United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park, NC

EPA 455/B-93-001d
July 1991
Revised August 1997

Stationary Source Compliance Training Series

EPA

COURSE# 350

Asbestos NESHAP Inspection and Safety Procedures

Reference Materials - Volume I

Collection of Published Guides and Other Informational Documents

Office of Air Quality
Clean Air
OAQPS
Planning and Standards

FOREWORD

This reference document contains additional background information on the Asbestos NESHAP standards and compliance monitoring methods. This document is intended to serve as reference material for persons attending Course #350 on asbestos NESHAP inspection and safety procedures. It is not being distributed as an EPA publication and is used only as supplemental information to the training course manual, Asbestos NESHAP Inspection and Safety Procedures: Student Manual, EPA 455/B-93-001a, revised March 1994.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
AIR AND RADIATION

ASBESTOS NESHAP GUIDANCE MATERIALS

The Asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR 61, Subpart M, was amended on November 20, 1990 by the U.S. Environmental Protection Agency (EPA) to increase the level of compliance with the demolition and renovation provisions.

In order to assist the public and regulated community to understand the requirements under the Asbestos NESHAP, a series of guidance documents were developed and are enclosed with this letter.

These documents are intended for information purposes **ONLY**, and may not in any way be interpreted to alter or replace the coverage or requirements of Subpart M.

If you have specific questions on any of these documents, please contact the Asbestos NESHAP Coordinator for your State. A list of coordinators can be found in the document entitled: Asbestos NESHAP National Contact List.

CONTENTS

ITEM 1 - Method for the Determination of Asbestos in Bulk Building Materials

ITEM 2 - Asbestos/NESHAP Regulated Asbestos Containing Material

ITEM 3 - Asbestos/NESHAP Adequately Wet Guidance

ITEM 4 - Reporting and Recordkeeping Requirements for Waste Disposal (A Field Guide)

ITEM 5 - Common Questions on the Asbestos NESHAP

ITEM 6 - The Asbestos/NESHAP Demolition Decision Tree

ITEM 7 - Guidelines For Asbestos NESHAP Landfill Recodkeeping

ITEM 8 - A Guide to Normal Demolition Practices Under the Asbestos NESHAP

ITEM 9 - Guidelines For Catastrophic Emergency Situations Involving Asbestos

ITEM 10 - Asbestos Sampling Bulletin

United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

EPA/600/R-93/116
July 1993

EPA

Test Method

Method for the Determination of Asbestos in Bulk Building Materials

ITEM 1
Method for the Determination of Asbestos in Bulk Building Materials

EPA/600/R-93/116
July 1993

TEST METHOD

METHOD FOR THE DETERMINATION OF ASBESTOS IN BULK BUILDING MATERIALS

by

R. L. Perkins and B. W. Harvey

EPA Project Officer
Michael E. Beard
Atmospheric Research and Exposure Assessment Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27709

EPA Contracts Nos. 68024550 and 68D10009
RTI Project No. 91U-5960-181

June 1993

Printed on Recycled Paper

DISCLAIMER

The information in this document has been funded wholly or in part by the United States Environmental Protection Agency under Contracts 68-02-4550 and 68D10009 to the Methods Research and Development Division, Atmospheric Research and Exposure Assessment Laboratory, Research Triangle Park, North Carolina. It has been subjected to the Agency's peer and administrative review, and it has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

TABLE OF CONTENTS

SECTION PAGE

1.0 INTRODUCTION . . . 1
1.1 References . . . 3

2.0 METHODS . . . 3
2.1 Stereomicroscopic Examination . . . 3
2.1.1 Applicability . . . 4
2.1.2 Range . . . 4
2.1.3 Interferences . . . 4
2.1.4 Precision and Accuracy . . . 4
2.1.5 Procedures . . . 5
2.1.5.1 Sample Preparation . . . 5
2.1.5.2 Analysis . . . 6
2.1.6 Calibration Materials . . . 8
2.1.7 References . . . 8
2.2 Polarized Light Microscopy . . . 9
2.2.1 Principle and Applicability . . . 9
2.2.2 Range . . . 10
2.2.3 Interferences . . . 10
2.2.4 Precision and Accuracy . . . 10
2.2.5 Procedures . . . 11
2.2.5.1 Sample Preparation . . . 11
2.2.5.1.1 Qualitative Analysis Preparation . . . 11
2.2.5.1.2 Quantitative Analysis Preparation . . . 12
2.2.5.2 Analysis . . . 13
2.2.5.2.1 Identification . . . 13
2.2.5.2.2 Quantitation of Asbestos Content . . . 16
2.2.5.2.3 Microscope Alignment . . . 22
2.2.6 References . . . 22
2.3 Gravimetry . . . 23
2.3.1 Principle and Applicability . . . 23
2.3.2 Interferences . . . 24
2.3.3 Quantitation . . . 25
2.3.4 Preliminary Examination and Evaluation . . . 25
2.3.5 Sample Preparation . . . 26
2.3.5.1 Drying . . . 26
2.3.5.2 Homogenization/Grain Size Reduction . . . 26
2.3.6 Procedure for Ashing . . . 27
2.3.7 Use of Solvents for Removal of Organics . . . 28
2.3.8 Procedure for Acid Dissolution . . . 29
2.3.9 Determination of Optimal Precision and Accuracy . . . 31
2.3.10 References . . . 31
2.4 X-Ray Powder Diffraction . . . 32
2.4.1 Principle and Applicability . . . 32
2.4.2 Range and Sensitivity . . . 35
2.4.3 Limitations . . . 35

TABLE OF CONTENTS (cont'd)

SECTION PAGE

2.4.3.1 Interferences 35
2.4.3.2 Matrix Effects 38
2.4.3.3 Particle Size Dependence 39
2.4.3.4 Preferred Orientation Effects 39
2.4.3.5 Lack of Suitably Characterized Standard Materials 39
2.4.4 Precision and Accuracy 40
2.4.5 Procedure 40
2.4.5.1 Sampling 40
2.4.5.2 Analysis 40
2.4.5.2.1 Sample Preparation 41
2.4.5.2.2 Milling 41
2.4.5.2.3 Ashing 42
2.4.5.2.4 Acid Washing 42
2.4.5.3 Qualitative Analysis 42
2.4.5.3.1 Initial Screening of Bulk Material 42
2.4.5.3.2 Detection of Minor or Trace Constituents 43
2.4.5.4 Quantitative Analysis 44
2.4.6 Calibration 46
2.4.6.1 Preparation of Calibration Standards 46
2.4.6.2 Analysis of Calibration Standards 47
2.4.7 Calculations 49
2.4.8 References 51
2.5 Analytical Electron Microscopy 51
2.5.1 Applicability 51
2.5.2 Range 52
2.5.3 Interferences 52
2.5.4 Precision and Accuracy 52
2.5.5 Procedures 52
2.5.5.1 AEM Specimen Preparation for Semi-Quantitative Evaluation 53
2.5.5.2 AEM Specimen Preparation for Quantitative Evaluation 54
2.5.5.2.1 Identification 54
2.5.6 References 54
2.6 Other Methodologies 53

3.0 QUALITY CONTROL/QUALITY ASSURANCE OPERATIONS- PLM 55
3.1 General Considerations 56
3.1.1 Training 56
3.1.2 Instrument Calibration and Maintenance 56
3.2 Quality Control of Asbestos Analysis 57
3.2.1 Qualitative Analysis 57
3.2.2 Quantitative Analysis 58
3.3 Interlaboratory Quality Control 59
3.4 Performance Audits 60
3.5 Systems Audits 60
3.6 References 61

TABLE OF CONTENTS (cont'd)

APPENDIX A: GLOSSARY OF TERMS

APPENDIX B: APPARATUS FOR SAMPLE PREPARATION AND ANALYSIS

APPENDIX C: PREPARATION AND USE OF CALIBRATION STANDARDS FOR BULK ASBESTOS

APPENDIX D: SPECIAL-CASE BUILDING MATERIALS

TABLES

TABLE		PAGE
1-1	Simplified Flowchart for Analysis of Bulk Materials	2
2-1	Suggested Acceptable Errors For PLM Analysis	11
2-2	Optical Properties of Asbestos Fibers	19
2-3	Typical Central Stop Dispersion Staining Colors	20
2-4	Optical Properties of Man-Made Textile Fibers	20
2-5	Optical Properties of Selected Fibers	21
2-6	The Asbestos Minerals and Their Nonasbestiform Analogs	34
2-7	Principal Lattice Spacings of Asbestiform Minerals	34
2-8	Common Constituents in Building Materials	36
2-9	Interferences in XRD Analysis of Asbestiform Minerals	37

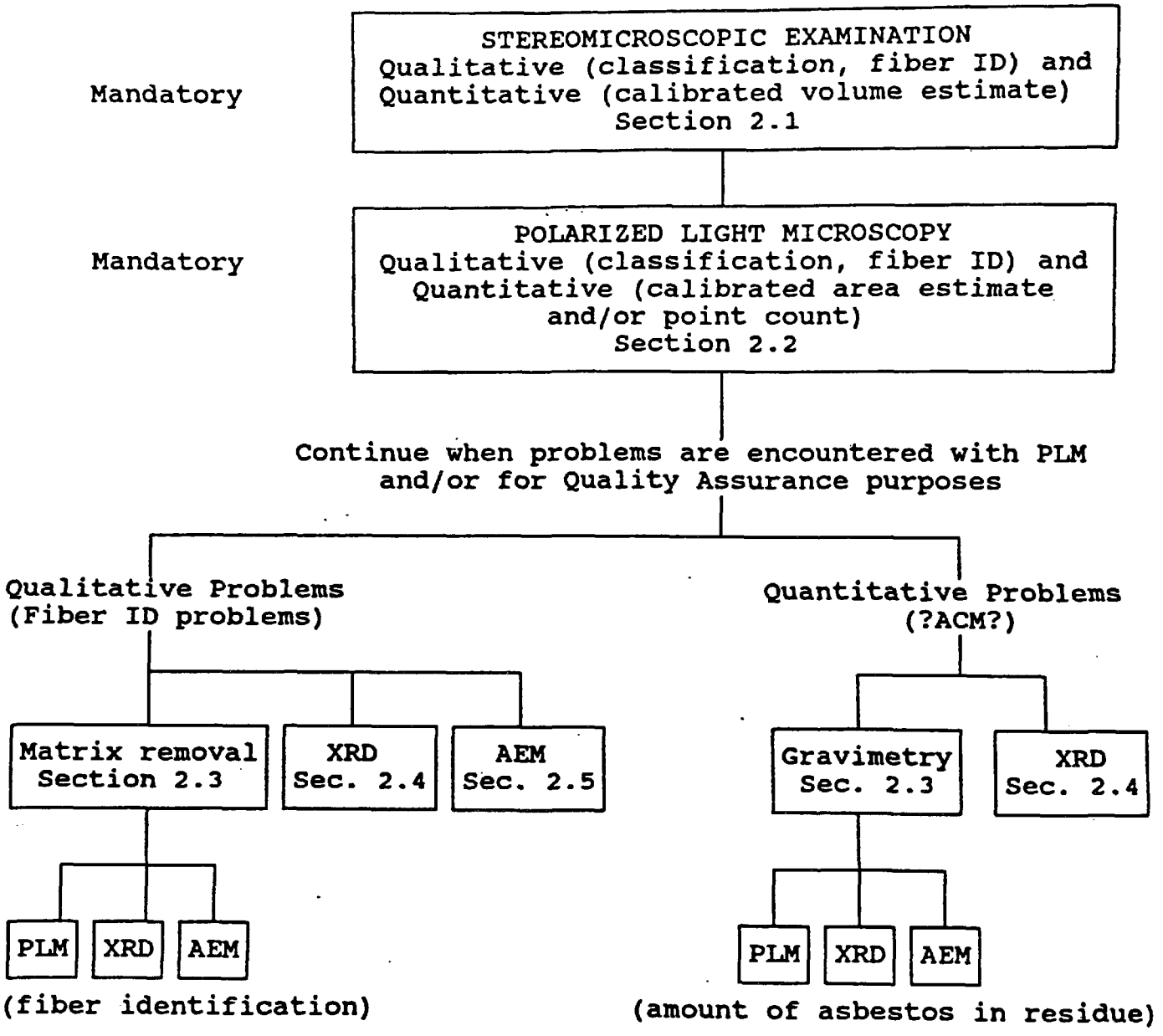
1.0 INTRODUCTION

Laboratories are now called upon to identify asbestos in a variety of bulk building materials, including loose-fill insulations, acoustic and thermal sprays, pipe and boiler wraps, plasters, paints, flooring products, roofing materials and cementitious products.

The diversity of bulk materials necessitates the use of several different methods of sample preparation and analysis. An analysis with a simple stereomicroscope is always followed by a polarized light microscopic (PLM) analysis. The results of these analyses are generally sufficient for identification and quantitation of major concentrations of asbestos. However, during these stereomicroscopic and PLM analyses, it may be found that additional techniques are needed to: 1) attain a positive identification of asbestos; 2) attain a reasonable accuracy for the quantity of asbestos in the sample; or 3) perform quality assurance activities to characterize a laboratory's performance. The additional techniques include x-ray diffraction (XRD), analytical electron microscopy (AEM), and gravimetry, for which there are sections included in the method. Other techniques will be considered by the Environmental Protection Agency (EPA) and may be added at some future time. Table 1-1 presents a simplified flowchart for analysis of bulk materials.

This Method for the Determination of Asbestos in Bulk Building Materials outlines the applicability of the various preparation and analysis methods to the broad spectrum of bulk building materials now being analyzed. This method has been evaluated by the EPA Atmospheric Research and Exposure Assessment Laboratory (EPA/AREAL) to determine if it offers improvements to current analytical techniques for building materials. This method demonstrated a capability for improving the precision and accuracy of analytical results. It contains significant revisions to procedures outlined in the Interim Method,[1] along with the addition of several new procedures. Each technique may reduce or introduce bias, or have some effect on the precision of the measurement, therefore results need to be interpreted judiciously. Data on each technique, especially those new to asbestos analysis, will be collected over time and carefully evaluated, with resulting recommendations for changes to the Method to be passed on to the appropriate program office within EPA.

TABLE 1-1. SIMPLIFIED FLOWCHART FOR ANALYSIS OF BULK MATERIALS



This is an analytical method. It is not intended to cover bulk material sampling, an area addressed previously[2,3,4,5] by the EPA. However, subsampling or sample splitting as it pertains to laboratory analysis procedures in this method, is discussed throughout.

1.1 References

1. Interim Method for the Determination of Asbestos in Bulk Insulation Samples, U.S. E.P.A. 600/M4-82-020, 1982.
2. Asbestos-Containing Materials in School Buildings: A Guidance Document, Part 1 and 2, U.S. E.P.A./O.T.S NO. C00090, 1979.
3. Asbestos in Buildings: Simplified Sampling Scheme for Friable Surfacing Materials, U.S. E.P.A. 560/5-85-030a, 1985.
4. Guidance for Controlling Asbestos-Containing Materials in Buildings, U.S. E.P.A. 560/5-85-024, 1985.
5. Asbestos-Containing Materials in Schools: Final Rule and Notice, 40 CFR Part 763, October, 1987.

2.0 METHODS

2.1 Stereomicroscopic Examination

A preliminary visual examination using a simple stereomicroscope is mandatory for all samples. A sample should be of sufficient size to provide for an adequate examination. For many samples, observations on homogeneity, preliminary fiber identification and semi-quantitation of constituents can be made at this point. Another method of identification and semi-quantitation of asbestos must be used in conjunction with the stereomicroscopic examination. A description of the suggested apparatus needed for stereomicroscopic examination is given in Appendix B.

The laboratory should note any samples of insufficient volume. A sufficient sample volume is sample-type dependent. For samples such as floor tiles, roofing felts, paper insulation, etc., three to four square inches of the layered material would be a preferred sample size. For materials such as ceiling tiles, loose-fill insulation, pipe insulation, etc., a sample size of approximately one cubic inch (~ 15cc) would be preferred. For samples of thin-coating materials such as paints, mastics, spray plasters, tapes, etc., a smaller sample

size may be suitable for analysis. Generally, samples of insufficient volume should be rejected, and further analysis curtailed until the client is contacted. The quantity of sample affects the sensitivity of the analysis and reliability of the quantitation steps. If there is a question whether the sample is representative due to inhomogeneity, the sample should be rejected, at least until contacting the client to see if: 1) the client can provide more material or 2) the client wishes the laboratory to go ahead with the analysis, but with the laboratory including a statement on the limited sensitivity and reliability of quantitation. If the latter is the case, the report of analysis should state that the client was contacted, that the client decided that the lab should use less material than recommended by the method, and that the client acknowledges that this may have limited the sensitivity and quantitation of the method. At the time the client is contacted about the material, he or she should be informed that a statement reflecting these facts will be placed in the report.

2.1.1 Applicability

Stereomicroscopic analysis is applicable to all samples, although its use with vinyl floor tile, asphaltic products, etc., may be limited because of small asbestos fiber size and/or the presence of interfering components. It does not provide positive identification of asbestos.

2.1.2 Range

Asbestos may be detected at concentrations less than one percent by volume, but this detection is highly material dependent.

2.1.3 Interferences

Detection of possible asbestos fibers may be made more difficult by the presence of other nonasbestos fibrous components such as cellulose, fiber glass, etc., by binder/matrix materials which may mask or obscure fibrous components, and/or by exposure to conditions (acid environment, high temperature, etc.) capable of altering or transforming asbestos.

2.1.4 Precision and Accuracy

The precision and accuracy of these estimations are material dependent and must be determined by the individual laboratory for the percent range involved. These values may be

determined for an individual analyst by the in-house preparation and analysis of standards and the use of error bars, control charts, etc.

The labs should also compare to National Voluntary Laboratory Accreditation Program (NVLAP) proficiency testing samples, if the lab participates in the Bulk Asbestos NVLAP, or to external quality assurance system consensus results such as from proficiency testing programs using characterized materials. However, at this time, consensus values for the quantity of asbestos have been shown to be unreliable. Only proficiency testing materials characterized by multiple techniques should be used to determine accuracy and precision.

2.1.5 Procedures

NOTE: **Exposure to airborne asbestos fibers is a health hazard. Bulk samples submitted for analysis are oftentimes friable and may release fibers during handling or matrix reduction steps. All sample handling and examination must be carried out in a HEPA-filtered hood, a class 1 biohazard hood or a glove box with continuous airflow (negative pressure). Handling of samples without these precautions may result in exposure of the analyst to and contamination of samples by airborne fibers.**

2.1.5.1 Sample Preparation

No sample preparation should be undertaken before initial stereomicroscopic examination. Distinct changes in texture or color on a stereomicroscopic scale that might denote an uneven distribution of components should be noted. When a sample consists of two or more distinct layers or building materials, each should be treated as a separate sample, when possible. Thin coatings of paint, rust, mastic, etc., that cannot be separated from the sample without compromising the layer are an exception to this case and may be included with the layer to which they are attached. Drying (by heat lamp, warm plate, etc.) of wet or damp samples is recommended before further stereomicroscopic examination and is mandatory before PLM examination. **Drying must be done in a safety hood.**

For nonlayered materials that are heterogeneous, homogenization by some means (mill, blender, mortar and pestle) may provide a more even distribution of sample components. It

may also facilitate disaggregation of clumps and removal of binder from fibers (rarely however, it may mask fibers that were originally discernable).

For materials such as cementitious products and floor tiles, breaking, pulverizing, or grinding may improve the likelihood of exposing fibrous components.

It may be appropriate to treat some materials by dissolution with hydrochloric acid to remove binder/matrix materials. Components such as calcite, gypsum, magnesite, etc., may be removed by this method. For materials found to possess a high organic content (cellulose, organic binders), ashing by means of a muffle furnace or plasma asher (for small, cellulosic samples), or dissolution by solvents may be used to remove interfering material. In either case, it is recommended that matrix removal be tracked gravimetrically.

Additional information concerning homogenization, ashing and acid dissolution may be found in Sections 2.2.5.1 and 2.3.

2.1.5.2 Analysis

Samples should be examined with a simple stereomicroscope by viewing multiple fields of view over the entire sample. The whole sample should be observed after placement in a suitable container (watchglass, weigh boat, etc.) substrate. Samples that are very large should be subsampled. The sample should be probed, by turning pieces over and breaking open large clumps. The purpose of the stereomicroscopic analysis is to determine homogeneity, texture, friability, color, and the extent of fibrous components of the sample. This information should then be used as a guide to the selection of further, more definitive qualitative and quantitative asbestos analysis methods. Homogeneity refers to whether each subsample made for other analytical techniques (e.g. the "pinch" mount used for the PLM analysis), is likely to be similar or dissimilar. Color can be used to help determine homogeneity, whether the sample has become wet (rust color), and to help identify or clarify sample labelling confusion between the building material sampler and the laboratory. Texture refers to size, shape and arrangement of sample components. Friability may be indicated by the ease with which the sample is disaggregated (see definitions in Appendix A) as received by the analyst. This does not necessarily represent the friability of the material as determined by the assessor at the collection site. The relative proportion of fibrous

components to binder/matrix material may be determined by comparison to similar materials of known fibrous content. For materials composed of distinct layers or two or more distinct building materials, each layer or distinct building material should be treated as a discrete sample. The relative proportion of each in the sample should be recorded. The layers or materials should then be separated and analyzed individually. Analysis results for each layer or distinct building material should be reported. If monitoring requirements call for one reported value, the results for the individual layers or materials should always be reported along with the combined value. Each layer or material should be checked for homogeneity during the stereomicroscopic analysis to determine the extent of sample preparation and homogenization necessary for successful PLM or other analysis. Fibers and other components should be removed for further qualitative PLM examination.

Using the information from the stereomicroscopic examination, selection of additional preparation and analytical procedures should be made. Stereomicroscopic examination should typically be performed again after any change or major preparation (ashing, acid dissolution, milling, etc.) to the sample. Stereomicroscopic examination for estimation of asbestos content may also be performed again after the qualitative techniques have clarified the identities of the various fibrous components to assist in resolving differences between the initial quantitative estimates made during the stereomicroscopic analysis and those of subsequent techniques. Calibration of analysts by use of materials of known asbestos content is essential.

The stereomicroscopic examination is often an iterative process. Initial examination and estimates of asbestos concentration should be made. The sample should then be analyzed by PLM and possibly other techniques. These results should be compared to the initial stereomicroscopic results. Where necessary, disagreements between results of the techniques should be resolved by reanalyzing the sample stereomicroscopically.

2.1.6 Calibration Materials

Calibration materials fall into several categories, including internal laboratory standards and other materials that have known asbestos weight percent content. These calibration materials could include:

- Actual bulk samples: asbestos-containing materials that have been characterized by other analytical methods such as XRD, AEM and/or gravimetry. (e.g. NVLAP test samples).

- Generated samples: in-house standards that can be prepared by mixing known quantities of asbestos and known quantities of asbestos-free matrix materials (by weight), and mixing (using blender, mill, etc.) thoroughly to achieve homogeneity; matrix materials such as vermiculite, perlite, sand, fiberglass, calcium carbonate, etc. may be used. A range of asbestos concentrations should be prepared (e.g. 1, 3, 5, 10, 20%, etc.). The relationship between specific gravities of the components used in standards should be considered so that weight/volume relationships may be determined.

- Photographs, drawings: photomicrographs of standards, computer-generated drawings, etc.

Suggested techniques for the preparation and use of in-house calibration standards are presented in Appendix C, and at greater length by Harvey et al.[1] The use of synthesized standards for analyst calibration and internal laboratory quality control is not new however, having been outlined by Webber et al.[2] in 1982.

2.1.7 References

1. Harvey, B. W., R. L. Perkins, J. G. Nickerson, A. J. Newland and M. E. Beard, "Formulating Bulk Asbestos Standards", **Asbestos Issues**, April 1991, pp. 22-29.

