure to asbestos fibers if not done carefully. These work practices are supplemented and facilitated by the regulatory, contractual, training, and supervisory provisions of this practice.

1.2 Materials covered include those installed in or on buildings and facilities and those used in external infrastructure such as water, wastewater, and electrical distribution systems. Also included is pavement made from asbestos-cement manufacturing waste.

1.3 The work practices described herein are intended for use only with asbestos-cement products already installed in buildings, facilities, and external infrastructure. They are not intended for use in construction or renovation involving the installation of new asbestos-cement products.

1.4 The work practices are primarily intended to be used in situations where small amounts of asbestos-cement products must be removed or disturbed in order to perform maintenance, renovation, or repair necessary for operation of the building, facility, or infrastructure.

1.5 The work practices described herein are also applicable for use where the primary objective is the removal of asbestos-cement products from the building or other location, particularly the use of wet methods and other means of dust and fiber control.

1.6 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.7 **Warning—**Asbestos fibers are acknowledged carcinogens. Breathing asbestos fibers can result in disease of the lungs including asbestosis, lung cancer, and mesothelioma. Precautions in this practice should be taken to avoid creating and breathing airborne asbestos particles from materials known or suspected to contain asbestos. Comply with all applicable regulatory requirements addressing asbestos.

1.8 *This practice does not address safety hazards associated with working on asbestos-cement products such as falling through roof panels or trench cave-ins. The use of power tools presents possible electrical hazards, particularly in wet environments. These and other safety hazards must be considered and controlled in compliance with the employer's policies and applicable regulations.*

1.9 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1368 Practice for Visual Inspection of Asbestos Abatement Projects

E2356 Practice for Comprehensive Building Asbestos Surveys

2.2 *Other Standards:*

Guidance Manual Asbestos Operations and Maintenance Work Practices[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *amended water, n*—water to which a surfactant has been added to reduce surface tension.

[1] This practice is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.07 on Sampling and Analysis of Asbestos.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from National Institute of Building Sciences (NIBS), 1090 Vermont Avenue, NW, Suite 700, Washington DC 20005-4905.

3.1.2 *asbestos, n*—the asbestiform varieties of serpentinite (chrysotile), riebeckite (crocidolite), cummingtonite-grunerite (amosite), anthophyllite, and actinolite-tremolite.

3.1.3 *asbestos-cement products, n*—materials containing asbestos fiber added during the manufacturing process to cement and other binders or fillers, including pavement made from waste material produced by this manufacturing process.

3.1.4 *asbestos-containing materials, n*—material containing more than one percent asbestos.

3.1.5 *dust and debris, n*—visible particles, fragments, or chunks of material, large enough to have settled in the work area by virtue of their weight, that are presumed to have originated from asbestos-containing material.

3.1.6 *friable material, n*—material easily crumbled or powdered by moderate (hand) pressure; also weakly-bound and low-density materials.

3.1.7 *non-friable material, n*—material not easily crumbled or powdered by moderate (hand) pressure; also strongly-bound and high-density materials.

3.1.8 *thickened substance, n*—a liquid with sufficient density and viscosity to capture dust and debris released from a material during one of the operations described in Section 7.

4. Summary of Practice

4.1 This practice describes the following aspects of maintenance, renovation, and repair operations involving installed asbestos-cement products:

4.1.1 The characteristics of asbestos-cement products commonly found in buildings, facilities, and external infrastructure such as utilities.

4.1.2 Maintenance, renovation, and repair operations that can result in the release of airborne asbestos fibers and the creation of asbestos-containing dust and debris.

4.1.3 Methods for controlling the release of airborne asbestos fibers and minimizing the creation of asbestos-containing dust and debris.

4.1.4 Methods of determining and minimizing worker and community exposure to airborne asbestos fibers from these materials and operations.

4.2 This practice accepts the premise that removal of asbestos-cement products is always the preferred approach because it eliminates the potential for exposure to asbestos fibers, but also acknowledges that removal is not always feasible or the most advantageous course of action. In situations where asbestos-cement products cannot be removed and replaced with asbestos-free materials, this practice provides techniques for maintenance, renovation, and repair operations that are most protective of worker and community health.

4.3 While the provisions of this practice can apply to abatement projects whose purpose is removal of the asbestos-cement products, such work may involve the handling of large, heavy pieces of material with mechanized equipment that is not discussed in this practice.

4.4 If the work can be done without disturbing any asbestos-cement products, that is the most desirable course of action to reduce the potential for exposure to asbestos fibers. Before commencing any work involving materials that are suspected of containing asbestos, ask if there is reliable information available to confirm the presence or absence of asbestos in the product. (See 8.1.1 and 8.1.2.)

4.5 This practice includes supporting information and general precautions applicable to the materials and work practices covered to enhance their understanding by the user. These sections are intended for users with a sufficient technical background to benefit from the material contained therein, and who are probably in a supervisory, management, or other official capacity within their organization. The appendices contain detailed step-by-step instructions for selected procedures and materials, and it is expected that these instructions will either be provided to workers in writing or explained to them verbally by their supervisors.

4.6 This practice does not require compliance with the regulations of any specific governmental agency, although excerpts and references are included. It is expected that users of this practice will comply with all applicable regulations in their country and other governmental jurisdiction thereof.

5. Significance and Use

5.1 The inhalation of airborne asbestos fibers has been shown to cause asbestosis, lung cancer, and mesothelioma.

5.1.1 The U.S. Environmental Protection Agency reports that "Effects on the lung are a major health concern from asbestos, as chronic (long-term) exposure to asbestos in humans via inhalation can result in a lung disease termed asbestosis. Asbestosis is characterized by shortness of breath and cough and may lead to severe impairment of respiratory function. Cancer is also a major concern from asbestos exposure, as inhalation exposure can cause lung cancer and mesothelioma (a rare cancer of the thin membranes lining the abdominal cavity and surrounding internal organs), and possibly gastrointestinal cancers in humans. EPA has classified asbestos as a Group A, known human carcinogen" (**1**).[4]

5.1.2 The World Health Organization states: "Exposure to asbestos occurs through inhalation of fibres primarily from contaminated air in the working environment, as well as from ambient air in the vicinity of point sources, or indoor air in housing and buildings containing friable asbestos materials. The highest levels of exposure occur during repackaging of asbestos containers, mixing with other raw materials and dry cutting of asbestos-containing products with abrasive tools" (**2**).

5.1.3 The World Bank states: "Health hazards from breathing asbestos dust include asbestosis, a lung scarring disease, and various forms of cancer (including lung cancer and mesothelioma of the pleura and peritoneum). These diseases usually arise decades after the onset of asbestos exposure. Mesothelioma, a signal tumor for asbestos exposure, occurs among workers' family members from dust on the workers' clothes and among neighbors of asbestos air pollution point sources" (**3**).

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.

5.2 Extensive litigation has occurred worldwide as a result of the health effects of asbestos over the past century, resulting in considerable economic consequences. The regulatory response to asbestos hazards has resulted in civil sanctions and criminal prosecution of violators.

5.3 Regarding the production and use of asbestos fiber:

5.3.1 The U.S. Geological Survey (USGS) reports: "World consumption was relatively steady between 2003 and 2007, averaging 2.11 million metric tons (Mt). The leading consuming countries in 2007 were, in decreasing order tonnage, China (30 %), India (15 %), Russia (13 %), Kazakhstan and Brazil (5 % each), and Thailand, Uzbekistan, and Ukraine (4 % each). These eight countries accounted for about 80 % of world asbestos consumption in 2007. From 2003 through 2007, apparent consumption declined in most countries. However, there were significant increases in apparent consumption in China, India, and Uzbekistan between 2003 and 2007. In general, world asbestos consumption is likely to decline as more countries institute bans on its use" (**4**).

5.3.2 The World Health Organization also states: "Bearing in mind that there is no evidence for a threshold for the carcinogenic effect of asbestos and the increased cancer risks have been observed in populations exposed to very low levels, the most efficient way to eliminate asbestos-related diseases is to stop using all types of asbestos. Continued use of asbestos-cement in the construction industry is of particular concern, because the workforce is large, it is difficult to control exposure, and in-place materials have the potential to deteriorate and pose a risk to those carrying out alterations, maintenance, and demolition" (**2**).

5.3.3 The Chrysotile (formerly Asbestos) Institute reports that: "More than 90 % of the world production of chrysotile is used in the manufacture of chrysotile-cement, in the form of pipes, sheets, and shingles. These products are used in some sixty industrialized and developing countries" (**5**).

5.4 It follows that the installed base of asbestos-cement products worldwide is enormous and continues to grow. In other words, the problem of exposure to asbestos fibers from working with these materials is substantial and will remain significant for the foreseeable future.

