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ASBESTOS IN CRAWL SPACES

by

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This document has been developed for use by Navy Asbestos Program Managers (APM), industrial hygenists, Safety and Health Managers, and facility managers to address asbestos contamination in crawl spaces. The contents provide direction for managing and abating asbestos hazards in these areas. Section 1 contains primarily the technical and regulatory requirements. Sections 2 and 3 are checklists with detailed discussions for clean-up or abatement in crawl spaces. These augment the NFESC Field Procedure Manuals for Managing Asbestos Abatement Demolition and Renovation Contracts, TM-2210-ENV and TM-2211-ENV, respectively. Section 4 lists the regulatory and technical references.

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OVERVIEW/ BACKGROUND

This document has been developed to help Navy Asbestos Program Managers (APM), industrial hygienists, Safety and Health Managers, and facility managers address asbestos-contamination in crawl spaces. The document provides direction for managing and abating asbestos hazards in these areas. Section 1 contains the technical and regulatory requirements for asbestos materials and contaminated soil in crawl spaces. Sections 2 and 3 are checklists with detailed discussions for clean-up or removal of asbestos in crawl spaces. The information herein augments Naval Facilities Engineering Service Center (NFESC) Field Procedure Manuals for Managing Asbestos Abatement for Demolition and Renovation Contracts, TM-2210-ENV and TM-2211-ENV respectively.

Protection of workers, building occupants, and the environment are the key elements in asbestos management. Regulatory and technical sources have been reviewed in the development of this document. Consult your state or local government for additional requirements regarding clean-up or soil removal in crawl spaces.

Many crawl spaces in older buildings may contain asbestos thermal system insulation (TSI) or other friable asbestos containing building materials (ACBM). These crawl spaces may also contain asbestos debris and contaminated soil. Typically, asbestos soil contamination can occur if TSI or other friable asbestos-containing materials (ACM) were damaged or removed without soil protection. Further crawl space contamination may have occurred through maintenance activities, leaks, or flooding. Any scheduled maintenance, renovation or demolition project, or ACM removal in crawl spaces must include a thorough evaluation of all potential hazards, including soil conditions and proper protection of workers, occupants, and the environment.

Naturally occurring asbestos may exist in rock formations, depending on geographic location. Several variations of asbestos minerals were previously mined in the Northeastern and Western United States. Asbestos is not generally considered as naturally occurring in soil in measurable quantities greater than one percent. Background levels in soil may contain traces of asbestos due to past uses/application of building materials or from automotive brakes and clutches. Standard regulatory definitions of asbestos are not applicable for contaminated soil.

Work in asbestos contaminated crawl spaces requires careful planning, sampling and assessment, worker protection, removal, and/or clean-up. The nature of soil in a crawl space varies from location to location, from virtually rock-like to silted fine soil, to damp sticky clay. Safe work practices and procedures are required in crawl spaces, using the same degree of care as occupied areas of a building. The following sections will discuss some necessary considerations when dealing with asbestos in crawl spaces.

SECTION 1. ASBESTOS IN CRAWL SPACES

There are health hazard, regulatory, and facilities management issues relating to asbestos-contaminated soil in crawl space. The areas of concern are categorized as follows:

- Exposure potential to workers, occupants, and contractors (OSHA)
- Sampling and assessment (OSHA & EPA)
- Contracts and In-house maintenance (NAVFAC)
- Construction Management (NAVFAC)
- Confined Spaces and other hazards (OSHA)
- Funding (NAVFAC)

A detailed discussion follows for each of the above areas to assist in developing worker and occupant protection, evaluation of hazards and management or abatement of asbestos-contaminated soil in crawl spaces.

1.1 Exposure Potential

Both the type of work and the potential for exposure trigger the Occupational Safety and Health Administration (OSHA) asbestos standards listed in Section 4. The accessibility of the material should also be considered when determining potential exposure. The Environmental Protection Agency (EPA) Asbestos Hazard Emergency Response Act (AHERA) regulations define "accessible" as disturbance of materials by building occupants or ***custodial or maintenance personnel in the course of their normal duties***. Some crawl spaces are considered accessible due to entry for maintenance purposes, for example a crawl space that contains a mechanical air handler and/or pump that requires normal/regular maintenance. Certain exceptions may exist where crawl spaces are locked, sealed, and no routine maintenance is performed.