2. Webber, J. S., A. Pupons and J. M. Fleser, "Quality-Control Testing for Asbestos Analysis with Synthetic Bulk Materials". **American Industrial Hygiene Associations Journal**, 43, 1982, pp. 427-431.

2.2 Polarized Light Microscopy

2.2.1 Principle and Applicability

Samples of bulk building materials taken for asbestos identification should first be examined with the simple stereomicroscope to determine homogeneity and preliminary fiber identification. Subsamples should then be examined using PLM to determine optical properties of constituents and to provide positive identification of suspect fibers.

The principles of optical mineralogy are well-established.[1,2,3,4] A light microscope equipped with two polarizing filters is used to observe specific optical characteristics of a sample. The use of plane polarized light allows for the determination of refractive indices relative to specific crystallographic orientations. Morphology and color are also observed while viewing under plane polarized light. Observation of particles or fibers while oriented between polarizing filters whose privileged vibration directions are perpendicular (crossed polars) allows for determination of isotropism/anisotropism, extinction characteristics of anisotropic particles, and calculation of birefringence. A retardation plate may be placed in the polarized light path for verification of the sign of elongation. If subsamples are prepared in such a way as to represent all sample components and not just suspect fibers, semi-quantitative analysis may also be performed. Semi-quantitative analysis involves the use of calibrated visual area estimation and/or point counting. Visual area estimation is a semi-quantitative method that must relate back to calibration materials. Point counting, also semi-quantitative, is a standard technique used in petrography for determining the relative areas occupied by separate minerals in thin sections of rock. Background information on the use of point counting[3] and the interpretation of point count data[5] is available.

Although PLM analysis is the primary technique used for asbestos determination, it can show significant bias leading to false negatives and false positives for certain types of materials. PLM is limited by the visibility of the asbestos fibers. In some samples the fibers may be reduced to a diameter so small or masked by coatings to such an extent that they cannot be reliably observed or identified using PLM.

2.2.2 Range

The detection limit for visual estimation is a function of the quantity of sample analyzed, the nature of matrix interference, sample preparation, and fiber size and distribution. Asbestos may be detected in concentrations of less than one percent by area if sufficient material is analyzed. Since floor tiles may contain fibers too small to be resolved by PLM ($< 0.25\ \mu m$ in diameter), detection of those fibers by this method may not be possible. When point counting is used, the detection limit is directly proportional to the amount of sample analyzed, but is also limited by fiber visibility. Quantitation by area estimation, both visual and by point counting, should yield similar results if based on calibration standards.

2.2.3 Interferences

Fibrous and nonfibrous, organic and inorganic constituents of bulk samples may interfere with the identification and quantitation of the asbestos mineral content. Binder/matrix materials may coat fibers, affect color, or obscure optical characteristics to the extent of masking fiber identity. Many organic mastics are soluble in refractive index liquids and, unless removed prior to PLM examination, may affect the refractive index measurement of constituent materials. Fine particles of other materials may also adhere to fibers to an extent sufficient to cause confusion in identification. Gravimetric procedures for the removal of interfering materials are presented in Section 2.3.

2.2.4 Precision and Accuracy

Data obtained for samples containing a single asbestos type in a sample matrix have been reported previously by Brantley et al.[6] Data for establishing the accuracy and precision of the method for samples with various matrices have recently become available. Perkins,[7] Webber et al.[8] and Harvey et al.[9] have each documented the tendency for visual estimates to be high when compared to point-count data. Precision and accuracy must be determined by the individual laboratory for the percent range involved. If point counting and/or visual estimates are used, a table of reasonably expanded errors, such as those shown in Table 2-1, should be generated for different concentrations of asbestos.

If the laboratory cannot demonstrate adequate precision and accuracy (documented by control charts, etc), quantitation by additional methods, such as gravimetry, may be required. Refer to the Handbook for SRM Users[10] for additional information concerning the concepts of precision and accuracy.

TABLE 2-1. SUGGESTED ACCEPTABLE ERRORS FOR PLM ANALYSIS
(Based on 400 point counts of a reasonably homogeneous sample or 100 fields of view for visual estimate)

% Area Asbestos	Acceptable Mean Result	% Area Asbestos	Acceptable Mean Result
1	>0-3%	50	40-60%
5	>1-9%	60	50-70%
10	5-15%	70	60-80%
20	10-30%	80	70-90%
30	20-40%	90	80-100%
40	30-50%	100	90-100%

2.2.5 Procedures

NOTE: Exposure to airborne asbestos fibers is a health hazard. Bulk samples submitted for analysis are oftentimes friable and may release fibers during handling or matrix reduction steps. All sample and slide preparations must be carried out in a HEPA-filtered, a class 1 biohazard hood, or a glove box with continuous airflow (negative pressure). Handling of samples without these precautions may result in exposure of the analyst to and contamination of samples by airborne fibers.

2.2.5.1 Sample Preparation

Slide mounts are prepared for the identification and quantitation of asbestos in the sample.

2.2.5.1.1 Qualitative Analysis Preparation

The qualitative preparation must allow the PLM analysis to classify the fibrous components of the sample as asbestos or nonasbestos. The major goal of the qualitative

preparation is to mount easily visible fibers in appropriate refractive index liquids for complete optical characterization. Often this can be accomplished by making immersion grain mounts of random subsamples of the homogeneous material. Immersion liquids with refractive indices close to the suspected (see stereomicroscopic analysis) asbestos mineral should be used for the qualitative analysis so that n_D can be determined. Problem samples include those with inhomogeneities, coatings, small fibers, and interfering compounds. Additional qualitative preparations are often necessary for these types of samples. All samples, but especially those lacking homogeneity, may require picking of fibers from specific sample areas during the stereomicroscopic examination. Coatings on the fibers often need to be removed by mechanical or chemical means. Teasing the particles apart or use of a mortar and pestle or similar mechanical method often is sufficient to free fibers from coatings. Chemical means of removing some coatings and interfering compounds are discussed in Section 2.3, Gravimetry.

2.2.5.1.2 Quantitative Analysis Preparation

The major purpose of the quantitative preparation is to provide the analyst with a representative grain mount of the sample in which the asbestos can be observed and distinguished from the nonasbestos matrix. This is typically performed by using randomly selected subsamples from a homogeneous sample (see stereomicroscopic analysis). Particles should be mounted in a refractive index (RI) liquid that allows the asbestos to be visible and distinguished from nonasbestos components. Care should be taken to ensure proper loading and even distribution of particles. Both the qualitative and quantitative sample preparations are often iterative processes. Initial samples are prepared and analyzed. The PLM analysis may disclose problems or raise questions that can only be resolved by further preparations (e.g. through the use of different RI immersion liquids, elimination of interfering compounds, sample homogenization, etc.)

For layered materials, subsamples should be taken from each individual or discrete layer. Each of these subsamples should be treated as a discrete sample, but as stated in Section 2.1.5.2, the results for the individual layers or materials may be combined if called for by monitoring requirements.

Homogenization involves the use of any of a variety of devices, such as a mortar and pestle, mill, or blender to pulverize, disaggregate and mix heterogeneous, friable bulk materials. Selection of the appropriate device is dependent upon personal preference and the nature of the materials encountered. A blender or mortar and pestle may be adequate for homogenizing materials that lack appreciable amounts of tacky matrix/binder, and for separating interfering components from the fibers. For materials which are unusually sticky or tacky, or contain unusually long asbestos fibers, milling (especially freezer milling) may be more efficient. However, milling should be discontinued as soon as the material being milled appears homogeneous, in order to reduce the potential for mechanically reducing fiber size below the resolving power of the polarizing microscope. Hammer mills or cutting mills may also be used on these materials; however, the same precaution regarding reduction of fiber size should be taken. Blending /milling devices should be disassembled (to the extent possible) and thoroughly cleaned after each use to minimize contamination.

2.2.5.2 Analysis

Analysis of bulk building materials consists of the identification and semi-quantitation of the asbestos type(s) present, along with the identification, where possible, of fibrous nonasbestos materials, mineral components and matrix materials. If the sample is heterogeneous due to the presence of discrete layers or two or more distinct building materials, each layer or distinct material should be analyzed, and results reported. Total asbestos content may also be stated in terms of a relative percentage of the total sample.

2.2.5.2.1 Identification

Positive identification of asbestos requires the determination of the following optical properties:

- Morphology
- Color and, if present, pleochroism
- Refractive indices (± .005)
- Birefringence
- Extinction characteristics
- Sign of elongation

Descriptions of the optical properties listed above for asbestos fibers may be found in Appendix A, Glossary of Terms. Table 2-2 lists the above properties for the six types of asbestos and Table 2-3 presents the central stop dispersion staining colors for the asbestos minerals with selected high-dispersion index liquids. Tables 2-4 and 2-5 list selected optical properties of several mineral and man-made fibers. All fibrous materials in amounts greater than trace should be identified as asbestos or nonasbestos, with all optical properties measured for asbestos and at least one optical property measured for each nonasbestos fibrous component that will distinguish each from asbestos. Small fiber size and/or binder may necessitate viewing the sample at higher magnification (400-500x) than routinely used (100x).

Although it is not the purpose of this section to explain the principles of optical mineralogy, some discussion of the determination of refractive indices is warranted due to its importance to the proper identification of the asbestos minerals. Following is a brief discussion of refractive index determination for the asbestos minerals.

All asbestos minerals are anisotropic, meaning that they exhibit different optical properties (including indices of refraction) in different directions. All asbestos minerals are biaxial, meaning that they have one principal refractive index parallel (or nearly parallel) to the length of the fiber and two principal refractive indices (plus all intermediate indices between these two) in the plane perpendicular (or nearly so) to the length of the fiber. Although chrysotile (serpentine) is classified as a biaxial mineral, it behaves as a uniaxial mineral (two principal refractive indices) due to its scrolled structure. Amosite and crocidolite, although also biaxial, exhibit uniaxial properties due to twinning of the crystal structure and/or random orientation of fibrils in a bundle around the long axis of the bundle. For all of the asbestos minerals except crocidolite, the highest refractive index (γ) is aligned with the fiber length (positive sign of elongation). For crocidolite, the lowest refractive index (α) is aligned with the fiber length (negative sign of elongation). A more complete explanation of the relationship of refractive indices to the crystallographic directions of the asbestos minerals may be found in References 1, 2, 4, 11 and 12. It should be noted that for the measurement of refractive indices in an anisotropic particle (e.g. asbestos fibers), the orientation of the particle is quite critical. Orientation with respect to rotation about the axis

of the microscope (and thus with respect to the vibration directions of the polarizer and analyzer) and also to the horizontal plane (plane of the microscope stage) will affect the determination of the correct values for refractive indices. The refractive index that is measured will always correspond to a direction perpendicular to the axis of the microscope (i.e., lying in the plane of the stage) and is the direction in that horizontal plane parallel to the vibration direction of the polarizer, by convention E-W.

To determine $\gamma(n \parallel)$ for chrysotile, anthophyllite and amosite, the index is measured when the length of the fiber is aligned parallel to the vibration direction of the polarizer (E-W). Under crossed polars, the fiber should be at extinction in this orientation. To determine the lowest refractive index, α $(n \perp)$, for chrysotile and amosite, the fiber should be oriented N-S (extinction position under crossed polars). The determination of $n \parallel$ and $n \perp$ with crocidolite is accomplished in the same manner as with amosite and chrysotile with the exception that the α and γ directions are reversed. For crocidolite, α is measured at the E-W position (parallel to the polarizer) and γ is measured at the N-S orientation (perpendicular to the polarizer). For anthophyllite, the fiber should be oriented N-S and the lowest and highest indices for this orientation should be measured. These correspond to α and β respectively.

The extinction behavior of tremolite-actinolite is anomalous compared to that of most monoclinic minerals due to the orientation of the optic axes relative to the crystallographic axes. This relationship is such that the refractive indices of the principal axes α and γ <u>are not measured</u> when the fiber is exhibiting the maximum extinction angle. The values measured at these positions are α' and γ'. The fiber exhibits an extinction angle within a few degrees of the maximum throughout most of its rotation. A wide range of refractive indices from α' to α, and from γ' to γ, are observed. For tremolite-actinolite, β is measured on those fibers displaying parallel extinction when oriented in the N-S position. The refractive index for α is also measured when the fiber is oriented generally in the N-S position and exhibits <u>the true extinction</u> angle; true α will be the <u>minimum</u> index. To determine the refractive index for γ, the fibers should be oriented E-W and exhibit the true extinction angle; true γ will be the <u>maximum</u> value for this orientation.

When viewing single fibers, the analyst may often be able to manipulate the microscope slide cover slip and "roll" the fibers to positions that facilitate measuring the true values of refractive indices. When viewing a large population of fibers with the microscope in the dispersion staining mode, the analyst can easily detect fibers that exhibit the highest and lowest indices (β and α) in the N-S position and the highest indices (γ) in the E-W position. Since individual asbestos fibrils cannot generally be resolved using polarized light microscopy, refractive indices are most commonly measured on fiber bundles. Such measurements would not result in true values for the indices and therefore by convention should be reported as α' and γ'.

Asbestos types chrysotile, amosite and crocidolite are currently available as SRM 1866 and actinolite, tremolite and anthophyllite as SRM 1867 from the Office of Standard Reference Materials, National Institute of Standards and Technology.

2.2.5.2.2 Quantitation of Asbestos Content

As described in Sections 2.1.5 and 2.1.6, a calibrated visual volume estimation of the relative concentrations of asbestos and nonasbestos components should be made during the stereomicroscopic examination. In addition, quantitation of asbestos content should be performed on subsample slide mounts using calibrated visual area estimates and/or a point counting procedure. Section 2.1.6 and Appendix C discuss the procedures for preparation and use of calibration standards. After thorough PLM analysis in which the asbestos and other components of the bulk material are identified, several slides should be carefully prepared from randomly selected subsamples. If the sample is not homogeneous, some homogenization procedure should be performed to ensure that slide preparations made from small pinch samples are representative of the total sample. Homogenization may range from gentle mixing using a mortar and pestle to a brief period of mixing using a blender equipped with a mini-sample container. The homogenization should be of short duration ($\sim$ 15 seconds) if using the blender technique so as to preclude a significant reduction in fiber size. The use of large cover slips (22x30mm) allows for large subsamples to be analyzed. Each slide should be checked to ensure that the subsample is representative, uniformly dispersed, and loaded in a way so as not to be dominated by superimposed (overlapping) particles.

During the qualitative analysis of the sample, the analyst should decide on the appropriate optical system (including magnification) to maximize the visibility of the asbestos in the sample while still allowing the asbestos to be uniquely distinguished from the matrix materials. The analyst may choose to alter the mounting medium or the optical system to enhance contrast. During the quantitative analysis, slides should be scanned using an optical setup that yields the best visibility of the asbestos. Upon finding asbestos, the parameters that were selected in the qualitative analysis for uniquely distinguishing it from the matrix should be used for identification. These properties will vary with the sample but include any or all of the parameters required for the qualitative analysis. For instance, low magnification allows for concurrent use of dispersion staining (focal screening), but compromises resolution of extremely small diameter fibers; use of a compensator plate and crossed polarizers frequently enhances the contrast between asbestos fibers and matrix material.

Visual area estimates should be made by comparison of the sample to calibration materials that have similar textures and fiber abundance (see Section 2.1.6 and Appendix C). A minimum of three slide mounts should be examined to determine the asbestos content by visual area estimation. Each slide should be scanned in its entirety and the relative proportions of asbestos and nonasbestos noted. It is suggested that the ratio of asbestos to nonasbestos material be recorded for several fields for each slide and the results be compared to data derived from the analysis of calibration materials having similar textures and asbestos content.

For point counting, an ocular reticle (cross-line or point array) should be used to visually superimpose a point or points on the microscope field of view. The cross-line reticle is preferred. Its use requires the scanning of most, if not all, of the slide area, thereby minimizing bias that might result from lack of homogeneity in the slide preparation. In conjunction with this reticle, a click-stop counting stage can be used to preclude introducing bias during slide advancement. Magnification used will be dictated by fiber visibility. The slide should be examined along multiple parallel traverses that adequately cover the sample area. The analyst should score (count) only points <u>directly over</u> occupied (nonempty) areas. Empty points should <u>not</u> be scored on the basis of the closest particle. If an asbestos fiber and a nonasbestos particle overlap so that a point is superimposed on their visual intersection,

a point should be scored for both categories. If the point(s) is/are superimposed on an area which has several overlapping particles, the slide should be moved to another field. While not including them in the total asbestos points counted, the analyst should record the presence of any asbestos detected but not lying under the reticle cross-line or array points. A minimum of 400 counts (maximum of eight slides with 50 counts each to minimum of two slides with 200 counts each) per sample is suggested, but it should be noted that accuracy and precision improve with number of counts. Point counting provides a determination of the projected area percent asbestos. Conversion of area percent to dry weight percent is not feasible unless the specific gravities and relative volumes of the different materials are known. It should be noted that the total amount of material to be analyzed is dependent on the asbestos concentration, i.e. the lower the concentration of asbestos, the larger the amount of sample that should be analyzed, in both the visual estimation and point counting methods. Quantitation by either method is made more difficult by low asbestos concentration, small fiber size, and presence of interfering materials.

It is suggested that asbestos concentration be reported as volume percent, weight percent or area percent depending on the method of quantitation used. A weight concentration cannot be determined without knowing the relative specific gravities and volumes of the sample components.

Mineral	Morphology and Color[1]	Refractive Indices[2] α	Refractive Indices[2] γ[5]	Birefringence[6]	Extinction	Sign of Elongation
Chrysotile (asbestiform serpentine)	Wavy fibers. Fiber bundles have splayed ends and "kinks". Aspect ratio typically >10:1. Colorless[3]	1.493-1.546 1.532-1.549 1.529-1.559 1.544-1.553	1.517-1.557 1.545-1.556 1.537-1.567 1.552-1.561	0.004-0.017	Parallel	+ (length slow)
Amosite (asbestiform grunerite)	Straight to curved, rigid fibers. Aspect ratio typically >10:1. Colorless to brown, nonpleochroic or weakly so.[4] Opaque inclusions may be present	1.657-1.663 1.663-1.686 1.663-1.686 1.676-1.683	1.699-1.717 1.696-1.729 1.696-1.729 1.697-1.704	0.021-0.054	Usually parallel	+ (length slow)
Crocidolite (asbestiform riebeckite)	Straight to curved, rigid fibers. Aspect ratio typically > 10:1. Thick fibers and bundles common, blue to dark-blue in color. Pleochroic.	1.693 1.654-1.701 1.680-1.698	1.697 1.668-1.717 1.685-1.706	0.003-0.022	Usually parallel	- (length fast)
Anthophyllite-asbestos	Straight to curved fibers and bundles. Aspect ratio typically > 10:1. Anthophyllite cleavage fragments may be present with aspect ratios <10:1. Colorless to light brown.	1.598-1.652 1.596-1.694 1.598-1.674 1.6148[7]	1.623-1.676 1.615-1.722 1.615-1.697 1.6362[7]	0.013-0.028	Parallel	+ (length slow)
Tremolite-Actinolite-asbestos	Straight to curved fibers and bundles. Aspect ratio typically > 10:1. Cleavage fragments may be present with aspect ratios <10:1. Colorless to pale green	Tremolite 1.600-1.628 1.604-1.612 1.599-1.612 1.6063[7] Actinolite 1.600-1.628 1.612-1.668 1.613-1.628 1.6126[7]	Tremolite 1.625-1.655 1.627-1.635 1.625-1.637 1.6343[7] Actinolite 1.625-1.655 1.635-1.688 1.638-1.655 1.6393[7]	0.017-0.028 0.017-0.028	Parallel and oblique (up to 21°); Composite fibers show parallel extinction.	+ (length slow)

[1]Colors cited are seen by observation with plane polarized light.

[2]From references 2, 11, 12, and 18, respectively. Refractive indices for n_d at 589.3nm.

[3]Fibers subjected to heating may be brownish. (references 13, 14, and 15)

[4]Fibers subjected to heating may be dark brown and pleochroic. (references 13, 14, and 15)

[5]∥ to fiber length, except ⊥ to fiber length for crocidolite only.

[6]Maximum and minimum values from references 2, 11, 12, and 18 given.

[7]± 0.0007

TABLE 2-3. TYPICAL CENTRAL STOP DISPERSION STAINING COLORS[1]

Mineral	Cargille® RI Liquid	n∥	n⊥
Chrysotile	1.550HD	Magenta to light blue-green λ_0's ca. 520-620nm	Blue-green to pale blue λ_0's ca. 600-700nm
Amosite	1.680	Yellow to magenta λ_0's ca. 420-520nm	Blue magenta to light blue λ_0's ca. 560-660nm
Crocidolite	1.680	Yellow to magenta λ_0's ca. 420-520nm	Pale yellow to golden yellow λ_0's ca. 360-460nm
Anthophyllite-asbestos	1.605HD	Pale yellow to yellow λ_0's ca. 330-430nm	Golden yellow to light blue green λ_0's ca. 460-700nm
Tremolite-asbestos	1.605HD	Pale yellow to yellow λ_0's ca. 330-430nm	Golden yellow to light blue green λ_0's ca. 460-700nm
Actinolite-asbestos	1.605HD	Pale yellow λ_0's ca. 260-360nm	Pale yellow to golden yellow λ_0's ca. 360-460nm
	1.630HD	Yellow to magenta λ_0's ca. 420-520nm	Golden yellow to blue λ_0's ca. 450-600nm

[1]Modified from reference 16

TABLE 2-4. OPTICAL PROPERTIES OF MAN-MADE TEXTILE FIBERS[1,2]

Fiber Type	n∥	n⊥	n∥ - n⊥	Sign of Elongation
Polyester (Dacron®)	1.710	1.535	0.175	+
Polyamide (Nylon®)	1.582	1.514	0.063	+
Aramid (Kevlar®)	≈2.37	≈1.641	0.729	+
Olefin (Polyethylene)	1.556	1.512	0.044	+
Olefin (Polypropylene)	1.520	1.495	0.025	+
Viscose Rayon	1.535-1.555	1.515-1.535	0.020	+
Acetate	1.478-1.480	1.473-1.476	0.004-0.005	+
Acrylic (Orlon®)	1.505-1.515	1.507-1.517	0.004-0.002	-
Modacrylic (Dynel®)	1.535	1.532	0.002	+

[1]Modified from reference 17

[2]Refractive indices for specific fibers; other fibers may vary

TABLE 2-5. OPTICAL PROPERTIES OF SELECTED FIBERS[1]

FIBER TYPE	MORPHOLOGY	REFRACTIVE INDICES	BIREFRINGENCE ($n\parallel - n\perp$)	EXTINCTION ANGLE	SIGN OF ELONGATION	DISPERSION STAINING COLORS
Paper (Cellulose)	Tapered, flat ribbons	$n\parallel$ ~ 1.580 $n\perp$ ~ 1.530	High (0.05)	Parallel and incomplete	+	in 1.550HD $n\parallel$: yellow (λ_0's < 400nm) $n\perp$: pale blue (λ_0's > 700nm)
Olefin (polyethylene)	Filaments or shredded like chrysotile	$n\parallel$ ~ 1.556 $n\perp$ ~ 1.512	Moderate (0.044)	Parallel	+	in 1.550HD $n\parallel$: yellow to magenta (λ_0's = 440-540nm) $n\perp$: pale blue (λ_0's > 700nm)
Brucite (nemalite)	Straight fibers	$n\parallel$ ~ 1.560-1.590 $n\perp$ ~ 1.580-1.600	Moderate (0.012-0.020)	Usually parallel	- occasionally +	in 1.550HD $n\parallel$: golden yellow (λ_0's 440-460nm) $n\perp$: yellow (λ_0's 400-440nm)
Heated amosite	Similar to unheated, (brittle and shorter) pleochroic: $n\parallel$-dark brown $n\perp$ yellow	$n\parallel$ and $n\perp$ >1.700[2]	High (> 0.05)	Usually parallel	+	in 1.680HD $n\parallel$ & $n\perp$: both pale yellow to white (λ_0's < 400nm)
Glass fibers, Mineral wool	Exotic shapes, tear drops, single filaments	1.515-1.700	Isotropic	------	-	in 1.550HD usually pale blue to blue (λ_0's 580 to > 700nm)
Wollastonite	Straight needles and blades	$n\parallel$ ~ 1.630 $n\perp$ ~ 1.632 $n\perp$ also 1.610	Moderate to low (0.018 to 0.002)	Parallel and oblique	+ and -	in 1.605HD $n\parallel$ & $n\perp$: yellow to pale yellow (λ_0's < 460nm)
Fibrous talc	Thin cleavage ribbons and wavy fibers	$n\parallel$ ~ 1.60 $n\perp$ ~ 1.54	High (0.06)	Parallel and oblique	+	in 1.550HD $n\parallel$: pale yellow (λ_0's <400nm) $n\perp$: pale blue (λ_0's >660nm)

[1]From reference 19

[2]From references 13, 14, and 15

2.2.5.2.3 Microscope Alignment

In order to accurately measure the required optical properties, a properly aligned polarized light microscope must be utilized. The microscope is aligned when:

1) the privileged directions of the substage polarizer and the analyzer are at 90° to one another and are represented by the ocular cross-lines;

2) the compensator plate's privileged vibration directions are 45° to the privileged directions of the polarizer and analyzer;

3) the objectives are centered with respect to stage rotation; and,

4) the substage condenser and iris diaphragm are centered in the optic axis.