5.5 The significance of this practice is that it provides work practices that protect worker and community health within the resources available in developing as well as industrialized countries. It relies as much as possible on tools, equipment, and supplies that are readily available without recourse to specialty suppliers. The techniques require careful and diligent workmanship but do not require the services of highly-skilled tradesmen.

5.6 This practice is intended to be used not only by construction workers and tradesmen in the performance of their work, but also by building owners and others as the basis for preparing contracts and tenders for activities included in the scope of this practice. It will also provide a foundation for government officials to develop regulations intended to protect worker and community health. Where such regulations already exist, of necessity they take precedence over this practice in event of a conflict.

5.7 The persons who are most at risk of exposure to airborne asbestos fibers are those who perform work on asbestos-cement products during maintenance, renovation, and repair operations. This practice places its primary emphasis on the protection of their health. However, other members of the community—other workers and individuals in a building being renovated, residents of a house undergoing repairs, and unsuspecting bystanders—are at risk to a lesser degree. By minimizing the risk to the worker performing the maintenance, renovation, and repair operations, the potential exposure of others is reduced as well.

5.8 It is expected that employers will comply voluntarily with the provisions of this practice in the interest of protecting worker and community health and reducing their own liability. However, the existence of a regulatory infrastructure for occupational and community health greatly enhances compliance with measures to reduce exposure to asbestos fibers and other toxic materials. In some countries, such a system is highly advanced, but in others it needs to be created or further developed. These efforts can be furthered by referencing this practice in laws and regulations and requiring compliance with its provisions.

5.8.1 Issuance of construction permits can be made contingent on showing evidence of worker training, experience in the use of these procedures, and adequate resources (manpower, equipment, and supplies) to use them properly.

5.8.2 A contractual framework that references this practice and requires use of its procedures ensures the building owner or other party securing construction services under a contract or tender arrangement that the responding offeror has been informed as to the expected level of performance when working with asbestos-cement products.

6. Uses and Characteristics of Asbestos-Cement Products

6.1 In order to apply the methods for controlling the release of airborne asbestos fibers and minimizing the creation of asbestos-containing dust and debris, it is necessary to understand the uses to which asbestos-cement products have been put, their physical characteristics and their composition including asbestos fibers and other constituents.

6.2 All asbestos-cement products are defined and regulated as non-friable asbestos-containing materials—that is, while some of them may be broken into smaller pieces by hand without the use of tools or mechanical equipment, the broken pieces cannot be crumbled into powder by hand pressure alone. (See 3.1.6 and 3.1.7.) The materials are susceptible to being crushed into powder by the application of mechanically-multiplied force that may range from the use of pliers to the impact of construction equipment, creating dust and debris and releasing asbestos fibers. Asbestos-cement materials are also susceptible to weathering, chemical attack, corrosion and physical damage that may result in degradation of the surface. If any of these events occur the material is treated as friable asbestos-containing material.

6.3 Another common characteristic of all asbestos-cement products is their relative impermeability to water, which reduces the effectiveness of wetting agents that penetrate

friable asbestos-containing materials and reduce fiber release when the matrix of the material is disturbed.

6.4 Asbestos-cement products may be installed in combination with other friable and non-friable asbestos-containing materials. For example, asbestos-containing soundproofing may have been sprayed on the underside of an asbestos-cement roof deck or inside walls made of asbestos-cement panels. Work practices for these associated asbestos-containing materials are outside the scope of this practice, but are discussed in Practice E1368 and the ASTM Manual on Asbestos Control (**6**).

6.5 Examples of common asbestos-cement products include the following. This list is by no means exhaustive.

6.5.1 *Roofing Materials*—The afore-mentioned resistance to water penetration resulted in widespread use of asbestos-cement corrugated sheets and flat shingles for roofing applications.

6.5.2 *Siding*—The afore-mentioned resistance to water penetration resulted in widespread use of asbestos-cement corrugated sheets and flat shingles for construction of exterior walls on buildings.

6.5.3 *Flat Panels*—Panels of various thickness and finishes were used inside and outside buildings as architectural materials, tile underlay, electrical and thermal insulation, and in greenhouses.

6.5.4 *Tanks*—Tanks for water and other liquids have been constructed from asbestos-cement panels, fabricated from preformed sections and molded from asbestos-cement.

6.5.5 *Cooling Towers*—Flat and corrugated panels are used for roofs, siding, and louvers on cooling towers, and exhaust vents are made of asbestos-cement.

6.5.6 *Pipe*—Pipe of various sizes is found in facilities and utility infrastructures for conveying water and wastewater in pressure and non-pressure applications, and are primarily located underground. Pressure pipe has been made with crocidolite to improve its strength.

6.5.7 *Ducts*—Thin-walled ducts are used to house electrical and communications cables and to convey heating and cooling air for the conditioning of occupied spaces and other purposes.

6.5.8 *Exhaust Flues*—Exhaust flues from furnaces and boilers are sometimes made with asbestos-cement.

6.5.9 *Pavement*—Powdered waste material containing cement and asbestos fibers that results from the manufacturing of asbestos-cement products has been used as a paving material in residences and communities near the plants.

6.5.10 *Other Products*—Gutters and downspouts, laboratory tabletops, fume hoods, garden and greenhouse fixtures, and furniture, etc.

7. Potentially Hazardous Maintenance, Renovation, and Repair Operations

7.1 All of the operations described below involve disturbing the matrix of the asbestos-cement material, which inherently causes some degree of fiber release and creation of dust and debris. This practice contemplates the use of wet methods as described in Section 8 to control the release of asbestos fibers and the creation of dust and debris.

7.2 *Cutting*—Cutting operations involve a penetration through the material in a straight or curved line or by making a large-diameter hole. An example of the former would be using a knife or saw to make a rectangular hole in a piece of siding for passing an exhaust duct through. A large-diameter hole, such as a tap into a water pipe, is defined as one requiring a hole saw with cutting teeth, as opposed to a drill bit. Thin material may be cut by scoring the surface with a knife, inserting the blade of a chisel in the groove and striking the chisel sharply with a hammer.

7.3 *Drilling*—Drilling operations are done with a twist drill bit to make through holes or blind holes. If a power drill is used it might have an impact action as well as rotary motion. Masonry bits may be used for their resistance to wear.

7.4 *Breaking*—Flat and corrugated sheets and siding may be broken by bending, with the location and precision of the break controlled by scoring the surface and appropriately restraining the material. A section of duct may be removed in a similar manner by using a chisel to break the material where it has been scored with a sharp-pointed knife.

7.5 *Sanding*—Edges or surfaces of materials that have been cut or broken may have to be sanded to obtain the desired quality of finish, or to prepare the surface for bonding to a non-asbestos material.

7.6 *Grinding*—If an asbestos-cement pipe has to be mated with a non-asbestos replacement section, the ends of the pipe may require bevelling or otherwise finishing the mating surface. This may require grinding the end of the pipe.

7.7 *Filing*—Finishing the edges and surfaces of asbestos-cement products remaining in place after maintenance, renovation and repair work may require removal of small amounts of material with a hand file or rasp.

7.8 *Dismantling*—Pieces of material may be removed intact, or as nearly so as possible, by removing the fasteners that hold the material to the substrate or framework (as with a roof or cooling tower), or that hold the pieces together. Instead of fasteners, the pieces may be held on, or together with, an adhesive (which may also contain asbestos).

7.8.1 Removal of the asbestos-cement material may leave an asbestos-containing residue on the substrate. The residue should be removed by Scraping, Sanding, Grinding or Filing, using the control methods in Section 8. Under no circumstances should residue be removed using the Prohibited operations in 7.11.

7.8.2 Pieces of dismantled asbestos-cement products should not be dropped or thrown to the ground, but should be lowered while wet in a controlled manner. Brown has shown that dropping sheets of roofing to the ground results in airborne concentrations of 0.03 to 0.27 fibers/ml, while careful handling and wetting of the sheets reduces the concentrations to ND (non-detected) to 0.07 fibers/ml (**7**).

7.9 *Surface Cleaning*—Surfaces of asbestos-cement products may be coated with substances such as paint or other sealants, or with mold or other organic growth. Removal of these coatings by blasting or scraping can release asbestos fibers from the substrate. Brown suggests that external surfaces

of asbestos-cement sheets that have become weathered should not generally be coated because the coating will soon blister and peel due to poor surface adhesion (**8**). Asbestos fibers that adhere to the coating create a contaminated waste stream and disposal problem when the coating comes off the surface. (The health hazards of the coatings and any substances used to remove it are outside the scope of this practice.)