Whether exposures have been documented or no exposure assessment has been performed, the following is required for crawl spaces with ACM or presumed ACM (PACM):

- Notification: Notify personnel of the presence and location of the ACM and/or PACM. The notification can be given in writing or through personal communication between the building owner and the personnel entering the area.

- Warning Signs/Labels: Post warning signs at the entrance to each regulated area and at the entrance to mechanical rooms/areas. Affix labels to installed ACM and/or PACM where they will be clearly noticed, warning signs may be substituted if they contain the same information as the label. A regulated area is an area where airborne asbestos concentrations exceed, or there is a reasonable possibility they may exceed the permissible exposure limit (PEL) of 0.1 fibers per cubic centimeter (f/cc), or where Class I, II, or III asbestos work is conducted.

- Training: Provide EPA accredited Asbestos Worker or Contractor/Supervisor training for personnel conducting Class I or II asbestos work. Provide 16 hours of Operations and Maintenance training for all members of the maintenance and custodial staff who conduct any activities that will result in the disturbance of ACBM. Training shall comply with 40 CFR 763.92.

- Monitoring: Perform exposure monitoring for work operations covered by 29 CFR 1926.1101 to accurately determine the airborne concentrations of asbestos to which employees may be exposed.

- Respiratory protection and personal protection equipment (PPE): Provide adequate personal protection, in accordance with 29 CFR 1926.1101, where exposures are documented or no exposure assessment has been performed.

1.2 Sampling and Assessment

TSI is the most commonly installed ACM found in crawl spaces. TSI typically contains greater than one percent asbestos (range <1 – 80 %). Cement asbestos boards (transite) or tar products (usual range <50% asbestos) may have been used previously in some areas. OSHA and EPA define ACM as containing more than one percent asbestos. This definition focuses on a manufactured product, such as pipe insulation or floor tiles. The EPA analytical test method to identify asbestos is for asbestos-containing ***building*** materials. Laboratories usually provide results with analytical disclaimers for non-building materials such as; debris, soil, or settled dust.

Crawl space soil contamination usually results from past maintenance activities, accidental disturbance, or other damage to ACM. Although a soil sample may be identified as containing less than one percent asbestos, the building material that contaminates the soil is generally more than one percent asbestos. Use the following sampling and assessment procedures to evaluate asbestos in crawl spaces in addition to the procedures identified in NFESC Field Procedure Manuals for Managing Asbestos Abatement Demolition and Renovation Contracts, TM-2210-ENV and TM-2211-ENV respectively.

1.2.1 Soil Sampling

Special attention is required if sampling of the soil in crawl spaces is done. Three types of bulk sampling may be performed:

- Limited surface sampling of suspect debris to identify contamination or document improper removal methods.
- Specific sampling to determine abatement (removal) criteria.
- Background (or control) sampling outside of the crawl space area.

1.2.1.1 Limited Sampling is straightforward, based on visual inspection and discreet soil or debris bulk sample collection. OSHA requires collecting three samples of a suspect material for asbestos analysis. EPA recommends nine samples in their asbestos sampling scheme. Suspected contamination may be visually limited to locations in the immediate vicinity of TSI. Limited sampling and laboratory analysis can be used to quickly determine if asbestos contamination is present.

1.2.1.2 Specific Sampling requires determining the depth and extent of soil contamination. This sampling method develops a topographical type map including the depth of contamination. Collect samples in a grid layout, identified by depth (i.e. NW corner, grid 1, depth 1, 2, 3, 4 inches). Separate samples in one-inch depths and analyze separately until asbestos is detected below background samples. The American Society for Testing and Materials standard ASTM E 1368 recognizes that asbestos materials do not "burrow" into the hard pan. In most cases, pieces of debris will be limited to the top half-inch or so of the surface. However, soil types vary and asbestos may be found at greater depths.

The EPA sampling scheme for PCB Spill sites is recommended as a sampling strategy guide to achieve a 98 percent chance of detection. This protocol requires numerous samples collected within a grid, based on a diagram and radius of the suspected contaminated area. A brief summary of the PCB sample requirements follows:

- Radius of 4 feet or less requires 7 samples
- Radius from 4 –11 feet requires 19 samples
- Radius of 11 feet or more requires 37 samples

This type of sampling is extensive, costly, and should be used primarily for project designs to identify soil removal quantities (contamination depth times square feet of space = cubic yards for disposal).