Additionally, the accurate measurement of the refractive index of a substance requires the use of calibrated refractive index liquids. These liquids should be calibrated regularly to an accuracy of 0.004, with a temperature accuracy of 2°C using a refractometer or R.I. glass beads.

2.2.6 References

1. Bloss, F. Donald, **An Introduction to the Methods of Optical Crystallography,** Philadelphia: Saunders College Publishing, 1989.

2. Kerr, Paul F., **Optical Mineralogy**, 4th Edition, New York: McGraw Hill, 1977.

3. Chamot, E. M. and C. W. Mason, **Handbook of Chemical Microscopy, Volume One**, 3rd edition, New York: John Wiley & Sons, 1958.

4. Ehlers, Ernest G., **Optical Mineralogy, Vols. 1 and 2,** Palo Alto, CA: Blackwell Scientific Publications, 1987.

5. Chayes, F., **Petrographic Modal Analysis: An Elementary Statistical Appraisal,** New York: John Wiley & Sons, 1956.

6. Brantley, E. P., Jr., K. W. Gold, L. E. Myers, and D. E. Lentzen, **Bulk Sample Analysis for Asbestos Content: Evaluation of the Tentative Method**, EPA-600/S4-82-021, 1982.

7. Perkins, R.L., "Point-Counting Technique for Friable Asbestos-Containing Materials", The Microscope, 38, 1990, pp.29-39.

8. Webber, J.S., R. J. Janulis, L. J. Carhart and M.B. Gillespie, "Quantitating Asbestos Content in Friable Bulk Samples: Development of a Stratified Point-Counting Method", **American Industrial Hygiene Association Journal**, 51, 1990, pp. 447-452.

9. Harvey, B. W., R. L. Perkins, J. G. Nickerson, A. J. Newland and M. E. Beard, "Formulating Bulk Asbestos Standards", **Asbestos Issues**, April 1991, pp. 22-29.

10. **Handbook for SRM Users**, NIST (formerly NBS) Special Publication 260-100, U.S. Department of Commerce, 1985.

11. Deer, W.A., R. A. Howie, and J. Zussman, **An Introduction to the Rock Forming Minerals**, Longman, 1966.

12. Heinrich, E. W., **Microscopic Identification of Minerals**, McGraw Hill, 1965.

13. Kressler, J. R., "Changes in Optical Properties of Chrysotile During Acid Leaching", **The Microscope**, 31, 1983, pp. 165-172.

14. Prentice, J. and M. Keech, "Alteration of Asbestos with Heat", **Microscopy and Analysis**, 10, 1989, pp. 7-12.

15. Laughlin, G. and W. C. McCrone, "The Effect of Heat on the Microscopical Properties of Asbestos", **The Microscope**, 37, 1989, pp. 8-15.

16. **Interim Method for the Determination of Asbestos in Bulk Insulation Samples**, U.S. E.P.A. 600/M4-82-020, 1982.

17. McCrone, Walter C., "Routine Detection and Identification of Asbestos", **The Microscope**, 33, 1985, pp. 273-284

18. Reports of Analysis, SRM 1866 and 1867, National Institute of Standards & Technology.

19. McCrone, Walter C., **Asbestos Identification**, McCrone Research Institute, 1987.

2.3 Gravimetry

2.3.1 Principle and Applicability

Many components of bulk building materials, specifically binder components, can be selectively removed using appropriate solvents or, in the case of some organics, by ashing. The removal of these components serves the following purposes:

1) to isolate asbestos from the sample, allowing its weight to be determined;

2) to concentrate asbestos and therefore lower the detection limit in the total sample;

3) to aid in the detection and identification of fibrous components; and,

4) to remove organic (ashable) fibers which are optically similar to asbestos.

Common binder materials which are removed easily using the techniques described include: 1) calcite, gypsum, magnesite, brucite, bassanite, portlandite, and dolomite, using hydrochloric acid, and 2) vinyl, cellulose, and other organic components, by ashing. The removal of the binder components results in a residue containing asbestos, if initially present, and any other non-soluble or non-ashable components which were present in the original sample. Unless the procedures employed result in the loss of some asbestos, the weight percent of the residue is the upper limit for the weight percent of asbestos in the sample.

This section describes the procedure for removing acid-soluble and ashable components, and for determining the weight percent of the residue. However, the acid dissolution and ashing techniques can be used without the accompanying weight measurements to either liberate or clean fibers to aid in qualitative PLM or AEM analyses.

This technique is not an identification technique. Other methods, such as PLM, XRD, or AEM must be used to determine the identity of the components. A description of the suggested apparatus, reagents, etc. needed for the techniques described is included in Appendix B.

2.3.2 Interferences

Any components which cannot by removed from the sample by selective dissolution or ashing interfere with asbestos quantitation. These components include, but are not limited to, many silicates (micas, glass fibers, etc.) and oxides (TiO_2, magnetite, etc.). When interfering phases are present (the residue contains other phases in addition to asbestos), other techniques such as PLM, AEM, or XRD must be used to determine the percent of asbestos in the residue.

Care must be taken to prevent loss of or chemical/structural changes in the critical components (asbestos). Prolonged exposure to acids or excessive heating (above 500°C) can cause changes in the asbestos components in the sample and affect the optical properties.[1,2,3]

2.3.3 Quantitation

The weight of the residue remaining after solvent dissolution/ashing should be compared with the original weight of the material. Presuming no insoluble material is lost, the weight percent of the residue is the upper limit for the amount of asbestos in the sample. If the residue is comprised only of asbestos, then the weight percent of residue equals the weight percent of asbestos in the sample. If the residue contains other phases, then techniques such as PLM, XRD, or AEM must be employed to determine the relative abundance of asbestos in the residue.

The precision and accuracy of the technique are dependent upon the homogeneity of the material, the accuracy of the weight measurements, and the effectiveness of the sample reduction and filtering procedures. In practice, the precision can be equal to $\pm 1\%$, and the accuracy at 1 wt% asbestos can be less than or equal to $\pm 10\%$ relative.

The incomplete solution of components and the presence of other nonasbestos components in the residue contribute to producing a positive bias for the technique (falsely high percentages of asbestos).

2.3.4 Preliminary Examination and Evaluation

Stereomicroscopic and PLM examinations of the sample should already have been conducted prior to initiating this procedure. These examinations should have provided information about: 1) whether the sample contains components which can be removed by acid-washing, solvent dissolution, or ashing, and 2) whether the sample contains asbestos, or fibers that might be asbestos, or whether no asbestos was detected.

If the sample is friable and contains organic (ashable) components, the ashing procedure should be followed. If the sample is friable and contains HCl-soluble components, the acid dissolution procedure should be followed. If the sample is friable and contains both types of

components, the two procedures can be applied, preferably with acid dissolution following ashing.

If the sample is nonfriable (e.g. floor tiles), it is also recommended that the ashing procedure be used first, followed by the acid dissolution procedure. The ashing procedure reduces floor tiles to a material which is easily powdered, simplifying the sample preparation for acid dissolution.

2.3.5 Sample Preparation

2.3.5.1 Drying

Any moisture in the sample will affect the weight measurements, producing falsely low percentages of residue. If the sample is obviously wet, it should be dried at low temperature (using a heat lamp, or simply by exposure at ambient conditions, prior to starting the weighing procedure). If an oven is used, the drying temperature should not exceed 60°C. Drying by means of heat lamp or ambient air must be performed within a safety-filtered hood. Even if the sample appears dry, it can contain enough moisture to affect the precision and accuracy of the technique. The test for sample moisture involves placing the amount of sample to be used on the weighing pan; if the weight remains stable with time, then the sample is dry enough. If the weight decreases as the sample sits on the weighing pan, then the sample should be dried. Where conditions of moderate to high humidity are known to exist, all materials to be weighed should be allowed time to stabilize to these ambient conditions.

2.3.5.2 Homogenization/Grain Size Reduction

To increase the accuracy and precision of the acid dissolution technique, the sample should be homogenized prior to analysis. This reduces the grain size of the binder material and releases it from fiber bundles so that it may be dissolved in a shorter time period. Leaving the sample in the acid for a longer period of time to complete the dissolution process can adversely affect the asbestos components, and is not recommended. Homogenization of the sample also ensures that any material removed for analysis will more likely be representative of the entire sample.

Homogenization of friable samples prior to ashing may also accelerate the ashing process; however, the ashing time can simply be increased without affecting the asbestos in the sample. Nonfriable samples, such as vinyl floor tiles, can be broken or shaved into pieces to increase surface area and accelerate the ashing process.

Homogenization and grain size reduction can be accomplished in a variety of ways: 1) hand grinding in a mortar and pestle; 2) crushing with pliers or similar instrument; 3) mixing in a blender; 4) milling (i.e. Wylie mill, cryomill, etc.); or 5) any other technique which seems suitable. If the fibers are extremely long, a pair of scissors or similar implement can be used to reduce the fiber length.

2.3.6 Procedure for Ashing

1) **Weigh appropriate amount of material.**

   There is no restriction on the maximum weight of material used; however, a large amount of material may take longer to ash. Enough material should be used to avoid a significant contribution of weighing errors to the total accuracy and precision.

2) **Place material in crucible, weigh, and cover with lid.**

   Placing a lid on the crucible both minimizes the amount of oxygen available, slowing the rate of combustion of the sample, and prevents any foreign material from falling into the crucible during ashing.

3) **Place crucible into furnace, and ash for at least 6 hours.**

   The furnace temperature at the sample position should be at least 300°C but should not exceed 500°C. If the sample combusts (burns), the temperature of the sample may exceed 500°C. Chrysotile will decompose above approximately 500°C.

   The furnace area should be well-ventilated and the fumes produced by ashing should be exhausted outside the building.

   The ashing time is dependent on the furnace temperature, the amount of sample, and the surface area (grain size). Six hours at 450°C is usually sufficient.

4) **Remove crucible from furnace, allow contents to adjust to room temperature and humidity, and weigh.**

5) **Divide residue weight by starting weight and multiply by 100 to determine weight% residue.**

6) **Analyze residue and/or proceed to acid dissolution procedure.**

   If the objective was to remove organic fibers that may be confused optically with asbestos, examine residue with PLM to determine whether any fibers remain.

   If the sample is a floor tile, the acid dissolution procedure must now be performed. The residue does not have to be analyzed at this stage.

2.3.7 Use of Solvents for Removal of Organics

Solvent dissolution may be used as a substitute for low temperature ashing for the purpose of removing organic interferences from bulk building materials. However, solvent dissolution, because of the involvement of potentially hazardous reagents such as tetrahydrofuran, amyl acetate, 1-1-1, trichlorethane, etc., requires **that all work be performed with extreme caution inside a biohazard hood.** Material Safety Data Sheets should be reviewed before using any solvent. Solvent dissolution involves more apparatus than does ashing, and requires more time, mainly due to set-up and slow filtration resulting from viscous solvent/residue mixtures.

The following is a brief description of the solvent dissolution process.

1) **Weigh starting material.**

   Place approximately 15-25ml of solvent in a 100ml beaker. Add 2.5-3.0 grams (carefully weighed for continued gravimetric tracking) of powdered sample.

2) **Untrasonicate sample.**

   Place the beaker in an ultrasonic bath (or ultrasonic stirrer) for approximately 0.5 hours. The sample containers should be covered to preclude escape of an aerosol spray.

3) **Centrifuge sample.**

   Weigh centrifuge vial before adding beaker ingredients. Wash beaker with an additional 10-15ml of solvent to remove any remaining concentrate. Then centrifuge

at approximately 2000-2500 rpm for 0.5 hour. Use solvent-resistant centrifuge tubes.

4) **Decant sample, reweigh.**

After separation by centrifuging, decant solvent by pipetting. Leave a small amount of solvent in the centrifuge vial to minimize the risk of decanting solid concentrate. Allow solid concentrate to dry in vial, then reweigh.

2.3.8 Procedure for Acid Dissolution

1) **Weigh starting material, transfer to acid resistant container.**

Small, dry sample weights between 0.1g and 0.5g are recommended (determined for 47mm filters - adjust amount if different diameter filters are used). If too much material is left after acid dissolution the filter can get clogged and prevent complete filtration. Very small samples are also to be avoided, as the weighing errors will have a large effect on the total accuracy and precision of the technique.

2) **Weigh filter.**

3) **Add HCl to sample in container, stir, allow to sit for 2-10 minutes.**

Either concentrated or dilute HCl can be used. If concentrated HCl is used, add enough acid to completely soak the material, allow the reaction to proceed to completion, and then dilute with distilled water. Alternatively, a dilute solution, made by adding concentrated HCl to distilled water, can be used in the place of concentrated HCl. A solution of 1 part concentrated HCl to 3 parts distilled water (approximately 3N solution) has been found to be quite effective in removing components within 5 minutes. For a sample size less than 0.5g, 20-30 ml of a 3N HCl solution is appropriate. In either case (using concentrated or dilute HCl), the reaction will be more effective if the sample has been homogenized first. All obvious signs of reaction (bubbling) should cease before the sample is filtered. Add fresh acid, a ml or two at a time, to ensure complete reaction. It should be noted that if dolomite is present, a 15-20 minute exposure to concentrated HCl may be required to completely dissolve the carbonate materials.

NOTE: Other solvents may be useful for selective dissolution of nonasbestos components. For example, acetic acid will dissolve calcite, and will not dissolve asbestos minerals. If any solvent other than hydrochloric acid is used for the dissolution of inorganic components, the laboratory must be able to demonstrate that the solvent does not remove asbestos from the sample.

4) **Filter solution.**

Use the pre-weighed filter. Pour the solution into the vacuum filter assembly, then rinse all material from container into filter assembly. Rinse down the inside walls of the glass filter basin and check for particles clinging to the basin after removal.

5) **Weigh dried filter + residue, subtract weight of filter from total.**

6) **Divide residue weight by starting weight and multiply by 100 to determine weight% residue.**

7) **Analyze residue.**

Perform stereomicroscopic examination of residue (can be performed without removing the residue from the filter). Note in particular whether any binder material is still present.

Perform PLM, AEM, or XRD analysis of residue to identify fibers and determine concentration as described in the appropriate sections of this method.

8) **Modify procedure if necessary.**

If removal of the acid soluble components was not complete, start with a new subsample of material and try any of the following:

a) Decrease grain size of material (by grinding, milling, etc.)
b) Put solutions on hot plate - warm slightly
c) Increase soak time (exercise caution)

9) **Calculate relative weight% asbestos in sample.**

wt% asbestos in sample = % asbestos in residue x wt% residue ÷ 100

For floor tiles, if the ashing procedure was used first, multiply the weight % of asbestos in the sample, as determined above, by the weight percent of the residue from the ashing procedure, then divide by 100.

Example:
A = wt% residue from ashing = 70%
B = wt% residue from HCl = 20%
C = wt% of asbestos in HCl residue = 50%

wt% asbestos after HCl dissolution = B x C ÷ 100 = 20 x 50 ÷ 100 = 10%

wt% asbestos in floor tile = (B x C ÷ 100) x A ÷ 100 = 10 x 70 ÷ 100 = 7%

If weights are expressed in decimal form, multiply the weight % of asbestos in the sample by the weight % of the residue from the ashing procedure, then multiply by 100.

wt% asbestos after HCl dissolution = B x C = 0.2 x 0.5 = 0.1 (x 100 = 10%)

wt% asbestos in floor tile = (B x C) x A = 0.1 x 0.7 = 0.07 (x 100 = 7%)

2.3.9 Determination of Optimal Precision and Accuracy

The precision of the technique can be determined by extracting multiple subsamples from the original sample and applying the same procedure to each. The optimal accuracy of the technique can be determined by applying gravimetric standards. Mixtures of calcite and asbestos (chrysotile, amosite, etc.) in the following proportions are recommended for testing the accuracy of the acid dissolution technique: 0.1 wt% asbestos/99.9 wt% calcite, 1.0 wt% asbestos/99.0 wt% calcite, and 10 wt% asbestos/90 wt% calcite. Mixtures of cellulose and asbestos are useful for testing the accuracy of the ashing technique.

Mixtures of only two components, as described above, are simplifications of "real-world" samples. The accuracy determined by analyzing these mixtures is considered optimal and may not apply directly to the measurement of each unknown sample. However, analyzing replicates and standards using the full laboratory procedure, including homogenization, ashing, acid dissolution, filtration, and weighing, may uncover steps that introduce significant bias or variation that the laboratory may then correct.

2.3.10 References

1. Kressler, J. R., "Changes in Optical Properties of Chrysotile During Acid Leaching", **The Microscope**, 31, 1983, pp. 165-172.

2. Prentice, J. and M. Keech, "Alteration of Asbestos with Heat", **Microscopy and Analysis**, March 1989.

3. Laughlin, G. and W. C. McCrone, "The Effect of Heat on the Microscopical Properties of Asbestos", **The Microscope**, 37, 1989, pp. 8-15.

2.4 X-Ray Powder Diffraction

2.4.1 Principle and Applicability

The principle of x-ray powder diffraction (XRD) analysis is well established.[1,2] Any solid crystalline material will diffract an incident beam of parallel, monochromatic x-rays whenever Bragg's Law,

$$\lambda = 2d \sin \theta,$$

is satisfied for a particular set of planes in the crystal lattice, where

λ = the x-ray wavelength, Å;
d = the interplanar spacings of the set of reflecting lattice planes, Å and
θ = the angle of incidence between the x-ray beam and the reflecting lattice planes.

By appropriate orientation of a sample relative to the incident x-ray beam, a diffraction pattern can be generated that will be uniquely characteristic of the structure of the crystalline phases present.

Unlike optical methods of analysis, however, XRD cannot determine crystal morphology. Therefore, in asbestos analysis, XRD does not distinguish between fibrous and nonfibrous forms of the serpentine and amphibole minerals (Table 2-6). However, when used in conjunction with methods such as PLM or AEM, XRD techniques can provide a reliable analytical method for the identification and characterization of asbestiform minerals in bulk materials.

For qualitative analysis by XRD methods, samples should initially be scanned over limited diagnostic peak regions for the serpentine (~7.4 Å) and amphibole (8.2-8.5 Å) minerals (Table 2-7). Standard slow-scanning methods for bulk sample analysis may be used for materials shown by PLM to contain significant amounts of asbestos (>5 percent). Detection of minor or trace amounts of asbestos may require special sample preparation and step-scanning analysis. All samples that exhibit diffraction peaks in the diagnostic regions for asbestiform minerals should be submitted to a full (5°-60° 2θ; 1° 2θ/min) qualitative XRD scan, and their diffraction patterns should be compared with standard reference powder

diffraction patterns[3] to verify initial peak assignments and to identify possible matrix interferences when subsequent quantitative analysis will be performed.

Accurate **quantitative** analysis of asbestos in bulk samples by XRD is critically dependent on particle size distribution, crystallite size, preferred orientation and matrix absorption effects, and comparability of standard reference and sample materials. The most intense diffraction peak that has been shown to be free from interference by prior qualitative XRD analysis should be selected for quantitation of each asbestiform mineral. A "thin-layer" method of analysis[5,6] can be used in which, subsequent to comminution of the bulk material to $\sim 10\ \mu m$ by suitable cryogenic milling techniques, an accurately known amount of the sample is deposited on a silver membrane filter. The mass of asbestiform material is determined by measuring the integrated area of the selected diffraction peak using a step-scanning mode, correcting for matrix absorption effects, and comparing with suitable calibration standards. Alternative "thick-layer" or bulk methods[7,8] are commonly used for **semi-quantitative analysis.**

TABLE 2-6. THE ASBESTOS MINERALS AND THEIR NONASBESTIFORM ANALOGS

Asbestiform	Nonasbestiform	Chemical Abstract Service No.
Serpentine		
Chrysotile	Antigorite, lizardite	12001-29-5
Amphibole		
Anthophyllite asbestos	Anthophyllite	77536-67-5
Cummingtonite-grunerite asbestos (Amosite)	Cummingtonite-grunerite	12172-73-5
Crocidolite	Riebeckite	12001-28-4
Tremolite asbestos	Tremolite	77536-68-6
Actinolite asbestos	Actinolite	77536-66-4

TABLE 2-7. PRINCIPAL LATTICE SPACINGS OF ASBESTIFORM MINERALS[1]

Minerals	Principal d-spacings (Å) and relative intensities			JCPDS Powder diffraction file[2] number
Chrysotile (Serpentine)	7.31_{100} 7.36_{100} 7.10_{100}	3.65_{70} 3.66_{80} 2.33_{80}	4.57_{50} 2.45_{65} 3.55_{70}	21-543[3] 25-645 22-1162 (theoretical)
Amosite (Grunerite)	8.33_{100} 8.22_{100}	3.06_{70} 3.060_{85}	2.756_{70} 3.25_{70}	17-745 (nonfibrous) 27-1170 (UICC)
Anthophyllite	3.05_{100} 3.06_{100}	3.24_{60} 8.33_{70}	8.26_{55} 3.23_{50}	9-455 16-401 (synthetic)
Crocidolite (Riebeckite)	8.35_{100} 8.40_{100}	3.10_{55} 3.12_{55}	2.720_{35} 2.726_{40}	27-1415 (UICC) 19-1061
Actinolite	2.72_{100}	2.54_{100}	3.40_{80}	25-157
Tremolite	8.38_{100} 2.706_{100} 3.13_{100}	3.12_{100} 3.14_{95} 2.706_{60}	2.705_{90} 8.43_{40} 8.44_{40}	13-437[3] 20-1310[3] (synthetic) 23-666 (synthetic mixture w/richterite)

1. This information is intended as a guide only. Complete powder diffraction data, including mineral type and source, should be referred to ensure comparability of sample and reference materials where possible. Additional precision XRD data on amosite, crocidolite, tremolite and chrysotile are available from the U.S. Bureau of Mines, Reference 4.

2. From Reference 3

3. Fibrosity questionable

This XRD method is applicable as a confirmatory method for identification and quantitation of asbestos in bulk material samples that have undergone prior analysis by PLM or other optical methods.