7.10 *Scraping*—Residue may be removed from a surface by scraping with a sharp-edged blade on a hand tool such as a putty knife or chisel, using the control methods in Section 8.

7.11 *Prohibited Operations*—The following operations are not endorsed by this practice because of the high probability of excessive airborne fiber concentrations or the generation of excessive amounts of dust and debris, or both. Some of the operations are prohibited by law or regulation in certain jurisdictions.

7.11.1 *Cutting with High-Speed Power Saws*—According to the U K Health and Safety Executive, use of a circular saw for cutting asbestos-cement sheet has been shown to produce airborne fiber levels as high as 20 fibers/ml and a jig saw as high as 10 fibers/ml (**9**). Use of band saws and powered hacksaws operating at high cutting speeds would be expected to have a similar result. The effectiveness of dust capture devices for these tools and their suitability for many working conditions contemplated by this practice must be confirmed by testing prior to sanctioning their use. The limitations of the dust capture devices should be stated, so people will be aware of them, with a warning that if there is visible dust escaping to the air the equipment should not be used until properly repaired.

7.11.2 *Grinding with High-Speed Abrasive Wheels*—According to Vanherle, this method has been shown to result in high levels of airborne dust when used to mitre edges of corrugated asbestos-cement sheets (**10**).

7.11.3 *Burnishing with High-Speed Wire Brushes and Cleaning with Compressed Air* are also prohibited.

7.11.4 *High Pressure Water Blasting*—This method of cleaning weathered asbestos-cement surfaces can propel asbestos-rich material onto the surrounding properties and their grounds, and also creates a contaminated waste stream and disposal problem.

7.12 *Re-use and Re-cycling*—The re-installation of asbestos-cement products that have been removed during maintenance, renovation, and repair operations for other purposes in any building, facility or infrastructure is not endorsed by this practice. The re-cycling of removed materials for the manufacture of new asbestos-cement products is also not endorsed.

7.13 *Excavation*—Excavation for construction related to sub-surface infrastructure may disturb buried asbestos-cement pipes and electrical ducts, rendering them friable, contaminating the worksite, and creating an exposure hazard and disposal problem. Inspection of the worksite to locate these materials is required and, if they are found, the work practices herein must be followed.

8. Dust, Debris, and Fiber Control

8.1 The ultimate goal of the following control methods is to minimize the amount of airborne asbestos fibers that could be inhaled by workers or members of the community. Minimizing the release of asbestos fibers into the air during the operation is a primary objective. A secondary objective is to minimize the amount of dust and debris created and to prevent the re-entrainment of asbestos fibers into the air.

8.1.1 If reliable information is available confirming that asbestos is present in the product, the precautions in this section and Section 9 are mandatory. If information is not available it may be either assumed that the product is asbestos-cement or the product may be submitted for analysis to confirm or refute the presence of asbestos. For example, cellulose-cement sheet products have been increasingly used in several countries since the mid-1980s. If reliable evidence is provided that the material is “asbestos-free,” the work practices in this section are not required, but may be useful for general purposes of dust control.

8.1.2 There is no industry wide practice of labeling products to indicate that they contain asbestos, and the absence of such a label should not be taken as evidence that the product is asbestos-free. The presence or absence of asbestos in a material cannot be determined by looking at it with the unaided eye. A sample of the material must be collected and analyzed to determine if it contains asbestos fibers. For suspected asbestos-cement products analysis by Polarized Light Microscopy (**11**) should be sufficient. For sample collection techniques, see Practice E2356, Appendix X1.

8.1.3 If the presence of asbestos in the material is evident or cannot readily be disproved, determine if the work can be done without disturbing any asbestos-cement products. For example, wiring may be routed over a wall instead of through it, eliminating the need to drill a hole through an asbestos-cement panel. Instead of taking a vent pipe through an asbestos-cement roof, bring it out through a wall made of non-asbestos material. It may be possible to abandon asbestos-cement products in place and install a new component or system to perform their function.

8.2 *Wet Methods*—Water and other water-based liquids reduce the amount of airborne fibers released and control the spread of dust and debris. With friable asbestos-containing materials, the liquids penetrate the matrix to some degree. This does not happen with non-friable asbestos-cement products, where the liquid remains on the surface. Nonetheless, wet methods are still effective when used as follows.

8.2.1 *Water (with Surfactant):*

8.2.1.1 Water to which a surfactant has been added is called “amended water” and the surfactant is referred to as a “wetting agent.” The surfactant reduces surface tension and allows the water to spread across the surface more readily. It also promotes penetration into friable material and “amended water” will penetrate cracks and pores in non-friable materials, including asbestos-cement products, to some extent.

8.2.1.2 A formulation of one ounce of a surfactant consisting of equal parts polyoxyethylene ester and polyoxyethylene ether mixed with five gallons of water has been used in the asbestos abatement industry as “amended water.” Equally effective for the purpose of wetting the surface of asbestos-cement products is any liquid soap that will dissolve in water at room temperature.

8.2.1.3 "Amended water" is usually applied to friable asbestos-containing materials with an airless sprayer to minimize the release of fibers from the surface by the impact of the water droplets. For wetting small areas of asbestos-cement products for maintenance, renovation and repair work, a hand sprayer may be used or the water may be poured on the surface. For outdoor work, it may be more practical to use a disposable spray bottle instead of a wand sprayer, thus avoiding the problem of the nozzle getting plugged from being dropped in the dirt.

8.2.1.4 Control of the water is important because it becomes contaminated with asbestos fibers and debris from the operation. Provisions must be made for collecting the water in a plastic bag or other container, or for removing dirt contaminated by the run-off (see 8.5.2).

8.2.2 *Thickened Substances:*

8.2.2.1 Water by itself will not capture large amounts of dust and debris produced by some operations, particularly if power tools are used, and will evaporate or freeze in some climates. A heavy coating of a water-based substance is more effective, as its mass and viscosity traps dust and debris in addition to wetting the surface. The required thickness of the substance has to be determined through practice, and it is sometimes necessary to add more of the substance after the initial application if dust and debris are seen to be escaping from it.

8.2.2.2 The substance is collected with wet rags or paper towels after the operation is completed and placed in plastic bags for disposal (see 8.5.1). The asbestos-containing dust and debris remains entrained in the substance.

8.2.2.3 Most of these substances are viscous enough to retain their shape and consistency during the operation. For use on a vertical or overhead surface, it may be necessary to contain the substance in a paper, plastic, or thin metal cup. A disadvantage of some substances is their opacity, which obscures one's view of the surface being worked on. Using a clear substance, such as hair gel, overcomes this problem.

8.2.2.4 Thickened substances are particularly effective in containing large, non-respirable pieces of debris such as that generated by cutting with a chisel or breaking by bending ("score and snap"). Controlling the spread of this type of debris reduces the area to be cleaned up afterwards.

8.2.2.5 A thickened substance commonly used for controlling fibers, dust, and debris is shaving cream from a squeeze tube or pressurized can. Thick glue has also been used for this purpose. Any substance with sufficient density and viscosity that is otherwise compatible with the conditions of use (temperature, for example) and does not present a health hazard of its own is acceptable for this purpose.

8.2.2.6 Wet sponges serve a purpose similar to thickening agents for containing fibers, dust, and debris from some maintenance, renovation, and repair operations, in particular drilling holes through certain non-friable materials. The drill bit is driven through the sponge and placed on the mark, then the sponge is held against the surface while the hole is drilled. The sponge is disposed of as contaminated waste. Care must obviously be taken to avoid getting the sponge caught in the rotating drill bit or chuck, and the presence of water in the sponge creates a potential electrical hazard if a power drill is used.

8.2.3 *Liquid Adhesives*—A liquid with adhesive properties will bind the dust and debris into a solid matrix and entrain the fibers when it dries or cures. A wide variety of substances is available for this purpose, including paints, spray adhesives, glues and foams. The adhesive can be wiped from the surface being worked on while still in a liquid state and disposed of (see 8.5.1) or, if the material being worked on is to be disposed of, the contaminated adhesive can remain attached.

8.2.4 *Material Softening Agents*—Asbestos-cement being a highly caustic material, it will react readily with liquids of high acidity. Some common hypochlorite-based liquids such as household cleaners will soften the surface of an asbestos-cement product, making it easier to score, cut or break. It may be necessary to neutralize the excess liquid before disposal, but in the small amounts contemplated for maintenance, renovation and repair work, environmental contamination from disposal is not considered a major concern.