1.2.1.3 Background or Control Samples should be collected outside of the crawl space area for comparison. Collect four samples to represent the compass points (N, S, E, and W). Collect the samples at the same depth as the specific samples. When collecting limited samples, also collect background samples for comparison. The top one inch of background soil is adequate for a limited sample.

1.2.2 Sample Analysis

Send samples to an accredited asbestos laboratory that has specific analytical protocols for soil analysis. Soil sample analysis costs by polarized light microscopy (PLM) range from $15 – 20 (average) with standard turnaround times. Additional analysis by transmission electron microscopy (TEM) may be performed. Costs for TEM are approximately $65 – 100, in addition to the PLM analysis, which should always be performed first.

1.2.3 Assessment

Assessment is an important part of sampling to determine if there is a pathway or potential for building contamination. Factors to evaluate are:

- Access points into the building
- Chases/shafts or plenums, which may allow air movement and contamination into the building
- Elevator shafts which move large volumes of air

If either crawl space access or building air pathway is identified as a potential exposure source to building occupants, notify the activity asbestos program manager (APM) or designated activity representative immediately. All assessments need to be made on a case-by-case basis. Additional industrial hygiene or contract support may be required to assess potential hazards and abate hazards.

1.3 Contracts and In-House Maintenance

1.3.1 Construction Contracts

Renovation or demolition contracts require an accredited asbestos project designer to evaluate the extent of asbestos contamination in a crawl space. The design should also detail when crawl space entry is required to perform utility services during construction or total building demolition. During contract development, consider the scope of the construction contract and the amount and condition of ACM in the crawl space when determining the type of soil sampling to require. Although initial costs may appear to be significant, extensive specific sampling to develop an accurate cost estimate may avoid costly change orders during the construction phase.

1.3.2 In-House Maintenance

Maintenance work requires compliance with OSHA asbestos standards referred in Section 4. If maintenance work in a crawl space may disturb ACM or contaminated soil, conduct an exposure assessment and personal air sampling to determine the exposure potential. Also consider using limited soil sampling, paragraph 1.2.1.1, to determine degree of asbestos soil contamination. When performing limited sampling, sample and assess the entry points and work area. Follow the provisions of Section 1.1 to protect workers and building occupants. Perform clean-up as necessary to reduce further soil contamination.

1.3.3 Facility Services and Related Contracts

These contracts shall contain appropriate paragraphs or sections regarding potential exposure to asbestos. Additional paragraphs for special circumstances, such as crawl space entry, shall be added when appropriate. Paragraph 1.1 addresses the requirements for exposure potential.

1.4 Construction and Management

There are three options to address asbestos-contaminated soil in crawl spaces:

1. In-place management with controls
2. Soil removal
3. Encapsulation / Enclosure

1.4.1 In-Place Management with Controls.

In this system crawl space access is restricted to only trained personnel. The crawl space is designated as a regulated area and all maintenance and construction work in the space shall follow the provisions of OSHA 29 CFR 1926.1101. In-place management is not an option where building contamination results from crawl space access or air entrainment from crawl space plenums. Building contamination may occur from internal access hatches or stairways. Corrective action is required to eliminate exposures to building occupants. Fire-stop materials may be used to seal penetrations and prevent air entrainment. Restrict internal access, allowing only controlled access for maintenance. Section 2 provides a process checklist for clean-up and continuing in-place management.

1.4.2 Soil Removal.

The term soil removal is a bit of a misnomer, since the project should focus on the removal of asbestos, not soil. A thorough sampling and assessment, Section 1.2, of the crawl space and the soil will aid the project designer determine the extent of contamination.

A project to remove asbestos contaminated soil should also require the removal of all friable asbestos within the crawl space. This ensures the soil is not recontaminated at a later date. If soil removal exposes or compromises the building foundation, regulatory approval (EPA/ State) may be required to stop removal, provide backfill materials, and perform encapsulation or enclosure options. Some innovative soil removal technology is available, such as using trailer mounted vacuum systems equipped with High Efficiency Particulate Air (HEPA) filtration (Vacu-loader).