2.4.2 Range and Sensitivity

The range and sensitivity of the method have not been determined. They will be variable and dependent upon many factors, including matrix effects (absorption and interferences), diagnostic reflections selected and their relative intensities, preferred orientation, and instrumental limitations. A detection limit of one percent is feasible given certain sample characteristics.

2.4.3 Limitations

2.4.3.1 Interferences

Since the asbestiform and nonasbestiform analogs of the serpentine and amphibole minerals (Table 2-7) are indistinguishable by XRD techniques unless special sample preparation techniques and instrumentation are used,[9] the presence of nonasbestiform serpentines and amphiboles in a sample will pose severe interference problems in the identification and quantitative analysis of their asbestiform analogs.

The use of XRD for identification and quantitation of asbestiform minerals in bulk samples may also be limited by the presence of other interfering materials in the sample. For naturally-occurring materials, the commonly associated asbestos-related mineral interferences can usually be anticipated. However, for fabricated materials, the nature of the interferences may vary greatly (Table 2-8) and present more serious problems in identification and quantitation.[10] Potential interferences are summarized in Table 2-9 and include the following:

- **Chlorite** has major peaks at 7.19 Å and 3.58 Å that interfere with both the primary (7.31 Å) and secondary (3.65 Å) peaks for serpentine (chrysotile). Resolution of the primary peak to give good quantitative results may be possible when a step-scanning mode of operation is employed.

- **Vermiculite** has secondary peaks at 7.14 Å and 3.56 Å that could interfere with the primary peak (7.31 Å) and a secondary peak (3.65 Å) of serpentine (chrysotile).

TABLE 2-8. COMMON CONSTITUENTS IN BUILDING MATERIAL
(From Ref. 10)

A. Insulation Materials

Chrysotile
Amosite
Crocidolite
*Rock wool
*Slag wool
*Fiber glass
Gypsum ($CaSO_4 \cdot 2H_2O$)
Vermiculite (micas)
*Perlite
Clays (kaolin)
*Wood pulp
*Paper fibers (talc, clay carbonate filters)
Calcium silicates (synthetic)
Opaques (chromite, magnetite inclusions in serpentine)
Hematite (inclusions in "amosite")
Magnesite
*Diatomaceous earth

B. Flooring Materials

Calcite
Dolomite
Titanium Oxide
Quartz
Antigorite
Chrysotile
Anthophyllite
Tremolite
*Organic binders
Talc
Wollastonite

C. Spray Finishes or Paints

Bassanite
Carbonate minerals (calcite, dolomite, vaterite)
Talc
Tremolite
Anthophyllite
Serpentine (including chrysotile)
Amosite
Crocidolite
*Mineral wool
*Rock wool
*Slag wool
*Fiber glass
Clays (kaolin)
Micas
Chlorite
Gypsum
Quartz
*Organic binders and thickeners
Hydromagnesite
Wollastonite
Opaques (chromite, magnetite inclusion in serpentine)
Hematite (inclusions in "amosite")

D. Cementitious Materials

Chrysotile
Amosite
Crocidolite
Micas
Fiber glass
Cellulose
Animal hair
Quartz
Gypsum
Calcite
Dolomite
Calcium silicates

E. Roofing Materials

Chrysotile
Cellulose
Fiber glass
Mineral Wool
Asphalt
Quartz
Talc
Micas

* Amorphous materials--contribute only to overall scattered radiation and increased background radiation.

TABLE 2-9 INTERFERENCES IN XRD ANALYSIS OF ASBESTIFORM MINERALS

Asbestiform Mineral	Primary diagnostic peaks (approximate d spacings in Å)	Interference
Serpentine Chrysotile	7.3	Nonasbestiform serpentines, (antigorite, lizardite), chlorite, vermiculite, sepiolite, kaolinite, gypsum
	3.7	Nonasbestiform serpentines (antigorite, lizardite), chlorite, vermiculite, halloysite, cellulose
Amphibole Amosite (Grunerite) Antnophyllite Crocidolite (Riebeckite)	3.1	Nonasbestiform amphiboles (grunerite-cummingtonite, anthophyllite, riebeckite, tremolite), mutual interferences, talc, carbonates
Tremolite Actinolite	8.3	Nonasbestiform amphiboles (grunerite-cummingtonite, anthophyllite, riebeckite, tremolite), mutual interferences

- **Sepiolite** produces a peak at 7.47 Å which could interfere with the primary peak (7.31 Å) of serpentine (chrysotile).

- **Halloysite** has a peak at 3.63 Å that interferes with the secondary (3.65 Å) peak for serpentine (chrysotile).

- **Kaolinite** has a major peak at 7.15 Å that may interfere with the primary peak of serpentine (chrysotile) at 7.31 Å when present at concentrations of > 10 percent. However, the secondary serpentine (chrysotile) peak at 3.65 Å may be used for quantitation.

- **Gypsum** has a major peak at 7.5 Å that overlaps the 7.31 Å peak of serpentine (chrysotile) when present as a major sample constituent. This may be removed by careful washing with distilled water, or by heating to 300°C to convert gypsum to plaster of paris (bassanite).

- **Cellulose** has a broad peak that partially overlaps the secondary (3.65 Å) serpentine (chrysotile) peak.[8]

- Overlap of major diagnostic peaks of the amphibole minerals, grunerite (amosite), anthophyllite, riebeckite (crocidolite), and tremolite, at approximately 8.3 Å and 3.1 Å causes mutual interference when these minerals occur in the presence of one another. In some instances adequate resolution may be attained by using step-scanning methods and/or by decreasing the collimator slit width at the x-ray port.

- Carbonates may also interfere with quantitative analysis of the amphibole minerals grunerite (amosite), anthophyllite, riebeckite (crocidolite), and tremolite-actinolite. Calcium carbonate ($CaCO_3$) has a peak at 3.035 Å that overlaps major amphibole peaks at approximately 3.1 Å when present in concentrations of >5 percent. Removal of carbonates with a dilute acid wash is possible; however, the time in acid should be no more than 20 minutes to preclude any loss of chrysotile.[11]

- A major talc peak at 3.12 Å interferes with the primary tremolite peak at this same position and with secondary peaks of actinolite (3.14 Å), riebeckite (crocidolite) (3.10 Å), grunerite (amosite) (3.06 Å), and anthophyllite (3.05 Å). In the presence of talc, the major diagnostic peak at approximately 8.3 Å should be used for quantitation of these asbestiform minerals.

The problem of intraspecies and matrix interference is further aggravated by the variability of the silicate mineral powder diffraction patterns themselves, which often makes definitive identification of the asbestos minerals by comparison with standard reference diffraction patterns difficult. This variability results from alterations in the crystal lattice associated with differences in isomorphous substitution and degree of crystallinity. This is especially true for the amphiboles. These minerals exhibit a wide variety of very similar chemical compositions, resulting in diffraction patterns characterized by having major (110) reflections of the monoclinic amphiboles and (210) reflections of orthorhombic anthophyllite separated by less than 0.2 Å.[12]

2.4.3.2 Matrix Effects

If a copper x-ray source is used, the presence of iron at high concentrations in a sample will result in significant x-ray fluorescence, leading to loss of peak intensity, increased background intensity, and an overall decrease in sensitivity. This situation may be corrected by use of an x-ray source other than copper; however, this is often accompanied both by loss of intensity and by decreased resolution of closely spaced reflections. Alternatively, use of a

diffracted beam monochromator will reduce background fluorescent radiation, enabling weaker diffraction peaks to be detected.

X-ray absorption by the sample matrix will result in overall attenuation of the diffracted beam and may seriously interfere with quantitative analysis. Absorption effects may be minimized by using sufficiently "thin" samples for analysis.[5,13,14] However, unless absorption effects are known to be the same for both samples and standards, appropriate corrections should be made by referencing diagnostic peak areas to an internal standard[7,8] or filter substrate (Ag) peak.[5,6]

2.4.3.3 Particle Size Dependence

Because the intensity of diffracted x-radiation is particle-size dependent, it is essential for accurate quantitative analysis that both sample and standard reference materials have similar particle size distributions. The optimum particle size (i.e., fiber length) range for quantitative analysis of asbestos by XRD has been reported to be 1 to 10 μm.[15] Comparability of sample and standard reference material particle size distributions should be verified by optical microscopy (or another suitable method) prior to analysis.

2.4.3.4 Preferred Orientation Effects

Preferred orientation of asbestiform minerals during sample preparation often poses a serious problem in quantitative analysis by XRD. A number of techniques have been developed for reducing preferred orientation effects in "thick layer" samples.[7,8,15] For "thin" samples on membrane filters, the preferred orientation effects seem to be both reproducible and favorable to enhancement of the principal diagnostic reflections of asbestos minerals, actually increasing the overall sensitivity of the method.[12,14] However, further investigation into preferred orientation effects in both thin layer and bulk samples is required.

2.4.3.5 Lack of Suitably Characterized Standard Materials

The problem of obtaining and characterizing suitable reference materials for asbestos analysis is clearly recognized. The National Institute of Standards and Technology can

provide standard reference materials for chrysotile, amosite and crocidolite (SRM 1866) and anthophyllite, tremolite and actinolite (SRM 1867).

In addition, the problem of ensuring the comparability of standard reference and sample materials, particularly regarding crystallite size, particle size distribution, and degree of crystallinity, has yet to be adequately addressed. For example, Langer et al.[18] have observed that in insulating matrices, chrysotile tends to break open into bundles more frequently than amphiboles. This results in a line-broadening effect with a resultant decrease in sensitivity. Unless this effect is the same for both standard and sample materials, the amount of chrysotile in the sample will be under-estimated by XRD analysis. To minimize this problem, it is recommended that standardized matrix reduction procedures be used for both sample and standard materials.

2.4.4 Precision and Accuracy

Neither the precision nor accuracy of this method has been determined. The individual laboratory should obtain or prepare a set of calibration materials containing a range of asbestos weight percent concentrations in combination with a variety of matrix/binder materials. Calibration curves may be constructed for use in semi-quantitative analysis of bulk materials.

2.4.5 Procedure

2.4.5.1 Sampling

Samples taken for analysis of asbestos content should be collected as specified by EPA[19]

2.4.5.2 Analysis

All samples must be analyzed initially for asbestos content by PLM. XRD may be used as an additional technique, both for identification and quantitation of sample components. **Note: Asbestos is a toxic substance. All handling of dry materials should be performed in a safety-hood.**

2.4.5.2.1 Sample Preparation

The method of sample preparation required for XRD analysis will depend on: (1) the condition of the sample received (sample size, homogeneity, particle size distribution, and overall composition as determined by PLM); and (2) the type of XRD analysis to be performed (qualitative or quantitative; thin-layer or bulk).

Bulk materials are usually received as heterogeneous mixtures of complex composition with very wide particle size distributions. Preparation of a homogeneous, representative sample from asbestos-containing materials is particularly difficult because the fibrous nature of the asbestos minerals inhibits mechanical mixing and stirring, and because milling procedures may cause adverse lattice alterations.

A discussion of specific matrix reduction procedures is given below. Complete methods of sample preparation are detailed in Sections 2.4.5.3 and 2.4.5.4. **Note: All samples should be examined microscopically before and after each matrix reduction step to monitor changes in sample particle size distribution, composition, and crystallinity, and to ensure sample representativeness and homogeneity for analysis.**

2.4.5.2.2 Milling

Mechanical milling of asbestos materials has been shown to decrease fiber crystallinity, with a resultant decrease in diffraction intensity of the specimen; the degree of lattice alteration is related to the duration and type of milling process.[20-23] Therefore, all milling times should be kept to a minimum.

For **qualitative analysis**, particle size is not usually of critical importance and initial characterization of the material with a minimum of matrix reduction is often desirable to document the composition of the sample as received. Bulk samples of very large particle size (>2-3 mm) should be comminuted to ~ 100 μm. A mortar and pestle can sometimes be used in size reduction of soft or loosely bound materials though this may cause matting of some samples. Such samples may be reduced by cutting with a razor blade in a mortar, or by grinding in a suitable mill (e.g., a microhammer mill or equivalent). When using a mortar for grinding or cutting, the sample should be moistened with ethanol, or some other

suitable wetting agent, to minimize exposure, and the procedure should be performed in a HEPA-filtered hood.

For accurate, reproducible **quantitative analysis**, the particle size of both sample and standard materials should be reduced to $\sim 10\ \mu m$. Dry ball milling at liquid nitrogen temperatures (e.g., Spex Freezer Mill*, or equivalent) for a maximum time of 10 minutes (some samples may require much shorter milling time) is recommended to obtain satisfactory particle size distributions while protecting the integrity of the crystal lattice.[5] Bulk samples of very large particle size may require grinding in two stages for full matrix reduction to $< 10\ \mu m$.[8,16]

Final particle size distributions should always be verified by optical microscopy or another suitable method.

2.4.5.2.3 Ashing

For materials shown by PLM to contain large amounts of cellulose or other organic materials, it may be desirable to ash prior to analysis to reduce background radiation or matrix interference. Since chrysotile undergoes dehydroxylation at temperatures between 550°C and 650°C, with subsequent transformation to forsterite,[24,25] ashing temperatures should be kept below 500°C. Use of a muffle furnace is recommended. In all cases, calibration of the furnace is essential to ensure that a maximum ashing temperature of 500°C is not exceeded (see Section 2.3).

2.4.5.2.4 Acid Washing

Because of the interference caused by gypsum and some carbonates in the detection of asbestiform minerals by XRD (see Section 2.4.3.1), it may be necessary to remove these interferences by a simple acid washing procedure prior to analysis (see Section 2.3).

2.4.5.3 Qualitative Analysis

2.4.5.3.1 Initial Screening of Bulk Material

Qualitative analysis should be performed on a representative, homogeneous portion of the sample, with a minimum of sample treatment, using the following procedure:

1. Grind and mix the sample with a mortar and pestle (or equivalent method, see Section 2.4.5.2.2) to a final particle size sufficiently small ($\sim 100\ \mu m$) to allow adequate packing into a sample holder.

2. Pack sample into a standard bulk sample holder. Care should be taken to ensure that a representative portion of the milled sample is selected for analysis. Particular care should be taken to avoid possible size segregation of the sample. **(Note: Use of back-packing method[26] for bulk sample preparation may reduce preferred orientation effects.)**

3. Mount the sample on the diffractometer and scan over the diagnostic peak regions for the serpentine (~ 7.4 Å) and amphibole (8.2-8.5 Å) minerals (see Table 2-7). The x-ray diffraction equipment should be optimized for intensity. A slow scanning speed of $1°\ 2\theta$/min is recommended for adequate resolution. Use of a sample spinner is recommended.

4. Submit all samples that exhibit diffraction peaks in the diagnostic regions for asbestiform minerals to a full qualitative XRD scan ($5°$-$60°\ 2\theta$; $1°\ 2\theta$/min) to verify initial peak assignments and to identify potential matrix interferences when subsequent quantitative analysis is to be performed.

5. Compare the sample XRD pattern with standard reference powder diffraction patterns (i.e., JCPDS powder diffraction data[3] or those of other well-characterized reference materials). Principal lattice spacings of asbestiform minerals are given in Table 2-7; common constituents of bulk insulation and wall materials are listed in Table 2-8.

2.4.5.3.2 Detection of Minor or Trace Constituents

Routine screening of bulk materials by XRD may fail to detect small concentrations ($<1\%$) of asbestos. The limits of detection will, in general, be improved if matrix absorption effects are minimized, and if the sample particle size is reduced to the optimal 1 to 10 μm range, provided that the crystal lattice is not degraded in the milling process. Therefore, in those instances when confirmation of the presence of an asbestiform mineral at very low levels is required, or where a negative result from initial screening of the bulk material by XRD (see Section 2.4.5.3.1) is in conflict with previous PLM results, it may be desirable to prepare the sample as described for quantitative analysis (see Section 2.4.5.4) and step-scan over appropriate 2θ ranges of selected diagnostic peaks (Table 2-7). Accurate

transfer of the sample to the silver membrane filter is not necessary unless subsequent quantitative analysis is to be performed.

2.4.5.4 Quantitative Analysis

The proposed method for quantitation of asbestos in bulk samples is a modification of the NIOSH-recommended thin-layer method for chrysotile in air.[6] A thick-layer bulk method involving pelletizing the sample may be used for semi-quantitative analysis;[7,8] however, this method requires the addition of an internal standard, use of a specially fabricated sample press, and relatively large amounts of standard reference materials. Additional research is required to evaluate the comparability of thin- and thick-layer methods for quantitative asbestos analysis.

For quantitative analysis by thin-layer methods, the following procedure is recommended:

1. Mill and size all or a substantial representative portion of the sample as outlined in Section 2.4.5.2.2.

2. Dry at 60°C for 2 hours; cool in a desiccator.

3. Weigh accurately to the nearest 0.01 mg.

4. Samples shown by PLM to contain large amounts of cellulosic or other organic materials, gypsum, or carbonates, should be submitted to appropriate matrix reduction procedures described in Sections 2.4.5.2.3 and 2.4.5.2.4. After ashing and/or acid treatment, repeat the drying and weighing procedures described above, and determine the percent weight loss, L.

5. Quantitatively transfer an accurately weighed amount (50-100 mg) of the sample to a 1-L volumetric flask containing approximately 200 mL isopropanol to which 3 to 4 drops of surfactant have been added.

6. Ultrasonicate for 10 minutes at a power density of approximately 0.1 W/mL, to disperse the sample material.

7. Dilute to volume with isopropanol.

8. Place flask on a magnetic-stirring plate. Stir.

9. Place silver membrane filter on the filtration apparatus, apply a vacuum, and attach the reservoir. Release the vacuum and add several milliliters of isopropanol to the reservoir. Vigorously hand shake the asbestos suspension and immediately withdraw

an aliquot from the center of the suspension so that total sample weight, W_T, on the filter will be approximately 1 mg. Do not adjust the volume in the pipet by expelling part of the suspension; if more than the desired aliquot is withdrawn, discard the aliquot and repeat the procedure with a clean pipet. Transfer the aliquot to the reservoir. Filter rapidly under vacuum. Do not wash the reservoir walls. Leave the filter apparatus under vacuum until dry. Remove the reservoir, release the vacuum, and remove the filter with forceps. (Note: Water-soluble matrix interferences such as gypsum may be removed at this time by careful washing of the filtrate with distilled water. Extreme care should be taken not to disturb the sample.)

10. Attach the filter to a flat holder with a suitable adhesive and place on the diffractometer. Use of a sample spinner is recommended.

11. For each asbestos mineral to be quantitated, select a reflection (or reflections) that has (have) been shown to be free from interferences by prior PLM or qualitative XRD analysis and that can be used unambiguously as an index of the amount of material present in the sample (see Table 2-7).

12. Analyze the selected diagnostic reflection(s) by step-scanning in increments of 0.02° 2θ for an appropriate fixed time and integrating the counts. (A fixed count scan may be used alternatively; however, the method chosen should be used consistently for all samples and standards.) An appropriate scanning interval should be selected for each peak, and background corrections made. For a fixed time scan, measure the background on each side of the peak for one-half the peak-scanning time. The net intensity, I_a, is the difference between the peak integrated count and the total background count.

13. Determine the net count, I_{Ag}, of the filter 2.36 Å silver peak following the procedure in step 12. Remove the filter from the holder, reverse it, and reattach it to the holder. Determine the net count for the unattenuated silver peak, I°_{Ag}. Scan times may be less for measurement of silver peaks than for sample peaks; however, they should be constant throughout the analysis.

14. Normalize all raw, net intensities (to correct for instrument instabilities) by referencing them to an external standard (e.g., the 3.34 Å peak of an α-quartz reference crystal). After each unknown is scanned, determine the net count, I°_{r}, of the reference specimen following the procedure in step 12. Determine the normalized intensities by dividing the peak intensities by I°_{r}:

$$\hat{I}_a = \frac{I_a}{I_r^\circ}, \quad \hat{I}_{Ag} = \frac{I_{Ag}}{I_r^\circ}, \text{ and } \hat{I}_{Ag}^\circ = \frac{I_{Ag}^\circ}{I_r^\circ}.$$

2.4.6 Calibration

2.4.6.1 Preparation of Calibration Standards

1. Mill and size standard asbestos materials according to the procedure outlined in Section 2.4.5.2.2. Equivalent standardized matrix reduction and sizing techniques should be used for both standard and sample materials.

2. Dry at 100°C for 2 hours; cool in a desiccator.

3. Prepare two suspensions of each standard in isopropanol by weighing approximately 10 and 50 mg of the dry material to the nearest 0.01 mg. Transfer each to a 1-L volumetric flask containing approximately 200 mL isopropanol to which a few drops of surfactant have been added.

4. Ultrasonicate for 10 minutes at a power density of approximately 0.1 W/mL, to disperse the asbestos material.

5. Dilute to volume with isopropanol.

6. Place the flask on a magnetic stirring plate. Stir.

7. Prepare, in triplicate, a series of at least five standard filters to cover the desired analytical range, using appropriate aliquots of the 10 and 50 mg/L suspensions. For each standard, mount a silver membrane filter on the filtration apparatus. Place a few mL of isopropanol in the reservoir. Vigorously hand shake the asbestos suspension and immediately withdraw an aliquot from the center of the suspension. Do not adjust the volume in the pipet by expelling part of the suspension; if more than the desired aliquot is withdrawn, discard the aliquot and resume the procedure with a clean pipet. Transfer the aliquot to the reservoir. Keep the tip of the pipet near the surface of the isopropanol. Filter rapidly under vacuum. Do not wash the sides of the reservoir. Leave the vacuum on for a time sufficient to dry the filter. Release the vacuum and remove the filter with forceps.

2.4.6.2 Analysis of Calibration Standards

1. Mount each filter on a flat holder. Perform step scans on selected diagnostic reflections of the standards and reference specimen using the procedure outlined in Section 2.4.5.4, step 12, and the same conditions as those used for the samples.

2. Determine the normalized intensity for each peak measured, $\hat{I}^{\circ}_{std}$, as outlined in Section 2.4.5.4, step 14.

2.4.7 Calculations

For each asbestos reference material, calculate the exact weight deposited on each standard filter from the concentrations of the standard suspensions and aliquot volumes. Record the weight, w, of each standard. Prepare a calibration curve by regressing $\hat{I}^{\circ}_{std}$, on w. Poor reproducibility ($\pm$15 percent RSD) at any given level indicates problems in the sample preparation technique, and a need for new standards. The data should fit a straight-line equation.

Determine the slope, m, of the calibration curve in counts/microgram. The intercept, b, of the line with the $\hat{I}^{\circ}_{std}$ axis should be approximately zero. A large negative intercept indicates an error in determining the background. This may arise from incorrectly measuring the baseline or from interference by another phase at the angle of background measurement. A large positive intercept indicates an error in determining the baseline or that an impurity is included in the measured peak.

Using the normalized intensity, $\hat{I}_{Ag}$ for the attenuated silver peak of a sample, and the corresponding normalized intensity from the unattenuated silver peak $\hat{I}^{\circ}_{Ag}$, of the sample filter, calculate the transmittance, T, for each sample as follows:[27,28]

$$T = \frac{\hat{I}_{Ag}}{\hat{I}^{\circ}_{Ag}}$$

Determine the correction factor, f(T), for each sample according to the formula:

$$f(T) = \frac{-R(\ln T)}{1 - T^R}$$

where

$$R = \frac{\sin \theta_{Ag}}{\sin \theta_a}$$

θ_{Ag} = angular position of the measured silver peak (from Bragg's Law), and

θ_a = angular position of the diagnostic asbestos peak.