8.2.5 *Wet Wiping:*

8.2.5.1 The basic rule that asbestos-containing materials are never worked on dry applies to wiping the surface of asbestos-cement products. Removal of dust and debris from the surfaces is always done with wet rags, sponges or paper towels. It is not necessary to use "amended water" to wet the towels, although "amended water" sprayed or poured on a surface to be cleaned would spread more readily.

8.2.5.2 A second rule of wet-wiping is to wipe the surface with a paper towel only once and not to go back over it with the same towel, although the towel may be re-folded to expose a clean surface. Wet-wiping is done with the towel flat, not wadded up. If a rag or sponge is used, it is wet in a "clean bucket" and the water squeezed out into a "dirty bucket" after wiping the surface. The towels, rags, and sponges are disposed of after use.

8.3 *HEPA-filtered Vacuum Cleaners:*

8.3.1 A household vacuum cleaner or a shop vacuum should never be used for work on any asbestos-containing material, including asbestos-cement products, because the bags and filters cannot capture the microscopic asbestos fibers. Use of such devices might contaminate the area worse than if no vacuum at all was used.

8.3.2 A High Efficiency Particulate Air (HEPA) filter is capable of trapping asbestos fibers. Vacuum cleaners with a HEPA-rated final filter are available in hand-held and backpack models with sufficient suction and capacity for asbestos-cement products maintenance, renovation, and repair work.

8.3.3 HEPA-filtered vacuums are commonly used for asbestos Operations and Maintenance work and for abatement work in conjunction with wet-wiping for final cleaning of surfaces, with and without brushes or other devices attached to the nozzle. Prior to starting a maintenance, renovation, and repair operation, a HEPA-filtered vacuum could be used to remove visible dust from an asbestos-cement surface that has been deteriorated by weathering (as with roofing and siding) or debris from physical damage. To reduce the frequency of bag and filter changes required, and to minimize the pressure drop

(and airflow) caused by accumulation of dust on the HEPA filter, the device should be used sparingly and only after other methods of physically collecting dust and debris have been used as much as possible.

8.3.4 There are disadvantages to using HEPA-filtered vacuums, and they should be used only if wet methods (see 8.2) are not sufficient to pick up dust and debris and clean surfaces. Even if a HEPA-filtered vacuum is used, large pieces of asbestos-cement debris should be wetted and picked up by hand, as the suction of the vacuum may not be sufficient to capture the pieces and transport them through the hose to the collection bag.

8.3.4.1 The worker must be trained in the use of the HEPA-filtered vacuum, including cleaning and maintenance of the unit. This includes changing the bag and filters, storing the hose, and ensuring that the latches and connections are tight to prevent leaks.

8.3.4.2 Once the HEPA-filtered vacuum is used to pick up asbestos dust and debris it becomes a contaminated piece of equipment that must be properly accounted for. Opening the unit to change the bag or filter, or for other maintenance, must be done by a worker wearing a respirator and protective clothing in a location where the surrounding area will not be contaminated. The used bags and filters must be disposed of as contaminated waste.

8.4 *Tools and Equipment*—Tools and equipment used for maintenance, renovation and repair work on asbestos-cement products must be suitable for performing the operations in Section 7 on a material that is by its very nature hard and abrasive. In addition, the tools and equipment must not release excessive asbestos fibers or dust and debris. The use of hand tools is preferred whenever possible and power tools, when required, must be operated at low speed.

8.4.1 *Hand Tools:*

8.4.1.1 A description of numerous hand tools for asbestos-cement work is contained in AIA RCP2A, Catalogue of Tools for Working with Asbestos-cement Products on Site **(12)**. The devices shown in the section of RCP2A on hand-operated tools are manually-powered and are no different from similar tools available from numerous commercial suppliers. Except for a set of parallel shears that appears intended for cutting and punching holes during installation of large sheets, all of the tools shown in this section of RCP2A seem applicable to work covered by this practice. Such tools would be used for removing small sections of damaged asbestos-cement pipe, insertion of non-asbestos fitting in a straight run of asbestos-cement pipe, or making holes in asbestos-cement pipe for any purpose. However, the tools should be used with wet methods in accordance with Section 8.

8.4.1.2 The Underground Contractors Association of Illinois (UCA) Best Practices for Removing Asbestos-Cement Pipe **(13)** describes a "wheel cutter" for removing underground non-pressure pipe. While no illustration is provided, the description matches three devices shown in the section of RCP2A on low-speed dry-operating tools. A modified version of the UCA procedure is provided as Appendix X2 to this practice, again requiring the use of wet methods.

8.4.2 *Low-speed Power Tools:*

8.4.2.1 Power tools can be electrically or pneumatically driven, the former requiring batteries, line power or a generator and the latter requiring an air pressure supply or a powered compressor. Because wet methods will be used, electric power tools must be on a Ground Fault Circuit Interruption device to prevent electric shock to the workers. Tools powered by rechargeable battery packs are preferable for this reason.

8.4.2.2 RCP 2A show power tools with and without dust collection attachments that are all portable with the exception of table-mounted cutting units. Some of the tools, such as the power drill, are readily available from commercial sources, and for several of the specialized tools the power source is an ordinary power drill. With the exception of the bench-mounted units, all of the devices are portable enough to be used on installed asbestos-cement products for maintenance, renovation and repair work.

8.4.2.3 Vacuum-assisted power tools similar to those shown in RCP 2A are available from commercial suppliers. The suitability of any power tool regarding control of fiber release and worker exposure depends on the ability to control the speed of the power source to minimize the generation of dust and debris. For devices with dust collection attachments, the ability of the device to capture the fibers, dust, and debris is critical. One disadvantage of vacuum-assisted power tools, besides the obvious need for electric power not only for the tool but also for the suction device, is the introduction of a contaminated piece of equipment into the workplace that must be cleaned and maintained by qualified individuals.

8.4.3 *Tool Selection and Use*—This practice requires the use of manually-operated hand tools wherever feasible to perform the operations described herein. Use of these tools in conjunction with the control methods described in 8.2 will minimize exposure of workers to airborne asbestos fibers. The use of manually-operated hand tools is indicated where electrical power for power tools is not available, or where the use of wet methods for controlling fibers, dust, and debris creates electrical hazards in the absence of proper grounding precautions.

8.4.3.1 Where manually-operated hand tools do not provide sufficient physical force for the operation, or their use results in unacceptably low productivity at the work site, portable power tools may be used. Tools that can be operated at low speed, or in conjunction with wet methods for dust suppression, without the need for vacuum-assisted dust collection devices are preferred. The tools shall be operated at the slowest possible speed for cutting, drilling or otherwise disturbing the matrix of the asbestos-cement material. An employer is advised to rely on exposure monitoring as described in 9.2 when deciding on the appropriate use of power tools, with or without dust collection attachments.

8.4.3.2 Vanherle **(10)** lists several principles for minimizing the amount of airborne dust released from working on asbestos-cement products. The factors that he recommends considering in the selection and use of tools, whether manually-operated or powered, are:

(1) The influence of the size of the dust particles produced,
(2) The influence of the amount (volume) of dust produced,
(3) The avoidance of dust particles getting airborne, and
(4) The use of techniques which produce no dust at all.

While the operations described by Vanherle appear directed toward the installation of new asbestos-cement products, which is expressly not the subject of this practice, some of the operations are the same as required for maintenance, renovation, and repair work and the four precautions enumerated above apply to such work.

8.4.3.3 Procedures in the Guidance Manual specify the use of equipment, such as HEPA-filtered vacuum cleaners, and mini-enclosures, that are readily available and commonly used in the United States and other industrialized countries but may not be available to some users. Appropriate modifications may have to be made to accommodate local conditions.

8.5 *Waste Disposal*—Regulations for disposal of non-friable asbestos-containing materials tend to be more lenient than those covering friable materials, due to the lesser tendency of non-friable materials to release asbestos fibers and debris. However, it should be noted that this characteristic of non-friable materials, including asbestos-cement products, depends on the material remaining intact and the surfaces not becoming deteriorated. In the case of maintenance, renovation, and repair work, the very nature of the operations means that the waste stream will consist of a mixture of dust and debris, which must be treated as friable, and intact non-friable pieces of the material. Separation of the friable waste, as well as intact pieces with friable deteriorated surfaces, from non-friable materials may be impractical. If so, the more stringent regulations for disposal of friable asbestos-containing materials will have to be followed.

8.5.1 *Disposal of Removed Material*—Wet the removed pieces of the asbestos-cement products and any non-asbestos-containing materials that are contaminated with residue of asbestos-cement products, with soapy water. Wrap broken pieces with wet paper towels to cover any sharp edges. Place all the pieces in a 150 μm (0.006 in.) minimum thickness labelled disposal bag. Fill the bag no further than the point where the unfilled portion can be twisted, folded back on itself, and taped to seal it ("gooseneck" taping). Gently press the air out of the bag before sealing it, taking care to direct the expelled air away from the breathing zone of any worker. If the removed material contains sharp edges, place the bag in a second bag ("double-bagging") or in a rigid drum.