1.4.3 Encapsulation and/or Enclosure.

Soil conditions, water table, and access must be evaluated prior to determining which encapsulation and/or enclosure method can be used. State regulatory approval may be required prior to enclosure or encapsulation. Typically, gross debris clean up is required prior to encapsulation or enclosure. In addition some soil removal may be needed.

1.4.3.1 Encapsulation of soil, like encapsulation of other ACM, is a temporary method requiring an Asbestos Operation and Maintenance Program, which has limitations. There is a variety of soil encapsulation products available that have been used with varying results. Some polymer emulsion and vinyl acetate / acrylic copolymer projects have had good results. Other options include using a geo-textile membrane, which is covered with at least 4 to 6 inches of sand,

gravel. If the crawl space requires routine entry for maintenance, install suitable access pathways to avoid excessive damage to the encapsulant. Proper selection of an encapsulation technique requires specialized expertise. The NFESC, the Engineering Field Divisions and the Engineering Field Activities can provide support with this expertise.

1.4.3.2 Enclosure of soil includes the option of poured concrete over a geo textile membrane. This is considered a permanent remedy.

1.5 Area Clearance

Clearance sampling following soil abatement should consist of both air and bulk sampling. Collect air samples for clearance (clean-up, encapsulation, or soil removal). ASTM E 1368 recommends using the personal air samples of the abatement inspector, obtained during final inspection, as a representative indication of airborne fiber exposure risk. Aggressive air sampling can only be performed where enclosure by concrete has been performed. Use the results from both air and bulk soil samples to determine whether acceptable clearance criteria has been met.

1.6 Confined Spaces and Other Hazards

This part addresses other safety and health hazards that must be addressed prior to crawl space entry. Crawl spaces are commonly classified as confined spaces. An employer who has employees working in a confined space is required by OSHA to have a confined space entry program. Other safety and health hazards require evaluation prior to crawl space entry. Ensure proper evaluations are performed, which include:

- Confined space entry (Toxic, hazardous, or oxygen deficient atmospheres)
- Hot work (welding, torching, burning)
- Lock out/Tag out (electrical, steam, etc)
- Heat Stress
- Hazard Communication
- Trenching and Shoring
- Other applicable OSHA standards

1.7 Funding

Centralized funds are not generally available for contaminated crawl spaces. See OPNAVINST 5090.1 for funding guidance, and certain exceptions may also exist for Hazard Abatement funding. Building contamination caused by crawl space air plenums, where the only access is through the building, or other special conditions shall be evaluated on a case-by-case basis. Renovation or demolition projects involving crawl space work shall use project funds for assessment and management. Routine operations and maintenance costs shall be part of the activities operating budget.

SECTION 2. CLEAN UP ASBESTOS-CONTAINING DEBRIS IN CRAWL SPACE

Maintenance workers enter crawl spaces to repair pipes, install phone lines, or perform electrical work where ACM thermal system insulation, and/or asbestos debris may be present. Control access to crawl spaces and tunnels, where there is ACM. Only those who have at least 16 hours of asbestos O&M training (Class III) are allowed to enter an area and contact the TSI and debris for the purpose of maintenance or custodial activities, which disturbs ACM. The following checklist describes the necessary precautions when entering crawl spaces or tunnels for Class III work that results in the clean up of small amounts of asbestos-containing debris. The work includes cleaning up insulation debris that can be picked up in intact pieces, or deteriorated debris that is mixed into soil. Personal air sampling or a negative exposure assessment is required. Clearance by aggressive air sampling is not appropriate for crawl space work. The Competent Person should consider collecting passive air samples, for clearance, and bulk soil samples. This Class III work shall not exceed a total ACM that can be contained in one glove bag or waste bag which shall not exceed 60 inches in length and width. The clean-up for larger projects would be a Class I, Construction Standard job.