Calculate the weight, W_a, in micrograms, of the asbestos material analyzed for in each sample, using the absorption corrections:

$$W_a = \frac{\hat{I}_a f(t) - b}{m}$$

Calculate the percent composition, P_a, of each asbestos mineral analyzed for in the parent material, from the total sample weight, W_T, on the filter:

$$P_a = \frac{W_a(1 - .01L)}{W_T} \times 100$$

where

P_a = percent asbestos mineral in parent material;

W_a = mass of asbestos mineral on filter, in μg;

W_T = total sample weight on filter, in μg;

L = percent weight loss of parent material on ashing and/or acid treatment (see Section 2.4.5.4).

2.4.8 References

1. Klug, H. P. and L. E. Alexander, **X-Ray Diffraction Procedures for Polycrystalline and Amorphous Materials**, 2nd ed., New York: John Wiley and Sons, 1979.

2. Azaroff, L. V. and M. J. Buerger, **The Powder Method of X-Ray Crystallography**, New York: McGraw-Hill, 1958.

3. JCPDS-International Center for Diffraction Data Powder Diffraction Studies, 1601 Park Lane, Swarthmore, PA.

4. Campbell, W. J., C. W. Huggins, and A. G. Wylie, **Chemical and Physical Characterization of Amosite, Chrysotile, Crocidolite, and Nonfibrous Tremolite for National Institute of Environmental Health Sciences Oral Ingestion Studies**, U.S. Bureau of Mines Report of Investigation R18452, 1980.

5. Lange, B. A. and J. C. Haartz, Determination of microgram quantities of asbestos by x-ray diffraction: Chrysotile in thin dust layers of matrix material, **Anal. Chem.**, 51(4):529-525, 1979.

6. **NIOSH Manual of Analytical Methods**, Volume 5, U.S. Dept. HEW, August 1979, pp. 309-1 to 309-9.

7. Dunn, H.W. and J. H. Stewart, Jr., Determination of chrysotile in building materials by x-ray diffractometry, **Analytical Chemistry**, 54 (7); 1122-1125, 1982.

8. Taylor, A., Methods for the quantitative determination of asbestos and quartz in bulk samples using x-ray diffraction, **The Analyst**, 103(1231):1009-1020, 1978.

9. Birks, L., M. Fatemi, J. V. Gilfrich, and E. T. Johnson, **Quantitative Analysis of Airborne Asbestos by X-Ray Diffraction**, Naval Research Laboratory Report 7879, Naval Research Laboratory, Washington, DC, 1975.

10. **Asbestos-Containing Materials in School Buildings: A Guidance Document**, U. S. Environmental Protection Agency. EPA/OTS No. C00090, March 1979.

11. Krause, J. B. and W. H. Ashton, Misidentification of asbestos in talc, pp. 339-353, In: **Proceedings of Workshops on Asbestos: Definitions and Measurement Methods** (NBS Special Publication 506), C. C. Gravatt, P. D. LaFleur, and K. F. Heinrich (eds.), Washington, DC: National Measurement Laboratory, National Bureau of Standards, 1977 (issued 1978).

12. Stanley, H. D., The detection and identification of asbestos and asbestiform minerals in talc, pp. 325-337, In: **Proceedings of Workshop on Asbestos: Definitions and Measurement Methods** (NBS Special Publication 506), C. C. Gravatt, P. D. LaFleur, and K. F. Heinrich (eds.), Washington, DC: National Measurement Laboratory, National Bureau of Standards, 1977 (issued 1978).

13. Rickards, A. L., Estimation of trace amounts of chrysotile asbestos by x-ray diffraction, **Anal. Chem.**, 44(11):1872-3, 1972.

14. Cook, P. M., P. L. Smith, and D. G. Wilson, Amphibole fiber concentration and determination for a series of community air samples: use of x-ray diffraction to supplement electron microscope analysis, In: **Electron Microscopy and X-Ray Applications to Environmental and Occupation Health Analysis**, P. A. Russell and A. E. Hutchings (eds.), Ann Arbor: Ann Arbor Science Publications, 1977.

15. Rohl, A. N. and A. M. Langer, Identification and quantitation of asbestos in talc, **Environ. Health Perspectives**, 9:95-109, 1974.

16. Graf, J. L., P. K. Ase, and R. G. Draftz, **Preparation and Characterization of Analytical Reference Materials**, DHEW (NIOSH) Publication No. 79-139, June 1979.

17. Haartz, J. C., B. A. Lange, R. G. Draftz, and R. F. Scholl, Selection and characterization of fibrous and nonfibrous amphiboles for analytical methods development, pp. 295-312, In: **Proceedings of Workshop on Asbestos: Definitions and Measurement Methods** (NBS special Publication 506), C. C. Gravatt, P. D. LaFleur, and K. F. Heinrich (eds.), Washington, DC: National Measurement Laboratory, National Bureau of Standards, 1977 (issued 1978).

18. Personal Communication, A. M. Langer, formerly of Environmental Sciences Laboratory, Mount Sinai School of Medicine of the City University of New York, New York, NY, now of Brooklyn College, Brooklyn, N.Y.

19. **Asbestos in Buildings: Simplified Sampling Scheme for Friable Surfacing Materials**, U.S. Environmental Protection Agency. EPA 560/5-85-030a, October 1985.

20. Langer, A. M., M. S. Wolff, A. N. Rohl, and I. J. Selikoff, Variation of properties of chrysotile asbestos subjected to milling, **J. Toxicol. and Environ. Health**, 4:173-188, 1978.

21. Langer, A. M., A. D. Mackler, and F. D. Pooley, Electron microscopical investigation of asbestos fibers, **Environ. Health Perspect.**, 9:63-80, 1974.

22. Occella, E. and G. Maddalon, X-ray diffraction characteristics of some types of asbestos in relation to different techniques of comminution, **Med. Lavoro,** 54(10):628-636, 1963.

23. Spurny, K. R., W. Stober, H. Opiela, and G. Weiss, On the problem of milling and ultrasonic treatment of asbestos and glass fibers in biological and analytical applications, **Am. Ind. Hyg. Assoc. J.**, 41:198-203, 1980.

24. Berry, L. G. and B. Mason, **Mineralogy**, San Francisco: W. H. Greeman & Co., 1959.

25. Schelz, J. P., The detection of chrysotile asbestos at low levels in talc by differential thermal analysis, **Thermochimica Acta**, 8:197-204, 1974.

26. Reference 1, pp. 372-374.

27. Leroux, J., Staub-Reinhalt Luft, 29:26 (English), 1969.

28. Leroux, J. A., B. C. Davey, and A. Paillard, Proposed standard methodology for the evaluation of silicosis hazards, **Am. Ind. Hyg. Assoc. J.**, 34:409, 1973.

2.5 Analytical Electron Microscopy

2.5.1 Applicability

Analytical electron microscopy (AEM) can often be a reliable method for the detection and positive identification of asbestos in some bulk building materials, both friable and nonfriable. The method is particularly applicable to bulk materials that contain a large amount of interfering materials that can be removed by ashing and/or dissolution and contain asbestos fibers that are not resolved by PLM techniques. Many floor tiles and plasters would be included in this type of sample. In combination with suitable specimen preparation techniques, the AEM method can also be used to quantify asbestos concentrations.

2.5.2 Range

The range is dependent on the type of bulk material being analyzed. The upper detection limit is 100%, and the lower detection limit can be as low as 0.0001% depending on the extent to which interfering materials can be separated during the preparation of AEM

specimens, the sophistication of the AEM preparation, and the amount of labor expended on AEM examination.

2.5.3 Interferences

The presence of a large amount of binder/matrix materials associated with fibers can make it difficult to positively identify fibers as asbestos. The portion of the fiber examined by either electron diffraction or energy dispersive x-ray analysis (EDXA) must be free of binder/matrix materials.

2.5.4 Precision and Accuracy

The precision and accuracy of the method have not been determined.

2.5.5 Procedures

The procedures for AEM specimen preparation depend on the data required. In analysis of floor tiles, the weighed residue after removal of the matrix components (see Section 2.3, Gravimetry) is often mostly asbestos, and the task is primarily to identify the fibers. In this situation the proportion of asbestos in the residue can be estimated by AEM and this estimate can be used to refine the gravimetric result. For many floor tiles, the final result is not very sensitive to errors in this estimation because the proportion of asbestos in the residue is very high. For samples in which this is not the case, precise measurements can be made using a quantitative AEM preparation, in which each grid opening of the specimen grid corresponds to a known weight of the original sample or of a concentrate derived from the original sample. Asbestos fibers on these grids are then identified and measured, using a fiber counting protocol which is directed towards a precise determination of mass concentration. This latter procedure is suitable for samples of low asbestos concentration, or for those in which it is not possible to remove a large proportion of the matrix material.

2.5.5.1 AEM Specimen Preparation for Semi-Quantitative Evaluation

The residual material from any ashing or dissolution procedures (see Section 2.3) used (usually trapped on a membrane filter) should be placed in a small volume of ethanol or another solvent such as acetone or isopropyl alcohol, in a disposable beaker, and dispersed

by treatment in an ultrasonic bath. A small volume of this suspension (approximately 3μl) should be pipetted onto the top of a carbon-coated TEM grid. The suspension should be allowed to dry under a heat lamp. The grid is then ready for examination.

Samples that are not conducive to ashing or dissolution may also be prepared in this way for AEM analysis. A few milligrams of the sample may be ground in a mortar and pestle or milled, dispersed in ethanol or another solvent using an ultrasonic bath, and pipetted onto a grid as described previously.

2.5.5.2 AEM Specimen Preparation for Quantitative Evaluation

The objective of this preparation is to obtain a TEM grid on which a known weight of the bulk sample is represented by a known area of the TEM grid. A known weight of the bulk sample, or of the residue after extraction, should be dispersed in a known volume of distilled water. Aliquots of this dispersion should then be filtered through 0.22 μm pore-size MCE or 0.2 μm pore-size PC filters, using filtration techniques as described for analysis of water samples.[1] In order to obtain filters of appropriate particulate loading for AEM analysis, it may be necessary to perform serial dilutions of the initial dispersion. TEM grids should then be prepared from appropriately-loaded filters, using the standard methods.[2]

Determination of the mass concentration of asbestos on the TEM grids requires a different fiber counting protocol than that usually used for determination of numerical fiber concentrations. Initially, the grids should be scanned to determine the dimensions of the largest asbestos fiber or fiber bundle on the specimens. The volume of this fiber or bundle should be calculated. The magnification of the AEM should be set at a value for which the length of this fiber or bundle just fills the fluorescent screen. Asbestos fiber counting should then be continued at this magnification. The count should be terminated when the volume of the initial large fiber or bundle represents less than about 5% of the integrated volume of all asbestos fibers detected. This counting strategy ensures that the fiber counting effort is directed toward those fibers which contribute most to the mass, and permits a precise mass concentration value to be obtained.

2.5.5.2.1 Identification

To document the positive identification of asbestos in a sample, the analyst should record the following physical properties: morphology data, electron diffraction data, EDXA data, and any other distinguishing characteristics observed. For fibrous structures identified as nonasbestos, the unique physical property or properties that differentiate the material from asbestos should be recorded.

The purpose of the identification data collected is to prevent or limit false negatives and false positives. This can be accomplished by having a system for measuring and recording the d-spacings and symmetry of the diffraction patterns, determining the relative abundance of the elements detected by EDXA, and comparing these results to reference data. The laboratory should have a set of reference asbestos materials from which a set of reference diffraction patterns and x-ray spectra have been developed. Also, the laboratory should have available reference data on the crystallography and chemical composition of minerals that might analytically interfere with asbestos.

2.5.6 References

1. Chatfield, E.J., and M. J. Dillon, **Analytical Method for Determination of Asbestos Fibers in Water,** EPA-600/4-83-043. U.S. Environmental Protection Agency Environmental Research Laboratory, 1983.

2. Environmental Protection Agency's **Interim Transmission Electron Microscopy Analytical Methods--Mandatory and Nonmandatory--and Mandatory Section to Determine Completion of Response Actions**, Appendix A to subpart E, 40 CFR part 763.

2.6 Other Methodologies

Additional analytical methods (e.g. Scanning Electron Microscopy) may be applicable for some bulk materials. However, the analyst should take care to recognize the limitations of any analytical method chosen. Conventional SEM, for example, cannot detect small diameter fibers ($\sim < 0.2\mu m$), and cannot determine crystal structure. It is, however, very useful for observing surface features in complex particle matrices, and for determining elemental compositions.

3.0 QUALITY CONTROL/QUALITY ASSURANCE OPERATIONS- PLM

A program to routinely assess the quality of the results produced by the PLM laboratory must be developed and implemented. **Quality Control** (QC) is a system of activities whose purpose is to control the quality of the product or service so that it meets the need of the users. This also includes **Quality Assessment**, whose purpose is to provide assurance that the overall quality control is being done effectively. While the essential elements of a quality control system are described in detail elsewhere,[1,2,3,4,5,6] only several of the elements will be discussed here. **Quality Assurance** (QA) is comprised of Quality Control and Quality Assessment and is a system of activities designed to provide assurance that a product or service meets defined standards of quality.

The purpose of the Quality Assurance program is to minimize failures in the analysis of materials prior to submitting the results to the client. Failures in the analysis of asbestos materials include false positives, false negatives, and misidentification of asbestos types. False positives result from identification or quantitation errors. False negatives result from identification, detection, or quantitation errors.

For the stereomicroscopic and PLM techniques, the quality control procedures should characterize the accuracy and precision of both individual analysts and the techniques. Analysts should demonstrate their abilities on calibration materials, and also be checked routinely on the analysis of unknowns by comparison with results of a second analyst. The limitations of the stereomicroscopic and PLM techniques can be determined by using a second analytical technique, such as gravimetry, XRD, or AEM. For example, stereomicroscopic and PLM techniques can fail in the analysis of floor tiles because the asbestos fibers in the sample may be too small to be resolved by light microscopy. An XRD or AEM analysis is not subject to the same limitations, and may indicate the presence of asbestos in the sample.

The accuracy, precision, and detection limits of all analytical techniques described in this method are dependent on the type of sample (matrix components, texture, etc.), on the preparation of the sample (homogeneity, grain size, etc.), and the specifics of the method (number of point counts for PLM, mass of sample for gravimetry, counting time for XRD,

etc.). These should be kept in mind when designing quality control procedures and characterizing performance, and are variables that must be tracked in the quality assurance system.

3.1 General Considerations

3.1.1 Training

Of paramount importance in the successful use of this or any other analytical method is the well-trained analyst. It is highly recommended that the analyst have completed course work in optical mineralogy on the collegiate level. That is not to say that others cannot successfully use this method, but the classification error rate[7] may, in some cases, be directly attributable to level of training. In addition to completed course work in optical mineralogy, specialized course work in PLM and asbestos identification by PLM is desirable. Experience is as important as education. A good laboratory training program can be used in place of course work. Analysts that are in training and not yet fully qualified should have all analyses checked by a qualified analyst before results are released. A QC Plan for asbestos identification would be considered incomplete without a detailed description of the analyst training program, together with detailed records of training for each analyst.

3.1.2 Instrument Calibration and Maintenance

Microscope alignment checks (alignment of the polarizer at 90° with respect to the analyzer, and coincident with the cross-lines, proper orientation of the slow vibration direction of the Red I compensator plate, image of the field diaphragm focussed in the plane of the specimen, centering of the central dispersion staining stop, etc.) should be performed with sufficient frequency to ensure proper operations. Liquids used for refractive index determination and those optionally used for dispersion staining should have periodic refractive index checks using a refractometer or known refractive index solids. These calibrations must be documented.

Microscopes and ancillary equipment should be maintained daily. It is recommended that at least once per year each microscope be thoroughly cleaned and re-aligned by a professional microscope service technician. Adequate inventories of replaceable parts

(illumination lamps, etc.) should be established and maintained. All maintenance must be documented.

3.2 Quality Control of Asbestos Analysis

3.2.1 Qualitative Analysis

All analysts must be able to correctly identify the six regulated asbestos types (chrysotile, amosite, crocidolite, anthophyllite, actinolite, and tremolite) using combined stereomicroscopic and PLM techniques. Standards for the six asbestos types listed are available from NIST, and should be used to train analysts in the measurement of optical properties and identification of asbestos. These materials can also be used as identification standards for XRD and AEM.

Identification errors between asbestos types (e.g. reporting amosite when tremolite is present) implies that the analyst cannot properly determine optical properties and is relying on morphology as the identification criteria. This is not acceptable. Each analyst in the lab should prove his or her proficiency in identifying the asbestos types; this can be checked through use of calibration materials (NVLAP proficiency testing materials, materials characterized by an independent technique, and synthesized materials) and by comparing results with another analyst. The identification of all parameters (e.g. refractive indices, birefringence, sign of elongation, etc.) leading to the identification should fall within control limits determined by the laboratory. In addition, a subset of materials should be analyzed using another technique to confirm the analysis.

As discussed earlier, the qualitative analysis is dependent upon matrix and asbestos type and texture. Therefore, the quality assurance system should monitor for samples that are difficult to analyze and develop additional or special steps to ensure accurate characterization of these materials. When an analyst is found to be out of the control limits defined by the laboratory, he or she should undergo additional training and have confirmatory analyses performed on all samples until the problem has been corrected.

3.2.2 Quantitative Analysis

The determination of the amount of asbestos in a sample can be accomplished using the various techniques outlined in this method. The mandatory stereomicroscopic and PLM examinations provide concentrations in terms of volume, area, or weight, depending upon the calibration procedure. Gravimetric and quantitative XRD techniques result in concentrations in units of weight percent. Specific guidelines for determining accuracy and precision using these techniques are provided in the appropriate sections of this method. In general, however, the accuracy of any technique is determined through analysis of calibration materials which are characterized by multiple independent techniques in order to provide an unbiased value for the analyte (asbestos) in question. The precision of any technique is determined by multiple analyses of the sample. The analyst is the detector for stereomicroscopic and PLM techniques, as opposed to gravimetric and XRD techniques, and therefore must be calibrated as an integral part of the procedure.

As in the qualitative analysis, the laboratory should determine its accuracy and precision for quantitative asbestos analysis according to the type of material analyzed and the technique used for analysis. For example, the laboratory may determine that its analysts have a problem with calibrated area estimates of samples containing cellulose and chrysotile and therefore needs to make or find special calibration materials for this class of sample.

Calibration materials for quantitative analysis of asbestos are available through the Bulk Asbestos NVLAP as proficiency testing materials for those laboratories enrolled in NVLAP. In a report provided following a test round, the concentration of asbestos in each sample is given in weight percent with 95%/95% tolerance limits, along with a description of the major matrix components. Materials from other round robin and quality assurance programs for asbestos analysis may not have been analyzed by independent techniques; the concentrations may represent consensus PLM results that could be significantly biased. Therefore, values from these programs should <u>not</u> be used as calibration materials for quantitative analysis.

Calibration materials for quantitative analysis can also be synthesized by mixing asbestos and appropriate matrix materials, as described in Appendix C of this method. These

materials are usually simplifications of "real world" samples; therefore the accuracy and precision determined from analysis of these materials are probably ideal.

Limits on permissible analytical variability must be established by the laboratory prior to QC implementation. It is recommended that a laboratory initially be at 100% quality control (all samples reanalyzed.) The proportion of quality control samples can later be lowered gradually, as control indicates, to a minimum of 10%. Quantitative results for standards including the mean and error estimate (typically 95% confidence or tolerance intervals) should be recorded. Over time these data can be used to help determine control limits for quality control charts.

The establishment and use of control charts is extensively discussed elsewhere in the literature. [1,2,3,4,5] Several cautions are in order:

- Control charts are based on the assumption that the data are distributed normally. Using rational subgrouping, the means of the subgroups are approximately normally distributed, irrespective of the distribution of the individual values in the subgroups. Control charts for asbestos analysis are probably going to be based on individual measurements, not rational subgroups. Check the data for normality before proceeding with the use of control charts. Ryan[8] suggests a minimum of 50 analyses before an attempt is made to establish control limits. However, for this analysis, consider setting "temporary" limits after accumulating 20-30 analyses of the sample.

- Include <u>both</u> prepared slides as well as bulk samples in your reference inventory.

- Make certain that sample quantities are sufficient to last, and that the act of sampling will not alter the composition of the reference sample.

Data on analytical variability can be obtained by having analysts repeat their analyses of samples and also by having different analysts analyze the same samples.

3.3 Interlaboratory Quality Control

The establishment and maintenance of an interlaboratory QC program is fundamental to continued assurance that the data produced within the laboratory are of consistent high quality. Intralaboratory programs may not be as sensitive to accuracy and precision error, especially if the control charts (see Section 3.2.2) for all analysts in the laboratory indicate small percent differences. A routine interlaboratory testing program will assist in the detection of internal bias and analyses may be performed more frequently than proficiency

testing. Arrangements should be made with at least two (preferably more) other laboratories that conduct asbestos identification by PLM. Samples (the number of which is left to the participating laboratories, but at least 4-10) representing the types of samples and matrices routinely submitted to the lab for analysis should be exchanged with sufficient frequency to determine intralaboratory bias. Both reference slides and bulk samples should be used. Results of the interlaboratory testing program should be evaluated by each of the participating laboratories and corrective actions, if needed, identified and implemented. Since quantitation problems are more pronounced at low concentrations ($\leq$ 5%), it would be prudent to include approximately 30-50% from this concentration range in the sample selection process.

3.4 Performance Audits

Performance audits are independent quantitative assessments of laboratory performance. These audits are similar to the interlaboratory QC programs established between several laboratories, but with a much larger cohort (the EPA Asbestos Bulk Sample Analysis Quality Assurance Program had as many as 1100 participating laboratories). Participation in this type of program permitted assessment of performance through the use of "consensus" test materials, and served to assist in assessing the bias relative to individual interlaboratory, as well as intralaboratory programs. Caution should be exercised in the use of "consensus" quantitation results, as they are likely to be significantly responsible for the propagation of high bias in visual estimates. The current NIST/NVLAP[9] for bulk asbestos laboratories (PLM) does not use concensus quantitation results. Results are reported in weight percent with a 95% tolerance interval. The American Industrial Hygiene Association (AIHA)[10] also conducts a proficiency testing program for bulk asbestos laboratories. Quantitation results for this program are derived from analyses by two reference laboratories and PLM, XRD and gravimetric analysis performed by Research Triangle Institute.

3.5 Systems Audits

Where performance audits are quantitative in nature, systems audits are qualitative. Systems audits are assessments of the laboratory quality system as specified in the Laboratory

Quality Assurance Manual. Such an audit might consist of an evaluation of some facet of the QA Manual, or the audit may be larger in scope. For example, the auditor might request specific laboratory data sheets which will be evaluated against written procedures for data recording in the laboratory. Or, the auditor might request air monitoring or contamination control data to review for frequency of sampling, analysis methodology, and/or corrective actions taken when problems were discovered. The audit report should reflect the nature of the audit as well as the audit results. Any recommendations for improvement should also be reflected in such a report.

3.6 References

1. **Quality Assurance for Air Pollution Measurement Systems. Volume I, Principles.** EPA-600/9-76-005, March, 1976.

2. Juran, J. and F. Gryna, **Quality Planning Analysis**, 2nd edition, McGraw-Hill, Inc., 1980.

3. Taylor, J.R., **Quality Control Systems**, McGraw Hill, Inc., 1989.

4. Ratliff, T.A., **The Laboratory Quality Assurance System**, Van Nostrand Reinhold, 1990.

5. Taylor, J.K., **Quality Assurance of Chemical Measurements**, Lewis Publishers, 1987.

6. Bulk Asbestos Handbook, National Institute of Standards and Technology, National Voluntary Laboratory Accreditation Program, NISTIR 88-3879. October 1988.

7. Harvey, B.W., "Classification and Identification Error Tendencies in Bulk Insulation Proficiency Testing Materials," **American Environmental Laboratory**, 2(2), 4/90, pp. 8-14.