8.5.2 Dust and debris generated by the work can be disposed of in the same bag(s) as intact pieces of removed material. If no intact pieces are removed, as with drilling, sanding, and grinding operations, the dust and debris generated and associated cleaning supplies (such as paper towels) can be disposed of in lighter-weight sealable plastic bags as long as they are properly labelled. Gently press the air out of the bags before sealing them with duct tape.

8.5.3 For outdoor work, intact pieces of removed material that fall on the ground should be picked up and disposed of as in 8.5.1. Visible dust and debris should be wetted and picked up with the dirt it is laying on or has become partially buried in—do not attempt to pick this material out of the dirt. The contaminated dirt should be wetted and placed in disposal bags as in 8.5.1, leaving a surface visibly free of dust and debris.

8.5.4 For outdoor work in remote areas, such as along a water or wastewater distribution system, the bags of waste may be buried at the site next to the pipe, providing that precautions are taken against the waste being dug up and re-used, and measures taken to avoid disturbing the waste during future excavations. If a section of pipe is removed, crushing it to reduce the volume of waste buried or disposed of at a landfill is prohibited. Filling an intact section of pipe with waste and sealing the ends to create a container for disposal may be considered as a means of reducing the volume of waste to be buried or transported to a landfill.

8.5.5 Bags and other containers used for disposal of asbestos-containing materials shall be prominently labeled with the following:

DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD

or equivalent wording in the language(s) spoken by the workers.

8.6 Further guidance on dust and fiber control procedures for asbestos-cement products is contained in publications of the UK Health and Safety Executive (**9**) and the New Zealand Department of Labour (**14**).

9. Worker Exposure Determination and Minimization

9.1 A basic premise of this practice is that the procedures described will not result in exposure of workers to airborne fiber levels exceeding those set by government regulatory agencies, professional consensus organizations or the employer. The procedures must be validated to confirm compliance with these requirements, which involves air monitoring, personal protection, and training.

9.1.1 The purpose of these measures is to monitor and minimize the exposure of individuals performing the work. Equally important is monitoring and minimizing exposure of building occupants and others not involved in the work. This is done with additional air monitoring and by restricting access to the work area to authorized persons.

9.1.2 Although the work covered by this practice is intended to involve small amounts of asbestos-cement products and minimal release of airborne fibers, dust, and debris, it may be necessary to construct an enclosure to isolate the operation from individuals who are not participating in the work.

9.2 *Air Monitoring and Analysis:*

9.2.1 To ensure compliance with exposure limits, tests must be conducted under conditions "closely resembling" those occurring when the operation is used in practice. Such test are normally done with personal protection and engineering controls until the results show that fiber levels are sufficiently below the exposure limits to dispense with these precautions. (The decision to use personal protection and engineering controls regardless of fiber levels is a prerogative of the employer, or it may be mandated by regulations.)

9.2.2 If the operation is routinely performed with adequate frequency and consistency during the normal course of work, personal air sampling for worker exposure monitoring may provide sufficient data for validation purposes. The data must show with an acceptable level of confidence that the exposure

limits are not being exceeded—typically that the 95 % Upper Confidence Limit of the test data does not exceed the exposure limit.

9.2.3 If the procedure must be validated before it is used in practice, or if actual use is infrequent, the testing should be done in a chamber created for the purpose. Such a chamber is illustrated and described in the Annex to RCP 2A, and a similar chamber is described in STP 1342 (**15**).

9.2.3.1 The chamber must be of sufficient size to perform the operation being validated, be sealed except for entry of test personnel and make-up air and be under a slight negative pressure with a HEPA-filtered vacuum or other exhaust device. It should be isolated from extraneous sources of airborne fibers that might compromise the test results. A facility for clothing changes, possibly including a decontamination shower, should be attached.

9.2.3.2 Personnel performing the work and taking the air samples should wear respiratory protection and protective clothing. Unless gross contamination dictates the use of a decontamination shower, wet-wiping and "double-suiting" is adequate to prevent carrying fibers and debris out of the chamber.

9.2.3.3 A test plan should be developed and followed that covers the type(s) of asbestos-cement products and work practices being evaluated. No more than one type of material and work practice can be validated on a single test. Enough air samples of sufficient duration should be taken to meet the statistical requirements described in 9.2.2. Compliance with long-term (full-shift) and short-term exposure limits may be evaluated by having the worker wear two sampling pumps, with the filter cassette on one being used for the duration of the test and the cassettes on the other pump being changed at frequent (for example, 30-min) intervals.

9.2.3.4 In conducting these tests, it is important to set and maintain a steady pace of activity, establishing in advance how many holes to drill, meters (feet) of siding to cut, or other measure of work performed per unit of time.

9.3 *Respiratory Protection*—Respiratory protection must be provided in compliance with regulations and the policies of the employer. If the results of the testing described in 9.2 show that worker exposure is well below applicable limits, respiratory protection may be dispensed with at the option of the employer.

9.3.1 The minimum level of respiratory protection, if used, is the half-mask negative-pressure respirator with en elastomeric facepiece and P100 cartridges. These are the equivalent of a HEPA-filtered cartridge. Paper or cloth dust masks, surgical masks and "filtering facepieces" shall not be used.

9.3.2 If respirators are provided, the employer should have a program of fit-testing, training, cleaning and maintenance, and medical surveillance for affected workers. This program may be mandated in some jurisdictions.

9.4 *Protective Clothing*—In addition to special clothing required for safety reasons (for example, fire retardant), workers performing maintenance, renovation, and repair operations where gross contamination and fiber re-entrainment from clothing is possible should wear disposable clothing instead of or over their work clothes. This may be required in some jurisdictions regardless of the degree of expected contamination.

9.5 *Decontamination*—At a minimum, disposable work clothing should be wet-wiped before leaving the work area. Dust and debris should be removed from washable work clothing with a HEPA vacuum cleaner before leaving the work site. Washable work clothing should be laundered by the employer and not taken home by the worker. In addition to wet-wiping and HEPA-vacuuming, a decontamination shower may be required in some jurisdictions.

9.6 *Training*—All workers who perform maintenance, renovation, and repair procedures must be trained to ensure proficiency and consistency in their use. The training course should include basic information on the health hazards of asbestos fibers, how to recognize asbestos-containing materials (with emphasis on asbestos-cement products) and the specific procedures they will be performing. In addition to "classroom" sessions, the workers should do "hands-on exercises" to practice the procedures using materials that resemble the asbestos-cement products but are asbestos-free. Instructions should be given in the language(s) of the workers being trained.

APPENDIXES

(Nonmandatory Information)

X1. REMOVING DAMAGED ASBESTOS CEMENT PIPE[5]

X1.1 The purpose of this procedure is to remove a damaged section of an underground asbestos-cement pipe located in an outdoor environment, typically requiring excavation of an open trench. This procedure is applicable to pressure and non-pressure pipe of all sizes.

X1.1.1 This procedure may be used for the repair of damage to pressure pipes caused by:

X1.1.1.1 Excess pressure results in a longitudinal (banana) crack.

X1.1.1.2 Hammer blow (very high pressure) due to air in pipe and too rapid closing of valves resulting in a piece of pipe being blown off at one end.

X1.1.1.3 Pipe shear due to earth movement.

X1.1.1.4 Pipe break due to heavy load passing over pipe, crushing pipe locally.

[5] This procedure is based in part on Best Practices for Removing Asbestos Cement Pipe, prepared by the Underground Contractors Association of Illinois. The original procedure, including provisions for compliance with the US Occupational Safety and Health Administration regulations, is available from www.uca.org.

X1.1.1.5 Leak at a coupling joint where a natural rubber seal is consumed by anaerobic bacteria, resulting in a small localised leak which grows into a jet and erodes the pipe end in one place.

X1.1.2 This procedure may be used for the repair of damage to non-pressure pipes caused by pipe shear due to earth movement, leaks at coupling joints and corrosion of sewage pipes from dilute sulphuric acid due to inadequate venting of hydrogen sulphide produced by bacteria.

X1.1.3 This procedure is not applicable to removal of long runs of pipe, which would constitute an abatement project outside the scope of this practice.

X1.1.4 All applicable sections of the practice to which this procedure is appended are incorporated by reference.

X1.1.5 Prior to commencing the removal of the asbestos-cement pipe section, the employer should ensure that at least one worker is capable of identifying existing asbestos hazards, is qualified to train other workers, and has the authority to take prompt corrective measures to eliminate a hazardous condition.