CLEAN UP ASBESTOS DEBRIS IN CRAWL SPACES		
√	**DESCRIPTION**	**REFERENCE**
	1. Do workers have at least asbestos O&M training before entering crawl space?	29 CFR 1915.1001 (k)(9)(i) 29 CFR 1926.1101 (k)(9)(i)
	2. Is the crawlspace considered a confined space? Have workers had confined space training?	29 CFR 1910.146
	3. Has a competent person made a negative exposure assessment for this particular work?	29 CFR 1926.1101 (g)(8)(i)
	4. Are workers provided with appropriate protective equipment?	29 CFR 1926.1101 (h)(1) 40 CFR 61.145 (c)(8) 40 CFR 763.121 (k)(3)
	5. Are there at least two workers as a team?	29 CFR 1910.146
	6. Has a competent person reviewed the work practices as necessary for the conditions of the specific facility?	
	7. Have workers established an exclusion zone, set up an enclosure, and provided negative pressure system?	29 CFR 1915.1001 (g)(5)(i) 29 CFR 1926.1101 (g)(5)(i)
	8. Are the workers using engineering controls, and asbestos work practices such as HEPA filtered vacuum and wet methods?	29 CFR 1915.1001 (g)(1) 29 CFR 1926.1101 (g)(1)
	9. Have cleanup and tear-down work been performed properly?	
	10. Has the APM been notified?	

Detailed Discussion

Checklist Item #1. The workers performing asbestos clean up work shall have a minimum of 16 hours of asbestos O&M training with specific hands-on instruction in clean up of asbestos debris.

Checklist Item #2. If the crawl space is a confined space, workers must have had training in confined space entry before entering crawl spaces. They need to be familiar with the facilities confined space entry program, and follow the facility's confined space entry procedure. Review confined space requirements with the APM before start of work.

Checklist Item #3. Cleanup work in crawl space is classified as OSHA Class III activity where the work includes drilling, breaking, or sawing of ACM. If a competent person has not made a negative exposure assessment, some sort of enclosure is needed to protect the environment. Usually, the enclosure can be a glove bag, particularly in the case of pipe or fitting insulation. If the amount of debris does not fit comfortably into one 60" by 60" glovebag, stop work and notify the supervisor.

Checklist Item #4. Workers need to be protected with respirators, protective clothing and decontamination procedures.

Checklist Item #5. Due to confined space safety concerns, a minimum of two workers are recommended for crawl space. One worker should remain outside to communicate with inside worker and handle rescue arrangements if needed.

Checklist Item #6. Many crawl spaces have dirt floor and low headroom. There could also be other factors that will affect the work practices. A competent person needs to review the work procedure, and revise it as required by the condition of a specific facility. Refer to work practices specified in the National Institute of Building Sciences (NIBS) manual for examples that can be applied to the situation.

Checklist Item #7. Prepare work area with mini-enclosure and set up negative pressure to prevent contamination of the floor above and adjacent areas. Individual abatement sites may present various issues that may prohibit the use of negative air. However, if feasible, maintain a minimum negative pressure of 0.02 inches water gauge relative to outside pressure.

Checklist Item #8. Use engineering controls and work practices such as vacuum cleaners equipped with high efficiency particulate air (HEPA) filter, wet methods, local exhaust etc. to control asbestos. Adequately wet floor area and debris. Start working near entry area and work toward the rear of the area. Use drop-cloth below removal areas and decon the drop-clothe by HEPA vacuuming.

Checklist Item #9. Perform the following clean-up and tear-down steps to complete the work. Package and label asbestos waste for disposal. Clean tools, equipment and work area using wet wiping and HEPA vacuuming as appropriate. Decontaminate and remove protective clothing and respirators to be disposed as ACM. Complete visual inspection. Remove drop cloths and mini-enclosure, and dispose of as contaminated.

Checklist Item #10. Notify the APM or supervisor that the work is complete and return documents to the APM. Confirm with the APM the location and custodian of asbestos record documents that include: records of the presence, location, and quantity of ACM and PACM; employee personal air sample records; medical surveillance records; training records, and waste shipment records.

SECTION 3 REMOVAL IN CRAWL SPACES

Asbestos removal in crawl spaces can be tedious, difficult, and expensive. Thorough evaluation during the building survey and project design is very important. Crawl space height can vary from several feet to a few inches. Columns, sub-foundations, cross-bracing, waste water lines and other building systems can render an area almost inaccessible.

Asbestos inspections in crawl spaces should be done using the same requirements as a project in the occupied spaces of a building. The characteristics of the environment must be considered in designing the abatement project. During design, an asbestos accredited project designer shall specify the type of soil sampling required to determine size and complexity of soil contamination.