8. Ryan, T.P., **Statistical Techniques for Quality Improvement**, John Wiley & Sons, Inc., New York, 1989.

9. National Institute of Standards & Technology (NIST) National Voluntary Laboratory Accreditation Program (NVLAP), Building 411, Room A124, Gaithersburg, MD 20899, telephone (301) 975-4016.

10. American Industrial Hygiene Association (AIHA), 2700 Prosperity Avenue, Suite 250, Fairfax, VA 22031, (703) 849-8888.

APPENDIX A

Glossary Of Terms

APPENDIX A. GLOSSARY OF TERMS

Accuracy - The degree of agreement of a measured value with the true or expected value.

Anisotropic - Refers to substances that have more than one refractive index (e.g. are birefringent), such as nonisometric crystals, oriented polymers, or strained isotropic substances.

Asbestiform (morphology) - Said of a mineral that is like asbestos, i.e., crystallized with the habit of asbestos. Some asbestiform minerals may lack the properties which make asbestos commercially valuable, such as long fiber length and high tensile strength. With the light microscope, the asbestiform habit is generally recognized by the following characteristics:

- Mean aspect ratios ranging from 20:1 to 100:1 or higher for fibers longer than 5μm. Aspect ratios should be determined for fibers, not bundles.
- Very thin fibrils, usually less than 0.5 micrometers in width, and
- Two or more of the following:
  - Parallel fibers occurring in bundles,
  - Fiber bundles displaying splayed ends,
  - Matted masses of individual fibers, and/or
  - Fibers showing curvature

These characteristics refer to the population of fibers as observed in a bulk sample. It is not unusual to observe occasional particles having aspect ratios of 10:1 or less, but it is unlikely that the asbestos component(s) would be dominated by particles (individual fibers) having aspect ratios of <20:1 for fibers longer than 5μm. If a sample contains a fibrous component of which most of the fibers have aspect ratios of <20:1 and that do not display the additional asbestiform characteristics, by definition the component should not be considered asbestos.

Asbestos - A commercial term applied to the asbestiform varieties of six different minerals. The asbestos types are chrysotile (asbestiform serpentine), amosite (asbestiform grunerite), crocidolite (asbestiform riebeckite), and asbestiform anthophyllite, asbestiform tremolite, and asbestiform actinolite. The properties of asbestos that caused it to be widely used commercially are: 1) its ability to be separated into long, thin, flexible fibers; 2) high tensile strength; 3) low thermal and electrical conductivity; 4) high mechanical and chemical durability, and 5) high heat resistance.

Becke Line - A band of light seen at the periphery of a specimen when the refractive indices of the specimen and the mounting medium are different; it is used to determine refractive index.

Bias - A systematic error characterized by a consistent (non-random) measurement error.

Binder - With reference to a bulk sample, a component added for cohesiveness (e.g. plaster, cement, glue, etc.).

Birefringence - The numerical difference between the maximum and minimum refractive indices of an anisotropic substance. Birefringence may be estimated, using a Michel-Levy chart, from the interference colors observed under crossed polarizers. Interference colors are also dependent on the orientation and thickness of the grain, and therefore are used qualitatively to determine placement in one of the four categories listed below.

Qualitative	Quantitative(N-n)
none	0.00 or isotropic
low	≤ 0.010
moderate	0.011-0.050
high	> 0.050

Bulk Sample - A sample of building material taken for identification and quantitation of asbestos. Bulk building materials may include a wide variety of friable and nonfriable materials.

Bundle - Asbestos structure consisting of several fibers having a common axis of elongation.

Calibration Materials - Materials, such as known weight % standards, that assist in the calibration of microscopists in terms of ability to quantitate the asbestos content of bulk materials.

Color - The color of a particle or fiber when observed in plane polarized light.

Compensator - A device with known, fixed or variable retardation and vibration direction used for determining the degree of retardation (hence the thickness or value of birefringence) in an anisotropic specimen. It is also used to determine the sign of elongation of elongated materials. The most common compensator is the first-order red plate (530-550nm retardation).

Control Chart - A graphical plot of test results with respect to time or sequence of measurement, together with limits within which they are expected to lie when the system is in a state of statistical control.

Detection Limit - The smallest concentration/amount of some component of interest that can be measured by a single measurement with a stated level of confidence.

Dispersion Staining (focal masking) - An optical means of imparting apparent or virtual color to transparent substances by the use of stops in the objective back focal plane; ir it is used to determine refractive indices.

Error - Difference between the true or expected value and the measured value of a quantity or parameter.

Extinction - The condition in which an anisotropic substance appears dark when observed between crossed polars. This occurs when the vibration directions in the specimen are parallel to the vibration directions in the polarizer and analyzer. Extinction may be complete or incomplete; common types include parallel, oblique, symmetrical and undulose.

Extinction Angle - For fibers, the angle between the extinction position and the position at which the fiber is parallel to the polarizer or analyzer privileged directions.

Fiber - With reference to asbestiform morphology, a structure consisting of one or more fibrils.

Fibril - The individual unit structure of fibers.

Friable - Refers to the cohesiveness of a bulk material, indicating that it may be crumbled or disaggregated by hand pressure.

Gravimetry - Any technique in which the concentration of a component is determined by weighing. As used in this document, it refers to measurement of asbestos-containing residues after sample treatment by ashing, dissolution, etc.

Homogeneous - Uniform in composition and distribution of all components of a material, such that multiple subsamples taken for analysis will contain the same components in approximately the same relative concentrations.

Heterogeneous - Lacking uniformity in composition and/or distribution of material; components not uniform. Does not satisfy the conditions stated for homogenous; e.g., layered or in clumps, very coarse grained, etc.

Isotropic - Refers to substances that have a single refractive index such as unstrained glass, un-oriented polymers and unstrained substances in the isometric crystal system.

Lamda Zero (λ_0) - The wavelength (λ_0) of the dispersion staining color shown by a specimen in a medium; both the specimen and medium have the same refractive index at that wavelength.

Matrix - Nonasbestos, nonbinder components of a bulk material. Includes such components as cellulose, fiberglass, mineral wool, mica, etc.

Michel-Levy Scale of Retardation colors - A chart plotting the relationship between birefringence, retardation and thickness of anisotropic substances. Any one of the three variables can be determined if the other two are known.

Morphology - The structure and shape of a particle. Characterization may be descriptive (platy, rod-like, acicular, etc) or in terms of dimensions such as length and diameter (see asbestiform).

Pleochroism - The change in color or hue of colored anisotropic substance when rotated relative to the vibration direction of plane polarized light.

Point Counting - A technique used to determine the relative projected areas occupied by separate components in a microscope slide preparation of a sample. For asbestos analysis, this technique is used to determine the relative concentrations of asbestos minerals to nonasbestos sample components.

Polarization Colors - Interference colors displayed by anisotropic substances between two polarizers. Birefringence, thickness and orientation of the material affect the colors and their intensity.

Precision - The degree of mutual agreement characteristic of independent measurements as the result of repeated application of the process under specified conditions. It is concerned with the variability of results.

Reference Materials - Bulk materials, both asbestos-containing and nonasbestos-containing, for which the components are well-documented as to identification and quantitation.

Refractive Index (index of refraction) - The ratio of the velocity of light in a vacuum relative to the velocity of light in a medium. It is expressed as n and varies with wavelength and temperature.

Sign of Elongation - Referring to the location of the high and low refractive indices in an elongated anisotropic substance, a specimen is described as positive when the higher refractive index is lengthwise (length slow), and as negative when the lower refractive index is lengthwise (length fast).

Standard Reference Material (SRM) - A reference material certified and distributed by the National Institute of Standards and Technology.

Visual Estimate - An estimation of concentration of asbestos in a sample as compared to the other sample components. This may be a volume estimate made during stereomicroscopic examination and/or a projected area estimation made during microscopic (PLM) examination.

APPENDIX B

Apparatus For Sample Preparation And Analysis

B1.0 INTRODUCTION

The following lists the apparatus and materials required and suggested for the methods of sample preparation and analysis described in the test method.[1,2,3]

B2.0 STEREOMICROSCOPIC EXAMINATION

The following are suggested for routine stereomicroscopic examination.

- HEPA-filtered hood or class 1 biohazard hood, negative pressure
- Microscope: binocular microscope, preferably stereoscopic, 5-60X magnification (approximate)
- Light source: incandescent or fluorescent
- Tweezers, dissecting needles, scalpels, probes, etc. (for sample manipulation)
- Glassine paper, glass plates, weigh boats, petri dishes, watchglasses, etc. (sample containers)

The following are suggested for sample preparation.

- Mortar and pestle, silica or porcelain-glazed
- Analytical balance (readability less than or equal to one milligram) (optional)
- Mill or blender (optional)

B3.0 POLARIZED LIGHT MICROSCOPY

The laboratory should be equipped with a polarized light microscope (preferably capable of Köhler or Köhler-type illumination if possible) and accessories as described below.

- Ocular(s) binocular or monocular with cross hair reticle, or functional equivalent, and a magnification of at least 8X
- 10X, 20X, and 40X objectives, (or similar magnification)

- Light source (with optional blue "day-light" filter)
- 360-degree rotatable stage
- Substage condenser with iris diaphragm
- Polarizer and analyzer which can be placed at 90 degrees to one another, and can be calibrated relative to the cross-line reticle in the ocular.
- Accessory slot for wave plates and compensators (or demonstrated equivalent).
- Wave retardation plate (Red I compensator) with approximately 550 nanometer retardation, and with known slow and fast vibration directions.
- Dispersion staining objective or a demonstrated equivalent. (optional)
- Monochromatic filter (n_D), or functional equivalent. (optional)

In addition, the following equipment, materials and reagents are required or recommended.[1]

- NIST traceable standards for the major asbestos types (NIST SRM 1866 and 1867)
- Class I biohazard hood or better (see "Note", Section 2.2.5)
- Sampling utensils (razor knives, forceps, probe needles, etc.)
- Microscope slides and cover slips
- Mechanical Stage
- Point Counting Stage (optional)
- Refractive index liquids: 1.490-1.570, 1.590-1.720 in increments of less than or equal to 0.005; high dispersion, (HD) liquids are optional; however, if using dispersion staining, HD liquids are recommended.
- Mortar and pestle
- Distilled water
- HCl, ACS reagent grade concentrated

- Muffle furnace (optional)
- Mill or blender (optional)
- Beakers and assorted glassware (optional)
- Other reagents (tetrahydrofuran, amyl acetate, acetone, sodium hexametaphosphate, etc.) (optional)

B4.0 GRAVIMETRY

The following equipment, materials, and reagents are suggested.

- Scalpels
- Crucibles, silica or porcelain-glazed, with lids
- Muffle furnace - temperature range at least to 500°C, temperature stable to ± 10°C, temperature at sample position calibrated to ± 10°C
- Filters, 0.4 μm pore size polycarbonate
- Petri dishes
- Glass filtration assembly, including vacuum flask, water aspirator, and/or air pump
- Analytical balance, readable to 0.001 gram
- Mortar and pestle, silica or porcelain-glazed
- Heat lamp or slide warmer
- Beakers and assorted glassware
- Centrifuge, bench-top
- Class I biohazard hood or better
- Bulb pipettes
- Distilled water
- HCl, reagent-grade concentrated

- Organic solvents (tetrahydrofuran, amyl acetate,etc)
- Ultrasonic bath

B5.0 X-RAY DIFFRACTION

Sample Preparation

Sample preparation apparatus requirements will depend upon the sample type under consideration and the kind of XRD analysis to be performed.

- Mortar and pestle: agate or porcelain
- Razor blades
- Sample mill: SPEX, Inc., freezer mill or equivalent
- Bulk sample holders
- Silver membrane filters: 25-mm diameter, 0.45-μm pore size. Selas Corp. of America, Flotronics Div., 1957 Pioneer Road, Huntington Valley, PA 19006
- Microscope slides
- Vacuum filtration apparatus: Gelman No. 1107 or equivalent, the side-arm vacuum flask
- Microbalance
- Ultrasonic bath or probe: Model W140, Ultrasonics, Inc., operated at a power density of approximately 0.1 W/mL, or equivalent
- Volumetric flasks: 1-L volume
- Assorted pipets
- Pipet bulb
- Nonserrated forceps
- Polyethylene wash bottle
- Pyrex beakers: 50-mL volume

- Desiccator
- Filter storage cassettes
- Magnetic stirring plate and bars
- Porcelain crucibles
- Muffle furnace or low temperature asher
- Class 1 biohazard hood or better

Sample Analysis

Sample analysis requirements include an x-ray diffraction unit, equipped with:

- Constant potential generator; voltage and mA stabilizers
- Automated diffractometer with step-scanning mode
- Copper target x-ray tube: high intensity; fine focus, preferably
- X-ray pulse height selector
- X-ray detector (with high voltage power supply): scintillation or proportional counter
- Focusing graphite crystal monochromator; or nickel filter (if copper source is used, and iron fluorescence is not a serious problem)
- Data output accessories:
  - Strip chart recorder
  - Decade scaler/timer
  - Digital printer

  or

  - PC, appropriate software and Laser Jet Printer
- Sample spinner (optional)
- Instrument calibration reference specimen: α-quartz reference crystal (Arkansas quartz standard, #180-147-00, Philips Electronics Instruments, Inc., 85 McKee Drive, Mahwah, NJ 07430) or equivalent.

Reagents, etc.

Reference Materials - The list of reference materials below is intended to serve as a guide. Every attempt should be made to acquire pure reference materials that are comparable to sample materials being analyzed.

- Chrysotile: UICC Canadian, NIST SRM 1866 (UICC reference material available from: UICC, MRC Pneumoconiosis Unit, Llandough Hospital, Penarth, Glamorgan, CF61XW, UK); (NIST Standard Reference Materials available from the National Institute of Standards and Technology, Office of Reference Standards, Gaithersburg, MD 20899)
- Crocidolite: UICC, NIST SRM 1866.
- "Amosite": UICC, NIST SRM 1866.
- Anthophyllite-Asbestos: UICC, NIST SRM 1867
- Tremolite Asbestos: Wards Natural Science Establishment, Rochester, NY; Cyprus Research Standard, Cyprus Research, 2435 Military Ave., Los Angeles, CA 900064 (washed with dilute HCl to remove small amount of calcite impurity); Indian tremolite, Rajasthan State, India; NIST SRM 1867.
- Actinolite Asbestos: NIST SRM 1867

Adhesive - Tape, petroleum jelly, etc. (for attaching silver membrane filters to sample holders).

Surfactant - 1 Percent aerosol OT aqueous solution or equivalent.

Isopropanol - ACS Reagent Grade.

B6.0 ANALYTICAL ELECTRON MICROSCOPY

AEM equipment requirements will not be discussed in this document; it is suggested that equipment requirements stated in the AHERA regulations be followed. Additional information may be found in the NVLAP Program Handbook for Airborne Asbestos Analysis.[3]

The following additional materials and equipment are suggested:

- Analytical balance, readable to 0.001 gram
- Ultrasonic bath
- Glass filtration assembly (25mm), including vacuum flask and water aspirator
- Mixed cellulose ester (MCE) filters (0.22μm pore size) or 0.2μm pore size polycarbonate filters
- MCE backing filters (5μm pore size)
- Silica mortar and pestle
- Beakers - glass and disposable
- Pipettes, disposable, 1,5, and 10 ml

B7.0 REFERENCES

1. National Institute of Standards and Technology (NIST) National Voluntary Laboratory Accreditation Program (NVLAP) Bulk Asbestos Handbook, NISTIR 88-3879, 1988.
2. **Interim Method for the Determination of Asbestos in Bulk Insulation Samples,** U.S. E.P.A. 600/M4-82-020, 1982.
3. National Institute of Standards and Technology (NIST) National Voluntary Laboratory Accreditation Program (NVLAP) Program Handbook for Airborne Asbestos Analysis, NISTIR 89-4137, 1989.

APPENDIX C

Preparation and Use of Bulk Asbestos Calibration Standards

C1.0 INTRODUCTION

Evaluation of the results from national proficiency testing programs for laboratories analyzing for asbestos in bulk materials indicates that laboratories have had, and continue to have, problems with quantitation of asbestos content, especially with samples having a low asbestos concentration.[1] For such samples, the mean value of asbestos content reported by laboratories may be four to ten times the true weight percent value. It is assumed that the majority of the laboratories quantify asbestos content by visual estimation, either stereomicroscopically or microscopically; therefore, the problem of quantitation must be attributed to lack of or inadequate calibration of microscopists.

As calibration standards for asbestos-containing bulk materials are not currently commercially available, laboratories should consider generating their own calibration materials. This may be done rather easily and inexpensively.

C2.0 MATERIALS AND APPARATUS

Relatively pure samples of asbestos minerals should be obtained. Chrysotile, amosite and crocidolite (SRM 1866) and anthophyllite, tremolite and actinolite (SRM 1867) are available from NIST. A variety of matrix materials are commercially available; included are calcium carbonate, perlite, vermiculite, mineral wool/fiberglass, and cellulose. Equipment, and materials needed to prepare calibration bulk materials are listed below.

- Analytical balance, readable to 0.001 gram
- Blender/mixer; multi-speed, – one quart capacity
- Filtration assembly, including vacuum flask, water aspirator and/or air pump (optional)
- HEPA-filtered hood with negative pressure
- Filters, 0.4μm pore size polycarbonate (optional)
- Beakers and assorted glassware, weigh boats, petri dishes, etc.
- Hot/warm plate

- Asbestos minerals
- Matrix materials
- Distilled water.

C3.0 MATERIAL FORMULATION PROCEDURES

The formulation procedure involves first weighing appropriate quantities of asbestos and matrix material to give the desired asbestos weight percent. The following formula may be used to determine the weights of asbestos and matrix materials needed to give a desired weight percent asbestos.

$$\frac{WTa}{Wa} = \frac{WTm}{Wm}$$

Where:

WTa = weight of asbestos in grams (to 0.001 gram)
WTm = weight of matrix materials in grams (to 0.001 gram)
Wa = weight percent asbestos
Wm = weight percent matrix

Example: The desired total weight for the calibration sample is ~ 10 grams containing 5% asbestos by weight. If 0.532 grams of asbestos are first weighed out, what corresponding weight of matrix material is required?

WTa = 0.532 grams
Wa = 5%
Wm = 95%

$$\frac{0.532}{5} = \frac{WTm}{95}$$

Then: WTm = 10.108 grams

The matrix is then placed into the pitcher of a standard over-the-counter blender, the pitcher being previously filled to approximately one-fourth capacity (8-10 ounces) with distilled water. Blending is performed at the lowest speed setting for approximately ten seconds which serves to disaggregate the matrix material. The asbestos is then added, with additional blending of approximately 30 seconds, again at the lowest speed setting. Caution should be taken not to overblend the asbestos-matrix mixture. This could result in a significant reduction in the size of the asbestos fibers causing a problem with detection at normal magnification during stereomicroscopic and microscopic analyses. Ingredients of the

pitcher are then poured into a filtering apparatus, with thorough rinsing of the pitcher to ensure complete material removal. After filtering, the material is transferred to a foil dish which is placed on a hot plate. The material is covered and allowed to sit over low heat until drying is complete; intermittent stirring will speed the drying process. For fine-grained matrix materials such as gypsum, calcium carbonate, clays, etc., the sample is not filtered after the blending process. Instead, the ingredients in the pitcher are transferred into a series of shallow, glass (petri) dishes. The ingredients should be stirred well between each pouring to minimize the possible settling (and over-representation) of some components. The dishes are covered and placed on a hot plate until the contents are thoroughly dried. For small quantities of any matrix materials (15 grams or less), air-drying without prior filtering is generally very suitable for removing water from the prepared sample. For each material, the final step involves placing all formulated, dried subsamples into a plastic bag (or into one petri dish, for small quantities), where brief hand-mixing will provide additional blending and help to break up any clumps produced during drying. **All operations should be performed in a safety-hood with negative pressure.**

C4.0 ANALYSIS OF MATERIALS

All formulations should be examined with the stereomicroscope to determine homogeneity. Gravimetric analysis (ashing and/or acid dissolution) should be performed on those materials containing organic and/or acid-soluble components. Matrix materials to which no asbestos has been added should be analyzed by gravimetric analysis to determine the amount of nonashable or insoluble materials that are present. Several subsamples of each material should be analyzed by the gravimetric technique to provide information concerning the uniformity of the prepared materials. Experience has shown that the previously described formulation procedure results in relatively homogeneous materials.[2]

C4.1 Stereomicroscopic Analysis

Visual estimation of sample components using the stereomicroscope is in reality a comparison of the relative volumes of the components.[3] Therefore, differences in specific gravity between asbestos and matrix material must be considered and the relationship

between weight percent and volume percent must be determined.[4] Materials such as expanded vermiculite, perlite, and cellulose have specific gravities significantly lower than asbestos minerals. Table C1 lists the specific gravities for the three most commonly encountered asbestos varieties and several common matrix materials.

TABLE C1. SPECIFIC GRAVITIES OF ASBESTOS VARIETIES AND MATRIX MATERIALS

Asbestos Type	Specific Gravity	Matrix Type	Specific Gravity
Chrysotile	2.6	Calcium Carbonate	2.7
		Gypsum	2.3
Amosite	3.2	Perlite	~0.4
		Vermiculite (expanded)	~0.3
		Mineral Wool	~2.5
Crocidolite	3.3	Fiberglass	~2.5
		Cellulose	~0.9

The conversion of weight percent asbestos to equivalent volume percent asbestos is given by the following formula:

$$\frac{\frac{Wa}{Ga}}{\frac{Wa}{Ga} + \frac{Wm}{Gm}} \times 100 = Va$$

where:

Wa = weight percent asbestos
Ga = specific gravity of asbestos
Wm = weight percent matrix
Gm = specific gravity of matrix
Va = volume percent asbestos

Example: Chrysotile and perlite have been combined to form a 5% asbestos calibration standard, by weight. What is the equivalent volume percent asbestos?

$$Wa = 5\% \quad Ga = 2.6 \quad Wm = 95\% \quad Gm = 0.4$$

$$Va = \frac{\frac{5}{2.6}}{\frac{5}{2.6} + \frac{95}{0.4}} \times 100 = 0.8\%$$

Conversely, to convert volume percent asbestos to equivalent weight percent, the following formula may be used.

$$\frac{(Va)(Ga)}{(Va)(Ga)+(Vm)(Gm)} \times 100 = Wa$$

Vm = volume percent matrix

Example: A calibration standard consisting of amosite and cellulose is estimated to contain 2% asbestos, by volume. What is the equivalent weight percent asbestos?

$$Va = 2\% \quad Ga = 3.2 \quad Vm = 98\% \quad Gm = 0.9$$

$$Wa = \frac{(2)(3.2)}{(2)(3.2)+(98)(0.9)} \times 100 = 6.77\%$$

Volume percentages should be calculated for all calibration materials prepared so that visual estimates determined by examination with the stereomicroscope may be compared to true volume concentrations.

Figure C1 illustrates the relationship between volume percent and weight percent of chrysotile mixed with vermiculite and cellulose respectively. It should be noted that when asbestos in a low weight percentage is mixed with matrix materials having low specific gravities (vermiculite, perlite), the resulting volume concentration of asbestos is very low. For example, a mixture containing three percent chrysotile by weight in a cellulose matrix would result in a volume percent asbestos of approximately 1.1%; in a vermiculite matrix, the resulting volume percent asbestos would be approximately 0.4%. In the latter case especially, an analyst might possibly fail to detect the asbestos or consider it to be present in only trace amounts.