X1.1.6 The procedure for removing damaged asbestos cement pipe is shown in Table X1.1.

TABLE X1.1 Procedure for Removing Damaged Asbestos Cement Pipe

PREPARATION
1. Establish a regulated work area (RWA) using asbestos warning barricade tape and post asbestos-warning signs at the RWA entry point
2. Provide a hand/face wash station at the entry point to the RWA.
3. Establish a waste load-out area attached to the RWA.
4. Once the RWA is established and work begins, no access should be permitted without the required personal protective equipment.
5. Provide the following protective clothing and equipment: steel toe boots, hard hats, safety glasses and rubber or leather gloves. Respiratory protection may be required if airborne fiber levels exceed regulatory limits.
6. Conduct air monitoring to confirm that the applicable regulatory exposure limits are not being exceeded for this work activity, or that appropriate respiratory protection is being provided.
EXCAVATION
1. Machine or hand excavate to expose the asbestos-cement pipe in the area of suspected damage. Hand excavate areas under pipe where cuts/breaks are planned.
2. Excavation operations should be carefully executed so that pipe damage does not occur prior to removal.
3. For large-diameter or deeply-buried pipes, take necessary precautions against a trench cave-in that could endanger workers.
REMOVAL OF SMALL-DIAMETER NON-PRESSURE PIPE
1. All pipe cutting or breaking operations require constant wetting with soapy water to prevent asbestos fibers becoming air-borne.
2. Plan pipe cuts and breaks as necessary to accommodate the size and weight of pipe section being removed.
3. Use a wheel-type pipe cutter (or equivalent tool) to make the initial cut and drain the pipe of residual liquids.
4. Remove pipe sections at joint collars by scoring the collar with a sharp pointed knife and prying it apart with a chisel after covering the area of the cut with shaving cream or another thickened substance.
5. Pipe sections may be cut with a wheel-type pipe cutter (soil-pipe cutter) after being wet with soapy water.
6. Prior to pipe re-connection, trim the pipe ends with a wheel-type pipe cutter while wetting to minimize the release of airborne fibers.
7. Remove pipe sections from the trench in an “intact” condition. Wet and containerize waste materials as you go.
REMOVAL OF LARGE-DIAMETER PRESSURE PIPE
1. All pipe cutting or breaking operations require constant wetting with soapy water to prevent asbestos fibers becoming air-borne.
2. Plan pipe cuts and breaks as necessary to accommodate the size and weight of pipe section being removed. Large-diameter pipes and collars may require the use of mechanical lifting equipment.
3. Use a wheel-type pipe cutter (or equivalent tool) to make the initial cut and drain the pipe of residual liquids.
4. Remove joint collars by cutting into each collar in three places to a depth of 75 % of the thickness of the collar. Make the cuts with hand tools if possible, or with a power saw operated at low speed.
CAUTION: Do not use gasoline-powered tools in a trench due to the possible accumulation of carbon monoxide unless ventilation and air monitoring for CO are provided. Respirators for protection against asbestos fibers do not remove CO.
5. Pry the collar apart with a chisel or long-handled tool after covering the area of the cut with shaving cream or another thickened substance.
6. Pipe sections may be cut with a wheel-type pipe cutter (soil-pipe cutter) after being wet with soapy water.
7. Prior to pipe re-connection, trim the pipe ends with a wheel-type pipe cutter while wetting to minimize the release of airborne fibers.
8. Remove pipe sections from the trench in an “intact” condition. Wet and containerize waste materials as you go.
DISPOSAL
1. Wrap and seal the pipe ends in a minimum 6-mil plastic sheet, which is securely fastened and taped to close the pipe end. If large enough, an intact section of pipe can be filled with waste material that has been put into double plastic bags to reduce disposal volume.
2. Label the waste materials and stock-pile them in a designated load-out area. The following label is suggested:
DANGER
Contains Asbestos Fibers
Avoid Creating Dust
Cancer and Lung Disease Hazard
3. It is preferable to take the waste materials to an approved landfill for disposal. If this is not feasible economically, bury it in a defined spot near the line but NOT alongside the line’s pipes. Leave sufficient space for the repaired pipes to be properly bedded and supported on their sides by compacted earth.
4. The location of waste buried at the site must be recorded in the line’s records for future maintenance reference.

X2. WORKING ON DAMAGED ASBESTOS-CEMENT ELECTRICAL DUCTS ENCASED IN CONCRETE SLABS

X2.1 Asbestos-cement electrical ducts may be encased in buried concrete slabs. Excavation sometimes damages the concrete slab and breaks the duct. When this happens, it is necessary to inspect the cables for damage and repair the damaged section of duct.

X2.1.1 This procedure is used to remove enough of the slab to access the duct, then remove enough duct to access the cables. The work must be done in a way that minimizes duct breakage, production of debris and release of airborne asbestos fibers.

X2.1.2 Workers must have appropriate training and respiratory protection and protective clothing may be required.

X2.1.3 All applicable sections of the practice to which this procedure is appended are incorporated by reference.

X2.1.4 Prior to commencing work, the employer should ensure that at least one worker is capable of identifying existing asbestos hazards, is qualified to train other workers, and has the authority to take prompt corrective measures to eliminate a hazardous condition.

X2.2 Equipment and supplies required for this work are listed in Table X2.1.

X2.3 The Procedure for this work is shown in Table X2.2.

TABLE X2.1 Equipment and Supplies

Item	Comments
Bottle of soapy water	If spray bottle used have extra one available
Brushes	Heavy bristle
Chisels	1 in. (25 mm) and 2 in. (50 mm) blades
Disposable cloths or towels	
Disposal bag	6-mil (150 μm) labeled
Duct tape	
Hammers	Sledge and regular
Heavy marking pen	Waterproof
Jackhammers	Electric chipping hammer and large pneumatic hammer
Knife	"TLC" (tile, linoleum, carpet) knife with a hooked blade and sharp point
Protective clothing	Breathable fabric recommended
Respirators	Negative pressure air-purifying (full facepiece provides eye protection)
Shaving cream	Clear gel acceptable
Shovel and hand trowel	

TABLE X2.2 Procedure for Working on Damaged Asbestos-Cement Electrical Ducts Encased in Concrete Slabs

1. Excavate dirt from the top and side of the slab around the damaged area. Slope the sides of the trench to provide working room.
2. Remove any loose concrete covering the damaged duct. Do not remove concrete that is adhered to the duct.
3. If the slab is damaged to the extent that pieces of the duct have been knocked loose, do the following only if the pieces can be dislodged by hand (without using tools):
   a. Remove these pieces and get them away from the cables;
   b. Wet them with soapy water and put them in a disposal bag.
4. If removal of loose pieces exposes enough of the cables to inspect the cables for damage, do so at this time.
5. CAUTION: If the cables are not accessible enough to be inspected for damage, do not attempt to pry off broken pieces of duct. Continue with this procedure.
6. Starting at the ends of the damaged section, use the jackhammers to remove the concrete slab along the length of the duct.
   a. Remove concrete for at least six inches on either side of the damaged area;
   b. Remove concrete about ¾ of the way around the duct;
   c. Do not attempt to remove all of the concrete from the surface of the duct with the jackhammer and chisel;
   d. Do not expose adjacent ducts;
   e. Use the sledgehammer to fracture the concrete if necessary.
7. Brush all loose concrete pieces and debris off the slab and pick up loose concrete and debris in the dirt. If pieces of concrete that was in contact with the duct comes loose, wet it with soapy water and put them in a disposal bag.
8. Wet the concrete adhered to the duct with soapy water for the length of the section to be removed.

CAUTION: DO NOT POUR WATER INSIDE THE DUCT!

   a. Use a hammer and chisel to remove the wetted concrete over the one-inch width. Keep the surface wet.
   b. Always hold the chisel flat against the duct surface, never straight up and down.
   c. Use moist (not dripping wet) rags or paper towels to pick up the debris. Place the towels in a disposal bag. This debris may contain some asbestos fibers from the surface of the duct.

9. Wet the concrete adhered to the duct with soapy water around the duct at each end of the section to be removed. If the section of duct to be removed is more than 18 in. (50 cm) long, also wet it in the middle.

CAUTION: DO NOT POUR WATER INSIDE THE DUCT

   a. Use a hammer and chisel to remove the wetted concrete over a one-inch width.
   b. Always hold the chisel flat against the duct surface, never straight up and down.
   c. Use moist (not dripping wet) rags or paper towels to pick up the debris. Place the towels in a 6-mil (150-μm) labeled disposal bag. This debris may contain some asbestos fibers from the surface of the duct.