In general, asbestos abatement in crawlspaces usually consists of removing thermal system insulation from pipes and ducts, picking up insulation that has fallen or been taken off, removing and disposal of abandoned insulated piping systems, removing contaminated soil. Encapsulation, and/or enclosure may also be selected. Section 1.4 provides the technical information pertaining to asbestos-contaminated soil removal and encapsulation or enclosure options when abatement is performed.

CRAWLSPACE ABATEMENT CHECKLIST		
√	**DESCRIPTION**	**REFERENCE**
	1. Have federal, state, or local agencies been notified ten days in advance of work?	40 CFR 61.145(b)
	2. Has the workspace been isolated for the project?	29 CFR 1926.1101(e)
	3. Is the crawlspace considered a confined space? Is a permit required?	
	4. Have critical barriers been established?	29 CFR 1926.1101(g)(4)(ii)(A)
	5. Has negative pressure been established?	29 CFR 1926.1101 (g)(5)(i)
	6. Are engineering controls, and asbestos work practices such as HEPA filtered vacuum and wet methods in use?	29 CFR 1926.1101 (g)(1)
	7. Has visible asbestos debris been removed?	
	8. Has the ACM installed on surfaces or systems inside the crawlspace been removed before undertaking the excavation, enclosure, or encapsulation of the soil?	
	9. Has a thorough visual inspection of piping or ductwork been performed? Has the APM been notified?	

CRAWLSPACE ABATEMENT CHECKLIST		
√	**DESCRIPTION**	**REFERENCE**
REMOVAL/EXCAVATION		
	10. Has the crawlspace soil been evaluated?	
	11. Has the depth of soil removal been determined?	
	12. If Vacu-loading is used for removal, has the contractor obtained written approval from the EPA, state, or local agency before a dry removal project begins?	40 CFR 61.145 c(3)(ii)
ENCLOSURE		
	13. Does the poured concrete include drainage?	
	14. Are aggressive sampling techniques used to collect clearance air samples after enclosure is complete?	
ENCAPSULATION		
	15. Will the soil be encapsulated?	
	16. If using a geo-textile membrane, has it been covered with sand or gravel?	
	17. Have provisions been made for drainage?	

Detailed Discussion.

Checklist Item #1. Notify the EPA or approved state or local agencies if the asbestos area disturbed in this project, or a combination of projects during a year, meets or exceeds cut-off limits. The cut-off limits are: 80 linear meters (260 linear feet) on pipes, 15 square meters (160 square feet) on other facility components, or 1 cubic meter (35cubic feet) of facility components where the length could not be measured previously.

Checklist Item #2. Removal of ACM in crawl space has a high probability of inadvertent contamination of either people or the environment. Work area isolation is necessary. Follow Class I requirements.

Checklist Item #3. Crawl spaces can be confined spaces. Crawl spaces may be a permit required confined space during the heating season when steam pipes are active, and a non-permit confined space during the summer. Contractors who have employees working in a confined space are required by OSHA to have a confined space entry program, and entry procedures.

Checklist Item #4. Establish critical barriers by sealing penetration points, ventilation grills, and access hatches.

Checklist Item #5. Negative pressure is required to prevent contamination of the floor above and adjacent areas. Individual abatement sites may have various conditions that prohibit the use of negative air. However, if feasible, maintain a minimum negative pressure of 0.02 in. w.g. relative to outside pressure. Set up a full decontamination facility and load out area unless there are site-specific constraints. A mini enclosure may be used at the entrance if the space is very small.

Checklist Item #6. Contaminated crawl spaces are hard to clean. Asbestos removal work in crawl space is normally classified as OSHA Class I activity. Use engineering controls and work practices such as vacuum cleaners equipped with HEPA filter, wet methods, local exhaust etc. to control asbestos. Place 6-mil plastic underneath the pipes and ducts from which insulation is being removed to catch falling debris and contaminated water. Glove bags are often used in crawl spaces abatement to keep the soil from getting more contaminated than it already is. Remove contaminated soil as soon as asbestos removal of other materials is completed.