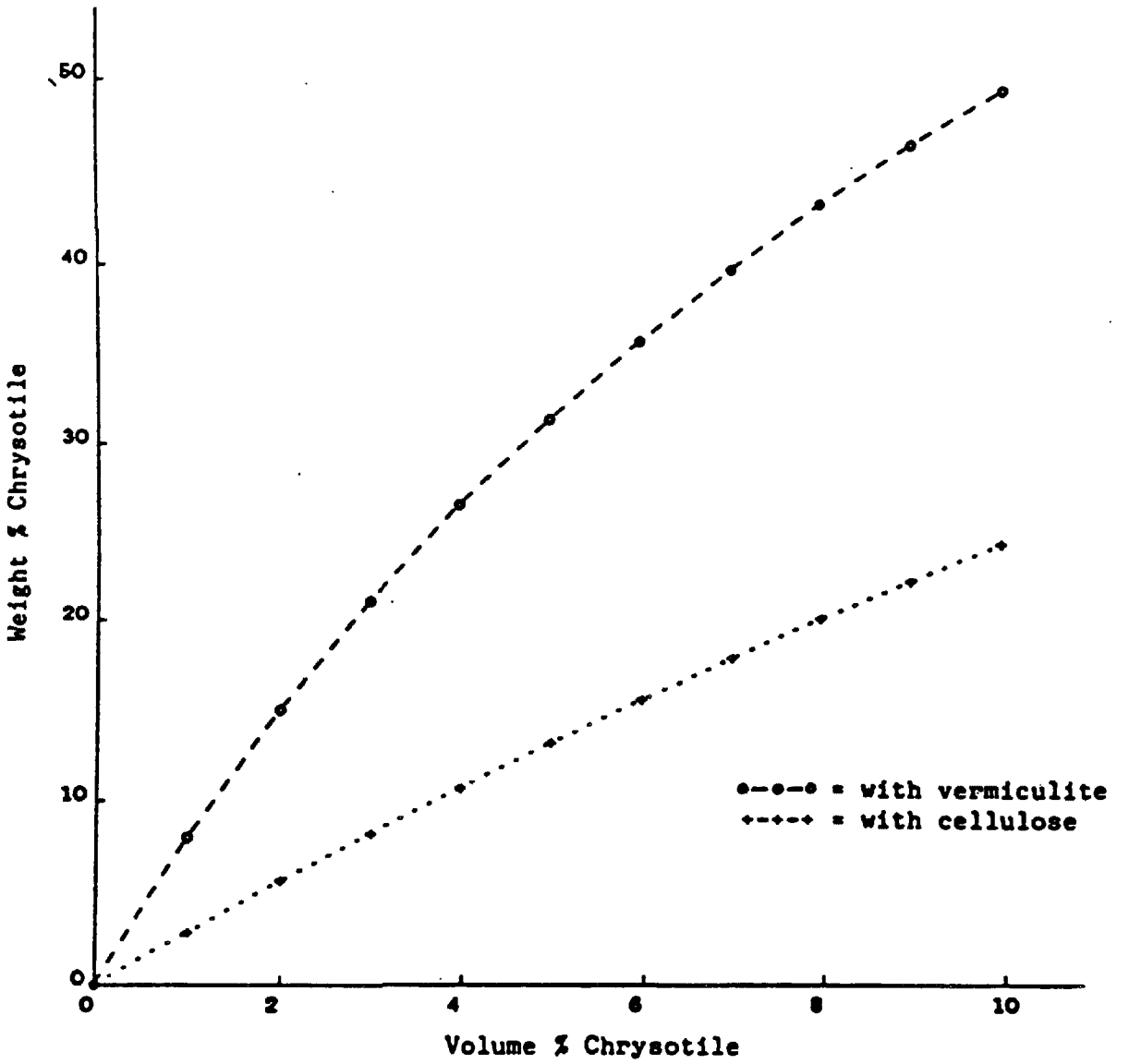


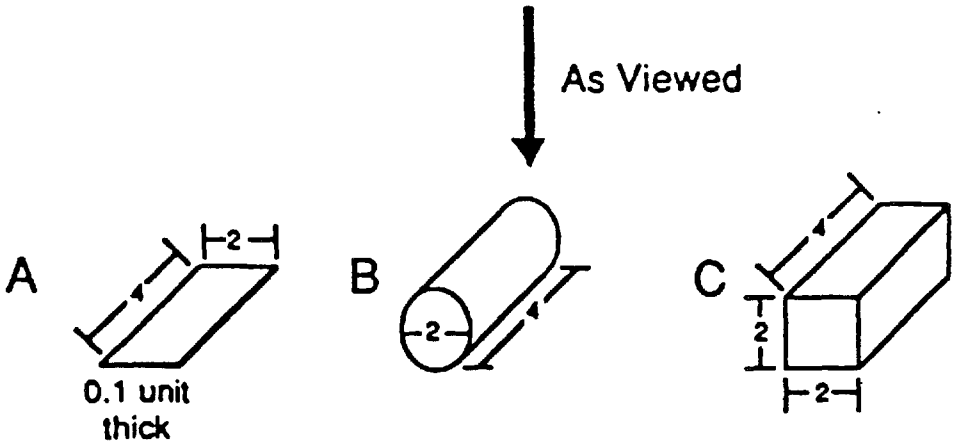
Figure C1. Relationship between volume % and weight % of chrysotile mixed with a)vermiculite and b) cellulose.

C4.2 Microscopical Analysis (PLM)

The polarized light microscope may be used to quantify asbestos and other components of a sample. Slide mounts are prepared from "pinch" samples of the calibration material and asbestos content is determined by visual area estimate and/or point counting. Both of these quantitation techniques are in fact estimates or measurements of the relative projected areas of particles as viewed in two dimensions on a microscope slide. For quantitation results to be meaningful, the following conditions should be met:

- The sample should be homogeneous for slide preparations, which are made from small pinches of the sample, to be representative of the total sample.
- Slide preparation should have an even distribution of particles and approach a one particle thickness (seldom achieved) to avoid particle overlap.
- All materials used should be identified and specific gravities determined in order to relate area percent to volume and/or weight percent.
- The size (thickness) relationship between matrix particles and asbestos fibers should be determined if the results based on projected area are to be related to volume and/or weight percent.

Particle characteristics can greatly affect the quantitation results obtained by visual area estimation or point counting. Figure C2 illustrates three hypothetical particle shapes of identical length and width (as viewed from above). Although the three-dimensional shape is different, the projected area is equal for all particles. The table accompanying Figure C2 presents data for each particle in terms of thickness, volume and projected area. It should be noted that although the projected areas may be equal, the volumes represented by the particles may vary by a factor of 20(0.8 vs 16 cubic units). It is obvious that quantitation of a sample consisting of a mixture of particles with widely ranging particle thicknesses could result in different results. For example, if a sample contained relatively thick bundles of asbestos and a fine-grained matrix such as clay or calcium carbonate, the true asbestos content (by volume) would likely be underestimated. Conversely, if a sample contained thick "books" of mica and thin bundles of asbestos, the asbestos content (by volume) would likely be overestimated.



Particle	Thickness	Volume	Projected Area
A	0.1 units	0.8 cubic units	8 sq. units
B	2 units	12.6 cubic units	8 sq. units
C	2 units	16 cubic units	8 sq. units

Note that although all particles have the same projected area, particle C volume is 20x that of particle A.

Figure C2. Relationship of projected area to volume and thickness for three different particles as viewed on a slide mount.

Table C2 illustrates several examples of expected results from area estimates or point counting of samples in which the asbestos fibers and matrix particles differ in thickness.

TABLE C2. RELATIONSHIP OF WEIGHT PERCENT, VOLUME PERCENT AND PARTICLE THICKNESS TO QUANTITATION RESULTS

Composition of Sample In Wt. %	Theoretical Vol. % Asbestos	Thickness Factor* (Matrix/Asbestos)	Expected Area %
1% Amosite 99% Calcium Carbonate	0.9	0.5	0.4
1% Amosite 99% Calcium Carbonate	0.9	1	0.9
1% Amosite 99% Calcium Carbonate	0.9	2	1.8
1% Amosite 99% Vermiculite	0.1	1	0.1
1% Amosite 99% Vermiculite	0.1	10	1.0
1% Amosite 99% Vermiculite	0.1	20	2.0
1% Amosite 99% Vermiculite	0.1	30	2.9

* Value represents the relationship between the mean thickness of the matrix particles compared to the mean thickness of the asbestos particles.

It should be noted that it is not uncommon for matrix particle thickness to differ greatly from asbestos fiber thickness, especially with matrix materials such as vermiculite and perlite; vermiculite and perlite particles may be 20 - 30 times as thick as the asbestos fibers.

The general size relationships between matrix particles and asbestos fibers may be determined by scanning slide mounts of a sample. A micrometer ocular enables the microscopist to actually measure particle sizes.

If a thickness factor can be determined for a calibration sample of known volume proportions of asbestos and matrix materials, an expected equivalent projected area asbestos can be calculated using the following formula:

$$\frac{Va}{\frac{Vm}{T} + Va} \times 100 = Aa$$

where:

Va	=	true volume percent asbestos
Vm	=	true volume percent matrix
T	=	thickness factor (mean size matrix particle/mean size asbestos fiber)
Aa	=	expected projected area percent asbestos

Example: A calibration standard of known weight percent asbestos is determined, by factoring in component specific gravities, to be 5.0% asbestos by volume. The matrix particles are estimated to be ten times thicker than the asbestos fibers. What would be the expected projected area percentage of asbestos?

$$Va = 5\% \quad Vm = 95\% \quad T = 10 \qquad Aa = \frac{5}{\frac{95}{10} + 5} \times 100 = 34.5\%$$

Conversely, to convert projected area percent asbestos to equivalent volume percent, the following formula may be used:

$$\frac{Aa}{T(Am) + Aa} \times 100 = Va$$

Where: Am = projected area matrix

Example: A slide containing a subsample of an amosite/mineral wool calibration standard is determined by point counting to have a projected area asbestos of 18.6%. If the mineral wool fibers are estimated to be six times the asbestos fibers, in diameter, what is the equivalent volume percent asbestos?

$$Am = 81.4\%$$
$$Aa = 18.6\%$$
$$T = 6$$
$$Va = \frac{(18.6)}{6(81.4) + 18.6} \times 100 = 3.67\%$$

Based on specific gravity values listed in Table 1C and on the above volume asbestos determination, what is the equivalent weight percent asbestos in the sample?

$$Va = 3.67\%$$
$$Ga = 3.2$$
$$Vm = 96.33\%$$
$$Gm = 2.5$$
$$Wa = \frac{(3.67)(3.2)}{(3.67)(3.2) + (96.33)(2.5)} \times 100 = 4.7\%$$

C5.0 USE OF CALIBRATION STANDARDS FOR QA/QC

Once the materials have been formulated and thoroughly characterized by all techniques to determine their suitability as calibration standards, a system for incorporating them into the QA/QC program should be established. Someone should be designated (QA officer, lab supervisor, etc.) to control the distribution of standards and to monitor the analysis results of the microscopists. Both precision and accuracy may be monitored with the use of suitable standard sets.

Records such as range charts, control charts, etc. may be maintained for volume (stereomicroscopic estimates), area (PLM) estimates and point counts. For point counts and area estimates, relatively permanent slides may be made using epoxy or Melt Mount *. Such slides may be very accurately quantified over time as to point count values, and due to their very long shelf life, may be used for QA/QC purposes almost indefinitely.

C6.0 REFERENCES

1. "Analysis Summaries for Samples used in NIST Proficiency Testing", National Institute of Standards and Technology (NIST) National Voluntary Laboratory Accreditation Program (NVLAP) for Bulk Asbestos, January 1989 to present.

2. Harvey, B. W., R. L. Perkins, J. G. Nickerson, A. J. Newland and M. E. Beard, "Formulating Bulk Asbestos Standards", **Asbestos Issues**, April 1991.

3. Perkins, R. L. and M. E. Beard, "Estimating Asbestos Content of Bulk Materials", **National Asbestos Council Journal**, Vol. 9, No. 1, 1991, pp. 27-31.

4. **Asbestos Content in Bulk Insulation Samples: Visual Estimates and Weight Composition**, U.S. Environmental Protection Agency 560/5-88-011, 1988.

APPENDIX D

Special-Case Building Materials

Asbestos laboratories are now called upon to analyze many types of bulk building materials that are very difficult to characterize by routine PLM analysis. These materials are dominantly nonfriable and can be grouped into the following categories:

- Cementitious Products (pipe, sheeting, etc.)
- Viscous Matrix Products (adhesives, cements, coatings, etc.)
- Vinyl Materials (vinyl floor tile, sheeting)
- Asphaltic Roofing Materials (shingles, roll roofing)
- Miscellaneous Products (paints, coatings, friction plates, gaskets, etc.)

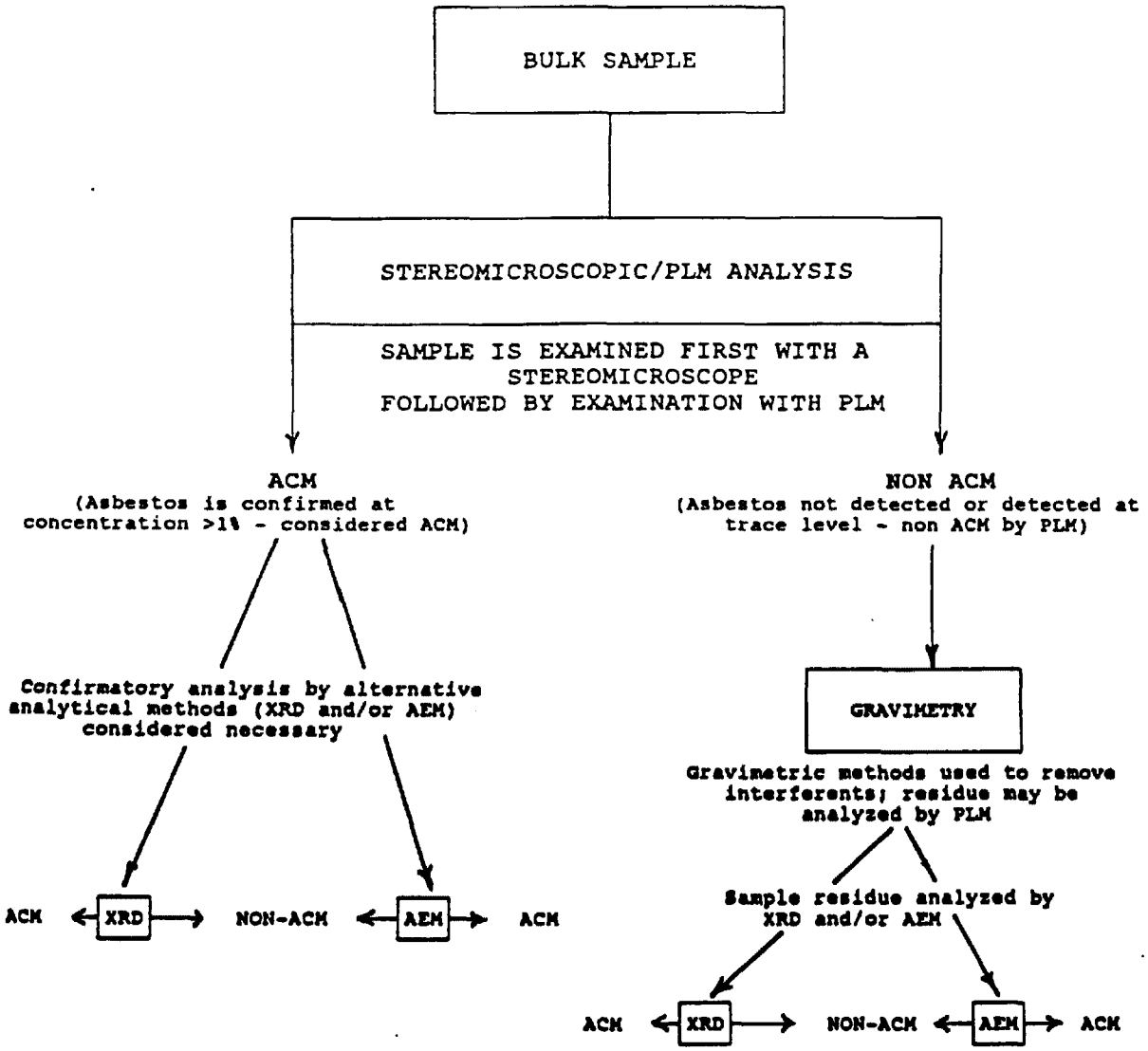
Materials characterized by interfering binder/matrix, low asbestos content, and/or small fiber size may require that additional sample treatment(s) and analysis be performed beyond routine PLM analysis. The sample treatment(s) required is(are) determined by the dominant nonasbestos sample components (see Section 2.3, Gravimetry). Materials containing an appreciable amount of calcareous material may be treated by dissolution with hydrochloric acid. Samples containing organic binders such as vinyl, plasticizers, esters, asphalts, etc. can be treated with organic solvents or ashed in a muffle furnace (preferred method) or low temperature plasma asher to remove unwanted components. Materials containing cellulose, synthetic organic fibers, textiles, etc. may also be ashed in a muffle furnace or low temperature plasma asher.

The method chosen for analysis of a sample after treatment is dependent on asbestos concentration and/or fiber size. An examination of the sample residue by PLM may disclose asbestos if the fibers are large enough to be resolved by the microscope, but additional analytical methods are required if the sample appears negative. Analysis by XRD is not fiber-size dependent, but may be limited by low concentration of asbestos and the presence of interfering mineral phases. In addition, the XRD method does not differentiate between fibrous and nonfibrous varieties of a mineral. Analysis by AEM is capable of providing positive identification of asbestos type(s) and semi-quantitation of asbestos content.

The following flowchart illustrates a possible scheme for the analysis of special-case building materials.

NOTE: Preliminary studies indicate that the XRD method is capable of detecting serpentine (chrysotile) in floor tile samples without extensive sample preparation prior to XRD analysis. XRD analysis of small, intact sections of floor tile yielded diffraction patterns that confirmed the presence of serpentine, even at concentrations of ~one percent by weight. TEM analysis of these same tiles confirmed the presence of chrysotile asbestos. With further investigation, this method may prove applicable to other types of nonfriable materials.

FLOWCHART FOR QUALITATIVE ANALYSIS OF SPECIAL CASE BUILDING MATERIALS SUCH AS FLOOR TILES, ASPHALTIC MATERIALS, VISCOUS MATRIX MATERIALS, ETC.*



*Although this flowchart is applicable to all bulk materials, it is primarily intended to be used with known problem materials that are difficult to analyze by PLM due to low asbestos concentration, and/or small fiber size, and/or interfering binder/matrix. In addition to being qualitative, the results may also be semi-quantitative. It should not be assumed that all samples need to be analyzed by AEM and XRD. The flowchart simply illustrates options for methods of analysis. Alternate methods such as SEM may be applicable to some bulk materials.

*U.S GOVERNMENT PRINTING OFFICE 1993 -750 -002/80237

ITEM 2

Asbestos/NESHAP Regulated Asbestos Containing Material

United States
Environmental Protection
Agency

EPA 340/1-90-018
December 1990

Air and Radiation (EN4341W)

EPA

Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance

ASBESTOS

EPA 340/1-90-018

ASBESTOS NESHAP
REGULATED ASBESTOS CONTAINING MATERIALS GUIDANCE

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Quality Planning and Standards
Stationary Source Compliance Division
Washington, DC 20460

December, 1990

CONTENTS

Section		Page
1.	INTRODUCTION	6
2.	FRIABLE ASBESTOS-CONTAINING MATERIALS	8
3.	NON-FRIABLE ASBESTOS-CONTAINING MATERIALS	9
	• Category I Nonfriable ACM	10
	• Category II Nonfriable ACM	11
4.	INSPECTION PROCEDURES TO DETERMINE THE POTENTIAL FOR FIBER RELEASE FROM NONFRIABLE ASBESTOS-CONTAINING MATERIALS	13
	• Friability Determination Decision Trees	14
	• General Inspection Procedures	16
	• Specific Inspection Procedures	17
	• Category I Nonfriable ACM	17
	• Category II Nonfriable ACM	19

APPENDICES

A	Asbestos NESHAP Coordinators (For Demolition/Renovation Activities)	A - 1
B	Regional Asbestos Coordinators (For Schools)	B-1

ACKNOWLEDGEMENTS

This document was written by Alliance Technologies, Inc., based on discussions with a work group from EPA. The group consisted of the Regional Asbestos NESHAP Coordinators, Ron Shafer, Scott Throwe, and Omayra Salgado of the Stationary Source Compliance Division, Charles Garlow and Elise Hoerath of the Air Enforcement Division and Sims Roy of the Standards Development Branch. We thank the individuals who reviewed an earlier draft and provided comments, many of which are incorporated in the final version. Their input is gratefully acknowledged.

1. INTRODUCTION

Section 112 of the Clean Air Act (CAA) requires EPA to develop emission standards for hazardous air pollutants. In response to this section the Environmental Protection Agency (EPA) published a list of hazardous air pollutants and promulgated the "National Emission Standards for Hazardous Air Pollutants" (NESHAP) regulations. Since asbestos presents a significant risk to human health as a result of air emissions from one or more source categories, it is therefore considered a hazardous air pollutant. The Asbestos NESHAP (40 CFR 61, Subpart M) addresses milling, manufacturing and fabricating operations, demolition and renovation activities, waste disposal issues, active and inactive waste disposal sites and asbestos conversion processes.

In the initial Asbestos NESHAP rule promulgated in 1973, a distinction was made between building materials that would readily release asbestos fibers when damaged or disturbed and those materials that were unlikely to result in significant fiber release.. The terms "friable" and "non-friable" were used to make this distinction. EPA has since determined that, if severely damaged, otherwise nonfriable materials can release significant amounts of asbestos fibers.

Friable asbestos-containing material (ACM), is defined by the Asbestos NESHAP, as any material containing more than 1 percent asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR Part 763, Section 1, Polarized Light Microscopy (PLM), that, when dry, can be crumbled, pulverized or reduced to powder by hand pressure. (Sec. 61.141)

Nonfriable ACM is any material containing more than 1 percent asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR Part 763, Section 1, Polarized Light Microscopy

(PLM), that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure. EPA also defines two categories of nonfriable ACM, Category I and Category II nonfriable ACM, which are described later in this guidance.

"Regulated Asbestos-Containing Material" (RACM) is (a) friable asbestos material, (b) Category I nonfriable ACM that has become friable, (c) Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting or abrading, or (d) Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations.

The purpose of this document is to assist asbestos inspectors and the regulated community in determining whether or not a material is RACM and thus subject to the Asbestos NESHAP.

The recommendations made in this guidance are solely recommendations. They are not the exclusive means of complying with the Asbestos NESHAP requirements. Following these recommendations is not a guarantee against findings of violation. The EPA intends for owners/operators to be reasonably certain whether or not they are subject to the NESHAP. In the end, if a question arises, determinations of whether asbestos containing materials are regulated by the Asbestos NESHAP are made by EPA inspectors on site.

2. FRIABLE ASBESTOS CONTAINING-MATERIALS

Due to their high tensile strength, incombustibility, corrosion and friction resistance and other properties, such as acoustical and thermal insulation abilities, asbestos fibers have been incorporated into over 3600 commercial products. Thermal system, fireproofing and acoustical insulation materials have been used extensively in the construction industry.

Thermal system applications include steam or hot water pipe coverings and thermal block insulation found on boilers and hot water tanks. Fireproofing insulation may be found on building structural beams and decking. Acoustical insulation (soundproofing) commonly has been applied as a troweled-on plaster in school and office building stairwells and hallways. Unfortunately, with time and exposure to damaging forces (e.g., severe weather, chemicals, mechanical forces, etc.), many asbestos- containing materials may become crumbled, pulverized or reduced to powder, thereby releasing asbestos fibers, or may deteriorate to the extent that they may release fibers if disturbed. Since inhalation of asbestos fibers has been linked to the development of respiratory and other diseases, any material which is friable, or has a high probability of releasing fibers, must be handled in accordance with the Asbestos NESHAP.