10. Wet any pieces of concrete that have fallen on the dirt, pick up the dirt and concrete pieces with the shovel or hand trowel, and put it in a disposal bag.
11. Use the point of the knife to score the duct lengthwise on top and bottom, and completely around on both ends (and in the middle if necessary). Keep the surface wet with soapy water.

CAUTION: DO NOT SPRAY OR POUR WATER INSIDE THE DUCT

   a. Score the duct about ⅛ in. (3 mm) deep. Do not cut completely through the duct.
   b. Use moist (not dripping wet) rags or paper towels to remove debris from the surface of the duct. Place the towels in a 6-mil (150-μm) labeled disposal bag.

12. Apply a thick layer of shaving cream over the lengthwise scored areas and over the scored areas around the duct at each end.
13. Cut through the duct where it has been scored on the top and ends.
   a. Use the 2 in. (50 mm) chisel to cut through the duct lengthwise on top.
   b. Use the 1 in. (25 mm) chisel to cut through the duct around both ends.
14. Cover all exposed duct surfaces with shaving cream, then remove the section of duct from around the cables by prying it off with the 2 in. chisel.
   a. Put the removed section in a disposal bag.
   b. The duct will break along the line scored on the bottom. It may also break into smaller pieces. Put all pieces and debris in the disposal bag.

DO NOT WIPE INSIDE THE DUCT WITH WET RAGS OR TOWELS!

15. Clean up the shaving cream and debris as follows:
   a. Wash the shaving cream and debris off the surface of the concrete;
   b. Wet the contaminated dirt and use the shovel to pick it up along with the shaving cream and debris;
   c. Place the dirt in the disposal bag. Do this until the surface of the dirt is visibly clean.
16. Clean the ends of the remaining sections of the duct for installation of a collar and an insert made of PVC or similar material.

X3. DRILLING HOLES IN ASBESTOS-CEMENT PANELS

X3.1 This procedure may be used to drill blind holes into a panel of sufficient thickness, which requires the use of a suitable depth gauge. It may also be used to drill holes through the panel where the debris generated on the back side of the panel can be contained or cleaned up, or will remain in an inaccessible location such as inside a wall cavity. The holes may be drilled in a vertical surface such as a wall, or in an overhead horizontal surface such as a ceiling.

X3.2 All applicable sections of the practice to which this procedure is appended are incorporated by reference.

X3.3 Prior to commencing work, the employer should ensure that at least one worker is capable of identifying existing asbestos hazards, is qualified to train other workers, and has the authority to take prompt corrective measures to eliminate a hazardous condition.

X3.4 Equipment and supplies required for this work are listed in Table X3.1.

X3.5 The procedures for this work are shown in Table X3.2.

TABLE X3.1 Equipment and Supplies

Drill bit (masonry bit preferred)
Duct tape
Hand or electric drill
Paper towels or rags
Permanent (waterproof) marking pen
Shaving cream, clear gel or other thickened substance
Small sealable plastic bag
Spray bottle with soapy water
Thin metal, Styrofoam® or heavy paper cups

TABLE X3.2 Procedures for Drilling Holes in Asbestos-Cement Panels

Procedure for Drilling on Vertical Surface
1. Tape bag open under spot to be drilled
2. Put tape over area to be drilled, extending tape down into bag
3. Mark hole location with spot on tape
4. Spray water on spot and begin drilling
5. Stop drill and remove bit after drilling
6. Wipe bit with wet towel or rag (put towel or rag in bag)
7. Pull tape and bag off panel (put tape in bag)
8. Close bag and seal with tape
Procedure for Drilling on Overhead Horizontal Surface
1. Mark hole location on panel
2. Drill hole through bottom of thin metal, Styrofoam™ or heavy paper cup
3. Fill cup with shaving cream
4. Put drill bit through hole in cup so that bit extends beyond lip of cup
5. Position bit on mark
6. Push pan against panel, completely covering the drill bit
7. Drill hole, stop drill and remove bit while holding cup against panel
8. Set drill down with bit resting over paper towel or rag
9. Remove cup, crush closed to contain shaving cream and put in a sealable plastic bag
10. Wipe drill bit clean with wet towel or rag and put towel or rag in a sealable plastic bag
11. Wipe panel with wet towel or rag and put towel or rag in a sealable plastic bag

X4. REMOVAL OF ASBESTOS-CEMENT PANELS

X4.1 This appendix addresses asbestos-cement panels used for interior walls and ceilings, and exterior roofing and siding panels on buildings and cooling towers. These panels are typically non friable if in good condition, usually about 6 mm (¼ in.) thick and not prone to significant fiber release unless severely deteriorated, crushed or damaged.

X4.1.1 These procedures are not intended for use where the objective is removal of large quantities of panels for renovation or demolition. These procedures are to be used when small panels or sections of large panels must be removed as part of a renovation project, when penetrations (including drilled and sawed holes) are required, or when small amounts of damaged or deteriorated panels must be removed for maintenance purposes.

X4.1.2 The size of panel(s) that can be removed using this procedure may be limited by local regulations. For reference, the amount of asbestos-containing materials that may be removed in a maintenance, renovation or repair operation in the United States ranges from 0.28 m^2 (3 ft^2) to that which will fit in a 1.5 m (60 in.) by 1.5 m (60 in.) disposal bag, depending on which regulation applies.

X4.1.3 Sanding, grinding, cutting, drilling, and sawing shall be limited to that required for the removal operation.

X4.1.4 Prior to commencing work, the employer should ensure that at least one worker is capable of identifying existing asbestos hazards, is qualified to train other workers, and has the authority to take prompt corrective measures to eliminate a hazardous condition.

X4.2 Equipment and supplies required for this work are listed in Table X4.1.

X4.3 The procedure for removal of interior wall and ceiling panels is shown in Table X4.2.

X4.4 The procedure for Removal of Exterior Roof and Siding Panel Sections is shown in Table X4.3.

X4.4.1 This procedure is not intended for use in removing in their entirety the large panels from which roofs and exterior walls are normally constructed. It is intended for removing small sections of such panels or small pieces of paneling that may have been installed for some purpose (to cover an

TABLE X4.1 Equipment and Supplies

Amended Water: Water to which a surfactant, such as a soap solution made with commercial grade detergent, has been added.
Disposal Bags: 0.006 in. (150 µm) thick leak tight polyethylene bags or wrap the panels in 0.006 in. (150 µm) thick polyethylene sheeting. The disposal package shall be labeled as follows: Avoid Opening or Breaking Container Breathing Asbestos is Hazardous to Your Health DANGER: Contains Asbestos Fibers or equivalent wording as required by applicable regulations in the language spoken by the workers.
Duct Tape: Shall be provided to seal the disposal bags and polyethylene sheeting.
Hand Tools: Snips, tile cutters or nail extractor to clip the nail heads of panels attached by nails. Knife or other tool with a sharp blade for scraping residue. Flat prying tool or prybar.
Polyethylene Sheet: 0.006 in. (150 µm) thick polyethylene film. Recommended roll sizes are 20 ft x 100 ft (6.1 m x 30.3 m) or 40 ft x 100 ft (12.2 m x 30.3 m).
Power Tools: Drills and saws for cutting asbestos-cement panels shall be selected and used in accordance with 8.4 of this practice. Hand drills and saws are preferable to power tools for removing screws and making small penetrations.
Shaving Cream: A thickened substance such as shaving cream in a pressurized or non-pressurized container to control debris and fibers generated by the work.
Spray bottle or agricultural grade garden sprayer (not a garden hose).

opening, for example). For removing a section of a large panel, some cutting and sanding may be required.

X4.4.2 This procedure applies to removal of sections of panels and louvers on cooling towers as well as roofing and siding on buildings.

TABLE X4.2 Removal of Interior Wall and Ceiling Panels

Preparation

1. Restricting Work Area
   a. Any room where wall or ceiling panels are being removed shall be completely closed off.
   b. Removal should be conducted in a time when the entire floor or building is minimally occupied.
2. Sealing off Work Area
   a. Once the work area is identified, protect the furniture and other room contents by covering them with polyethylene sheeting.
   b. Shut down the HVAC system if the air intake or return is located in the work area. Seal all vents or duct openings with polyethylene sheeting taped securely in place.
   c. Completely isolate the work area from the remaining portion of the building if cutting, sanding or drilling operations are employed.
   d. Install two layers of polyethylene sheeting, supported as necessary, in rooms or spaces inside the building, directly beneath the work area.
3. Once all preparation is complete, use a spray bottle or garden sprayer to thoroughly wet the surface of the panels with amended water and proceed with removal before the panels dry out.