Checklist Item #7. Carefully remove loose, visible asbestos debris by hand or with a HEPA vacuum prior to applying enclosure or encapsulation. Enclosing visible asbestos debris in a crawl space with cement may be considered as creating a disposal site. This would require a variety of State and Federal approvals. If encapsulated, the spray strikes the soil and asbestos fibers may become airborne and settle after the encapsulant is dry.

Checklist Item #8. Remove ACM installed on surfaces or systems inside the crawlspace before undertaking the excavation, enclosure, or encapsulation of the soil. Otherwise, the potential for recontamination of the soil will occur. Establish plastic barriers to prevent additional contamination of the soil and to avoid grinding asbestos debris deeper into the soil.

Checklist Item #9. Visually inspect piping or ductwork where asbestos removal was performed. Acceptance criteria are the same as any other location: no remaining material and no visible residue. After successful inspection, sealer is applied to the abated surfaces, and the plastic is removed from underneath the pipes and ducts. Conduct soil cleanup prior to final clearance sampling. Confirm with the APM the location and custodian of asbestos record documents that include: records of the presence, location, and quantity of ACM and PACM; employee personal air sample records; medical surveillance records; training records, and waste shipment records

Checklist Item #10. Refer to Section 1.2 Sampling and Assessment. Soil sampling may be needed to determine the degree of contamination and develop the project requirements for soil removal. Soil clean up and removal follows abatement of ACM on building systems (pipes, ducts).

Checklist Item #11. Asbestos materials generally does not "burrow" into the hard-pan. In most cases, pieces of debris will be limited to the top half-inch or so of the soil surface. Situations do exist where ACM is buried in trenches, or is carried by water into fissures of very porous soil. These conditions should be identified during the project design. Refer to Section 1.2 Sampling and Assessment.

Checklist Item #12. The advent of sophisticated Vacu-loading systems has made soil removal more practical and economical than hand methods of HEPA vacuuming and bagging of debris. Typically, a Vacu-loader is mounted on a vehicle chassis and consists of a cyclone debris separator attached to an assembly of HEPA filters and a bagging device. The cyclone separator channels most of the larger particles and pieces of rubble into bags, and the microscopic asbestos debris accumulates in the HEPA filters. Recent designs have incorporated a continuous bagging feature that enables the machine to cycle during the bagging process, instead of requiring partial shut down every time a bag is filled. In general, Vacu-loaders function optimally with dry, loose material. This requires specific permission from EPA, as per 40 CFR 61, to be performed as a dry removal. Water should be added to the soil prior to bagging (making the consistency of dog food) which adequately wets the material for disposal.

Checklist Item #13. Poured concrete is considered a permanent solution. Soil conditions, water table and access must be evaluated prior to determining the use of concrete. Unless provisions are made for drainage and ventilation, moisture and water may accumulate on the concrete. This may cause structural or indoor air quality problems.

Checklist Item #14. If specified in the contract, use aggressive sampling for post-abatement air test. Artificially circulate air using forced air equipment such a leaf blower to dislodge loose fibers, then slow speed fans to keep the fibers suspended during sampling. This way, fibers remain airborne during sampling process. Even though the site has been cleaned and has passed a visual test, the person conducting this air monitoring should wear a respirator since the levels of airborne asbestos still may be elevated. Refer to EPA publication 560/5-85-024 for additional information.

Checklist Item #15. The use of a soil encapsulate requires operations and maintenance. Soil conditions, water table, and access must be evaluated prior implementation.

Checklist Item #16. The geo-textile membrane must be covered with at least 4 to 6 inches of sand or gravel to ensure it remains intact.

Checklist Item #17. The vapor lock created by the membrane may interfere with drainage. Moisture may accumulate on top of the membrane and in the soil underneath unless drainage is allowed. See Checklist item 13.

SECTION 4. REFERENCES

1. American Society for Testing and Materials, ASTM E 1368, *Standard Practice for Visual Inspection of Asbestos Abatement Projects*, 1996
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4. EPA Office of Compliance, *Asbestos/ NESHAP Demolition Decision Tree*, June 1994.
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12. Occupational Safety and Health Administration (OSHA) 29 CFR 1926.1101, *Construction, Asbestos.*
13. OSHA 29 CFR 1915.1001, *Maritime, Asbestos.*
14. OSHA 29 CFR 1910.1001, *General Industry, Asbestos*