Worker Protection and Decontamination

1. Workers removing the panels shall wear appropriate clothing and respiratory protection in accordance with Section 9 of the practice in case there is any breakage, or during drilling, sanding or cutting operations.
2. If work consists entirely of removing whole panels that are intact and nails, screws or other fasteners do not have to be removed, a respirator is not required.
3. Workers shall dispose of single-use coveralls as asbestos waste.
4. A decontamination chamber need not be constructed if panels are only being removed without power cutting, sanding, or drilling operations being employed.
   a. If these operations are performed, decontamination should be performed according to Section 9 of this practice using a decontamination chamber near the work area.
   b. If gross contamination of workers' clothing is expected, workers shall shower when exiting the work area. .

Removal of Panels

1. Before starting the removal process, put two layers of polyethylene sheeting, in which the panels will be wrapped, on the floor.
   a. The sheets should be at least double the size of the panel, so the panels can be wrapped.
   b. As the panels are removed, place them on the sheets, wrap the sheets around the panels and tape them closed with duct tape.
2. Ceiling panels that are supported by gridwork without being held in place by nails, screws or other fasteners should be wetted thoroughly on both sides and lifted out of the grid without breaking them. If breakage occurs along the edges, wet the residue that remains stuck to the grid and scrape it off with a sharp blade.
3. Wall and ceiling panels that are attached are typically installed by one of three methods
   a. by nailing predrilled holes
   b. screwed directly to studs and rafters in predrilled holes, or
   c. use of tack strips.
4. If the panels are screwed-in or tack strips were used, wet the panel edges and remove the tack strips.
   a. Use foam or shaving cream when backing out screws to eliminate dust and debris.
   b. Set the screwdriver, apply a small amount of shaving cream on the area around the screw, and back out the fastening screws.
   c. Wipe off the shaving cream with a paper towel and discard the paper towel in an appropriate waste bag.
5. If the panels were nailed in, a snip or tile clipper may be used to cut off the head of the nails holding them in place. If a panel is broken and the edge remains attached, remove the remnant immediately, wet any residue on the studs or rafters and scrape it off with a sharp blade.
6. Cutting operations to remove part of a panel should be done in accordance with Section 8 of this practice.
   a. The work should be done with hand tools to the greatest extent possible, and if power tools must be used they should be operated at low speed and equipped with dust capture devices if available.
   b. If edges of the panel remaining in place must be finished by sanding or grinding, this must be done with the material being kept wet.
7. After removal of wall or ceiling panels is complete, the studs or rafters should be painted to fix any remaining fibers to the wood surface.
8. No airborne dust should be visible during the removal procedures.
   a. Use a spray bottle to mist the edges of the panels.
   b. Remove the panels in whole pieces.
   c. Ceiling panels shall not be dropped but carefully lowered to the floor and put on the polyethylene sheeting to wrap them.

Clean-up, Inspection and Disposal

1. A thorough visual inspection shall be conducted to ensure all residue from the panels has been removed and the studs, rafters, deck or exposed walls have been decontaminated. (This is particularly important when the panels have been glued, screwed or nailed in place.)
   a. All waste shall be bagged or completely double wrapped with polyethylene sheeting, labeled and taped prior to removal for the work area for disposal.
   b. The bags or wrapped waste are then decontaminated by wetting the outside of the bag or polyethylene sheeting and labeled with the appropriate placard before being placing in the disposal container.
   c. The work is complete when the work area is visually clean and all panels have been wrapped or placed in disposal bags, and all debris and contaminated materials have been bagged.
2. After the work area is inspected and waste disposed of, isolation barriers and decontamination chamber (if used) shall be taken down.
   a. Remove all signs, equipment and other waste or disposable materials and leave the property in a clean condition.
   b. Disposal should be in compliance with the country's asbestos disposal regulations.
   c. In the absence of country regulations regarding asbestos, the waste should be taken to a landfill and immediately buried so scavengers cannot sift through and salvage the bags or their contents.

TABLE X4.3 Removal of Exterior Roof and Siding Panel Sections

Preparation
1. The area adjacent to the section of roof or siding being worked on shall be restricted during the operation with rope and construction tape or barricades, or both.
2. One layer of polyethylene sheeting shall be placed on the ground next to the building for 10 ft (3 m) in all directions.
3. Roof and siding areas not involved in the work area shall be separated in a similar manner in partial roof or siding removal.
4. Seal all windows, doors, vents and duct openings near the work area with polyethylene sheeting taped securely in place.
5. Shut down the HVAC system if the air intake or return is located in the work area.
6. Once all preparation is complete, use a spray bottle or garden sprayer to thoroughly wet the surface of the panels with amended water and proceed with removal before the panels dry out.
Worker Protection and Decontamination
1. Workers removing the panel sections shall wear appropriate clothing and respiratory protection in accordance with Section 9 of the practice in case there is any breakage, or during drilling, sanding or cutting operations.
2. Workers shall dispose of single-use coveralls as asbestos waste.
3. A decontamination chamber need not be constructed if panel sections are only being removed without power cutting, sanding, or drilling operations being employed.
a. If these operations are performed, decontamination should be performed according to Section 9 of this practice using a decontamination chamber near the work area.
b. If gross contamination of workers' clothing is expected, workers shall shower when exiting the work area.
4. Removal of roofing and siding panel sections at elevated locations should be done with fall protection for the workers in accordance with regulations and local codes.
a. Asbestos-cement roofing panels become deteriorated due to weathering and may not be structurally sound enough to support a worker.
b. Workers should not place their weight on roofing panels to avoid the possibility of falling through.
Removal of Panel Sections
1. Before starting the removal process, put two layers of polyethylene sheeting, in which the panel sections will be wrapped, on the ground.
a. The sheets should be at least double the size of the panel, so the panel sections can be wrapped.
b. As the panel sections are removed, place them on the sheets, wrap the sheets around the panel sections and tape them closed with duct tape.
2. Roofing and siding panels are typically attached or installed by nailing predrilled holes or are screwed directly to studs and rafters in predrilled holes. If the section of panel to be removed has been fastened to the structure, the nails or screws will have to be removed.
3. If the panels are screwed-in, it is much easier to control debris than if nails were used.
a. Wet the panel edges and use foam or shaving cream when backing out screws to eliminate dust and debris.
b. Set the screwdriver, apply a small amount of shaving cream on the area around the screw, and back out the fastening screws.
c. Wipe off the shaving cream with a paper towel and discard the paper towel in an appropriate waste bag.
4. If the panels were nailed in, a snip or tile clipper may be used to cut off the head of the nails holding them in place.
a. Use of a prybar may be necessary to pull the nails out.
b. Large gauge nails were typically used to secure roofing panels and a wooden block will be necessary to pull them out and keep damage to a minimum.
5. Cutting operations to remove part of a panel should be done in accordance with Section 8 of this practice.
a. The work should be done with hand tools to the greatest extent possible
b. If power tools must be used they should be operated at low speed and equipped with dust capture devices.
6. If a section of a panel is broken during removal and the edge remains attached, remove the remnant immediately, wet any residue on the structure and scrape it off with a sharp blade.
7. When removing roof sheets, handle the sheeting in a horizontal orientation to prevent dust build-up from dropping into the underlying area.
8. After removal of roofing or siding panel sections is complete, the underlying structure should be painted to fix any remaining fibers to the wood surface.
9. No airborne dust should be visible during the removal procedures.
a. Use wet methods in accordance with Section 8 of this practice and remove the panel sections intact as possible.
b. Panel sections shall not be dropped but carefully lowered to the ground and put on the polyethylene sheeting to wrap them.
Clean-up, Inspection and Disposal
1. A thorough visual inspection shall be conducted to ensure all residue from the panel sections has been removed and the underlying structure has been decontaminated.
a. All waste shall be bagged or completely double wrapped with polyethylene sheeting, labeled and taped prior to removal for the work area for disposal.
b. The bags or wrapped waste are then decontaminated by wetting the outside of the bag or polyethylene sheeting and labeled with the appropriate placard before being placing in the disposal container.
c. The work is complete when the work area is visually clean and all panel sections have been wrapped or placed in disposal bags, and all debris and contaminated materials have been bagged.
2. After the work area is inspected and waste disposed of, isolation barriers and decontamination chamber (if used) shall be taken down.
a. Remove all signs, equipment and other waste or disposable materials and leave the property in a clean condition.
b. Disposal should be in compliance with the country's asbestos disposal regulations.
c. In the absence of country regulations regarding asbestos, the waste should be taken to a landfill and immediately buried so scavengers cannot sift through and salvage the bags or their contents.

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