The following work practices should be followed whenever demolition/renovation activities involving RACM occur:

- notify EPA of intention to demolish/renovate,
- remove all RACM from a facility being demolished or renovated before any disruptive activity begins or before access to the material is precluded,

- keep RACM adequately wet before, during, and after removal operation,

- conduct demolition/renovation activities in a manner which produces no visible emissions to the outside air, and

- handle and dispose of all RACM in an approved manner.

3. NONFRIABLE ASBESTOS-CONTAINING MATERIALS

Because of the resilient nature of asbestos, it is used in materials exposed to a wide variety of stressful environments. These environments can cause the deterioration of binding materials and cause nonfriable materials to become friable. For example, asbestos-containing packings and gaskets (Category I nonfriable ACM) used in thermal systems may be found in poor condition as a result of the heat they have encountered. In petrochemical handling facilities, which may have miles of transfer pipes and fittings which contain asbestos gaskets and/or packings, profound degradation of the ACM may occur due to exposure to organic-based liquids and gases or to corrosive agents used to chemically clean these lines.

When nonfriable ACM is subjected to intense mechanical forces, such as those encountered during demolition or renovation, it can be crumbled, pulverized, or reduced to powder, and thereby release asbestos fibers. When nonfriable materials are damaged or are likely to become damaged during such activities, they must be handled in accordance with the Asbestos NESHAP.

There are two categories of nonfriable materials: Category I Nonfriable ACM and Category II Nonfriable ACM.

CATEGORY I NONFRIABLE ACM

Category I nonfriable ACM is any asbestos-containing packing, gasket, resilient floor covering or asphalt roofing product which contains more than 1 percent asbestos as determined using polarized light microscopy (PLM) according to the method specified in Appendix A, Subpart F, 40 CFR Part 763. (Sec. 61. 141)

Category I nonfriable ACM must be inspected and tested for friability if it is in poor condition before demolition to determine whether or not it is subject to the Asbestos NESHAP. If the ACM is friable, it must be handled in accordance with the NESHAP. Asbestos-containing packings, gaskets, resilient floor coverings and asphalt roofing materials must be removed before demolition *only if* they are in poor condition and are friable.

The Asbestos NESHAP further requires that if a facility is demolished by intentional burning, all of the facility's ACM, including Category I and II nonfriable ACM, be considered RACM and be removed prior to burning (Sec. 61.145 (c)(10)). Additionally, if Category I or Category II nonfriable ACM is to be sanded, ground, cut, or abraded, the material is considered RACM and the owner or operator must abide by the following (Sec. 61.145 (c)(1)):

(i) Adequately wet the material during the sanding, grinding, cutting, or abrading operations.

(ii) Comply with the requirements of 61.145(c)(3)(i) if wetting would unavoidably damage equipment or present a safety hazard.

(iii) Handle asbestos material produced by the sanding, grinding, cutting, or abrading, as asbestos-containing waste material subject to the waste handling and collection provisions of Section 61.150.

CATEGORY II NONFRIABLE ACM

Category II nonfriable ACM is any material, excluding Category I nonfriable ACM, containing more than 1 percent asbestos as determined using polarized light microscopy according to the methods specified in Appendix A, Subpart F, 40 CFR Part 763 that, when dry, *cannot* be crumbled, pulverized, or reduced to powder by hand pressure. (Sec. 61.141)

Category II nonfriable ACMs (cement siding, transite board shingles, etc.) subjected to intense weather conditions such as thunderstorms, high winds or prolonged exposure to high heat and humidity may become "weathered" to a point where they become friable. The photograph in Figure 1 demonstrates a split asbestos shingle that has become friable along the cracked edge.

The following table lists examples and other relevant information about Category I and Category II nonfriable ACM.

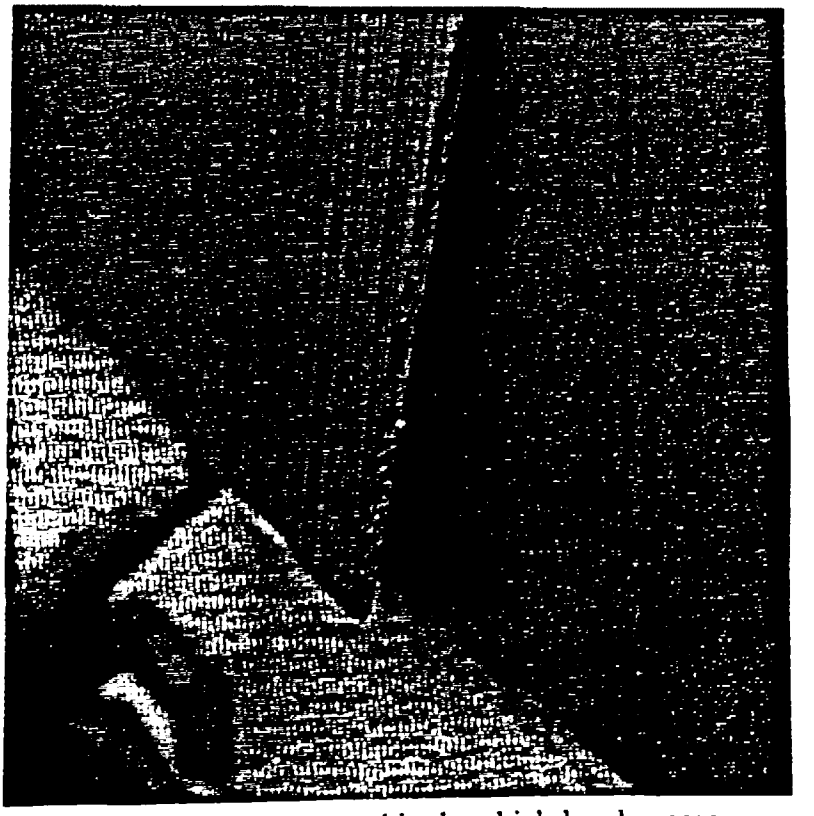


Figure 1. Nonfriable asbestos shingle which has become friable along the broken axis.

TABLE 1. NONFRIABLE ASBESTOS PRODUCTS

Subdivision Generic name		Asbestos (%)	Binder/sizing
Cementitious extrusion panels:		8	portland cement
concrete-like products	corrugated	20-45	portland cement
(Category II)	flat	40-50	portland cement
	flexible	30-50	portland cement
	flexible perforated	30-50	portland cement
	laminated (outer surface)	35-50	portland cement
	roof tiles	20-30	portland cement
	clapboard and shingles:		
	clapboard	12-15	portland cement
	siding shingles	12-14	portland cement
	roofing shingles	20-32	portland cement
	pipe	20-15	portland cement
Roofing felts	smooth surface	10-15	asphalt
(Category I)	mineral surface	10-15	asphalt
	shingles	1	asphalt
	pipeline	10	asphalt
Asbestos-containing	caulking putties	30	linseed oil
compounds	adhesive (cold applied)	5-25	asphalt
(Category I and II)	roofing asphalt	5	asphalt
	mastics	5-25	asphalt
	asphalt tile cement	13-25	asphalt
	roof putty	10-25	asphalt
	plaster/stucco	2-10	portland cement
	sealants fire/water	50-55	castor oil or polyisobuxylene
	cement, insulation	20-100	clay
	cement, finishing	85	clay
	cement, magnesia	15	magnesium carbonate
Asbestos ebony products		80	portland cement
Floor tile and vinyl/asbestos tile		21	poly(vinyl)chloride
Sheet goods asphalt/asbestos tile		25-33	asphalt
sheet goods/resilient		30	dry oils

From EPA Guidance entitled "Guidance for Controlling Asbestos-Containing Materials in Buildings" (Purple Book), Appendix A, Page A-1; EPA 560/5-85-024.

Except for the following, Section 61.145(c) of the Asbestos NESHAP requires that each owner or operator of a demolition or renovation activity involving RACM remove all such material from a facility being demolished or renovated before any activity begins that would break up, dislodge, or similarly disturb the material or preclude access to the material for subsequent removal.

ACM *need not be removed* before demolition if it:

(i) Is a Category I nonfriable ACM that is not friable.

(ii) Is on a facility component that is encased in concrete or other similarly hard material and is adequately wet whenever exposed during demolition.

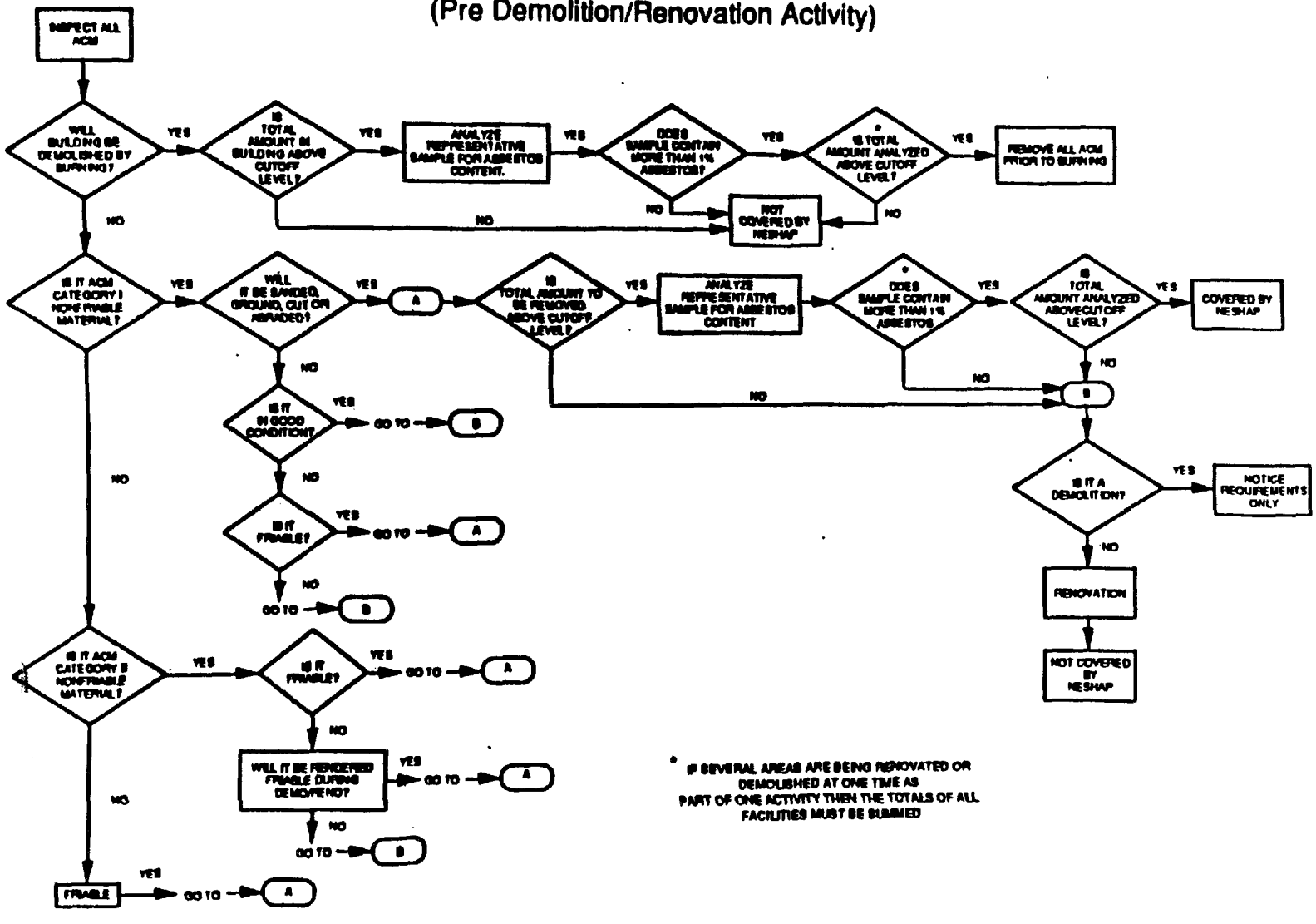
(iii) Was not accessible for testing and therefore was not discovered until after demolition began and, as a result of the demolition, cannot be safely removed. If not removed for safety reasons, the exposed RACM and any asbestos-contaminated debris must be treated as asbestos-containing waste material and kept adequately wet at all times until disposed of.

(iv) Is a Category II nonfriable ACM and the probability is low that the material will become crumbled, pulverized, or reduced to powder during demolition.

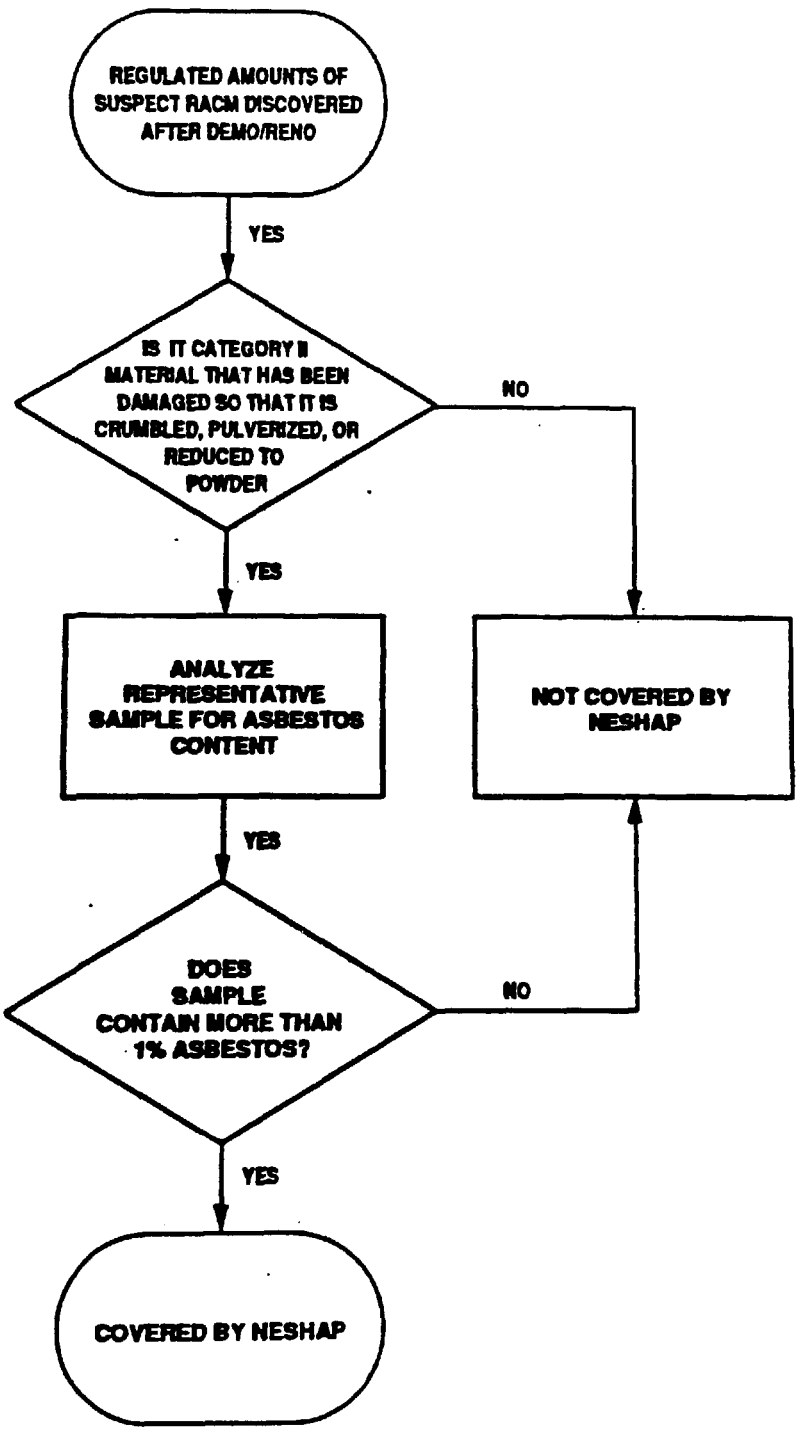
4. INSPECTION PROCEDURES TO DETERMINE THE POTENTIAL FOR FIBER RELEASE FROM NONFRIABLE ASBESTOS-CONTAINING MATERIALS

Members of the regulated community (i.e. abatement contractors, industrial hygienists, building owners & operators, etc.) should become familiar with these procedures as they are designed to enhance compliance with the Asbestos NESHAP.

Asbestos NESHAP RACM Decision Tree
(Pre Demolition/Renovation Activity)



Asbestos NESHAP RACM Decision Tree
(Post Demolition/Renovation Activity)



GENERAL INSPECTION PROCEDURES

1. Identify all nonfriable suspect ACM and determine whether it is Category I or II.

2. If it is Category I nonfriable RACM:

   - Is it in "poor condition?"
     [Is the binding of the ACM losing its integrity? Is the ACM peeling, cracking, or crumbling? (Remember, friable ACM may not appear in poor condition.)]

   - Is it friable?

     - Collect a piece of dry ACM and seal it in a transparent, reclosable sample bag.

     - Apply hand pressure and observe if the ACM falls apart to the extent that it is crumbled, pulverized, or reduced to powder. Does it occur suddenly, all at once?

     - Send representative samples of the RACM to an analytical laboratory which is able to test them for the presence of asbestos according to the methods specified in 40 CFR Part 763 Subpart F, Appendix A.

     - Ask the owner/operator if any ACM or RACM has been sampled and analyzed. If so, determine where the samples were taken and ask if the methods of demolition/ renovation were considered when assessing

the fiber release potential of the material.- Will it or has it been subjected to sanding, grinding, cutting or abrading?

3. If it is Category II nonfriable ACM:

- Has the material been crumbled, pulverized or reduced to powder or is there a high probability that it will be crumbled, pulverized or reduced to powder during the demolition/renovation operations, thus rendering the material friable and subject to the Asbestos NESHAP?

- If Category II nonfriable ACM has been or will be crumbled, pulverized, or reduced to powder by demolition or renovation forces, take representative samples and send them to a laboratory to test for the presence of asbestos according to the method specified in 40 CFR Part 763, Subpart F, Appendix A.

5. SPECIFIC INSPECTION PROCEDURES

Category I Nonfriable ACM

Packings and Gaskets

These materials are often very difficult to find because they are usually placed inside ovens, doors, pipes, boilers, etc.
Often a packing or gasket is discovered during a stripping or demolition activity. For example, some boilers have an asbestos-containing paraffin wax packing between the steam lines that travel between the mud and fire boxes. The paraffin binding of the packing may decompose due to the high temperatures, and render the packing friable. Observe all of the packing and note areas that are in poor condition. Packings in poor condition appear dry and

discolored, and fibers may be visible.

A representative piece of asbestos-containing packing material (in good or poor condition) should be removed with a utility knife and sealed in a transparent, reclosable bag. Apply hand pressure to the packing in the sample bag to determine if any portion is crumbled, pulverized or reduced to powder. If the material simply deforms, but does not crumble or reduces to a powder, then the material is considered nonfriable.

Resilient Floor Covering

There is a wide variety of resilient floor covering applications that contain asbestos. The most common are linoleum flooring and vinyl asbestos tile (VAT). VAT is most commonly found in either a 9"x9" or a 12"x12" square size. The 9"x9" VAT's are normally found in older buildings because they were manufactured earlier than the 12"x12" VAT's; however, floor tile sizes and resilient floor covering applications vary greatly since many buildings have been re-tiled several times.

In order to determine if a resilient floor covering is in poor condition look for sections or tiles which are cracked or peeling to the extent that they are crumbled. Floor coverings in poor condition can often be found near doorways or loading/staging areas where the floor has sustained a lot of stress and traffic. If the floor covering is in poor condition, collect a small representative sample and seal it in a transparent, sample bag. Hand pressure should be applied to determine if the material can be crumbled, pulverized, or reduced to powder. If it can, the material is considered friable. Resilient floor covering that will be or has been sanded, ground or abraded is subject to the Asbestos NESHAP. Figure 2 depicts a VAT which is in poor condition.

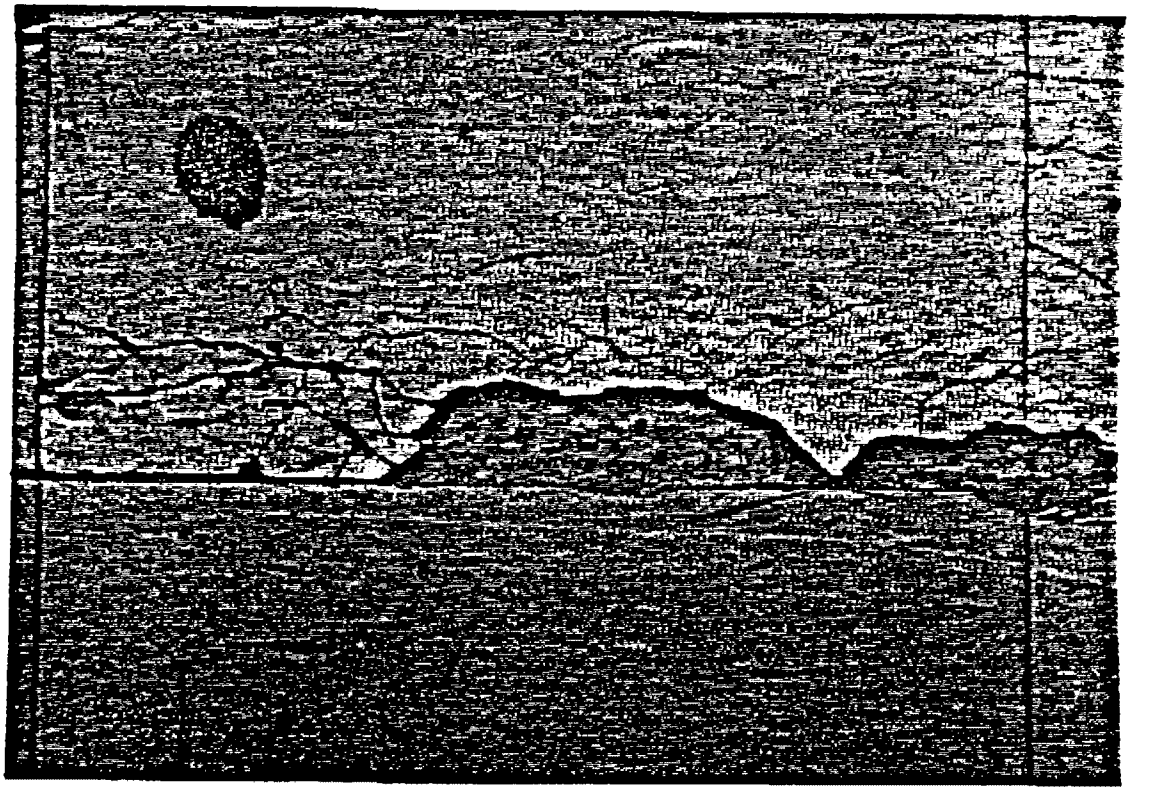


Figure 2. VAT in poor condition

Asphalt Roofing Products

Asbestos-containing roofing felts have been widely used in "built-up" roofs. Built-up roofing was used on flat surfaces and consists of alternating layers of roofing felt and asphalt. The roofing felt consists of asbestos paper saturated and coated with asphalt. Asphalt-asbestos roofing products made from roofing felt coated with asphalt were reportedly used on residential structures for only a short time (1971-1974).

To determine if an asphalt roofing product is covered by the Asbestos NESHAP, examine the RACM to spot any areas where the material is in poor condition and friable. Figure 3 illustrates a section of roofing felts which have deteriorated and display fibers.

If possible, sample areas where fibers can be seen protruding from the matrix of the asphalt. The sample should be sealed into a transparent, reclosable sample bag and hand pressure applied to see if the sample can be crumbled, pulverized, or reduced to powder

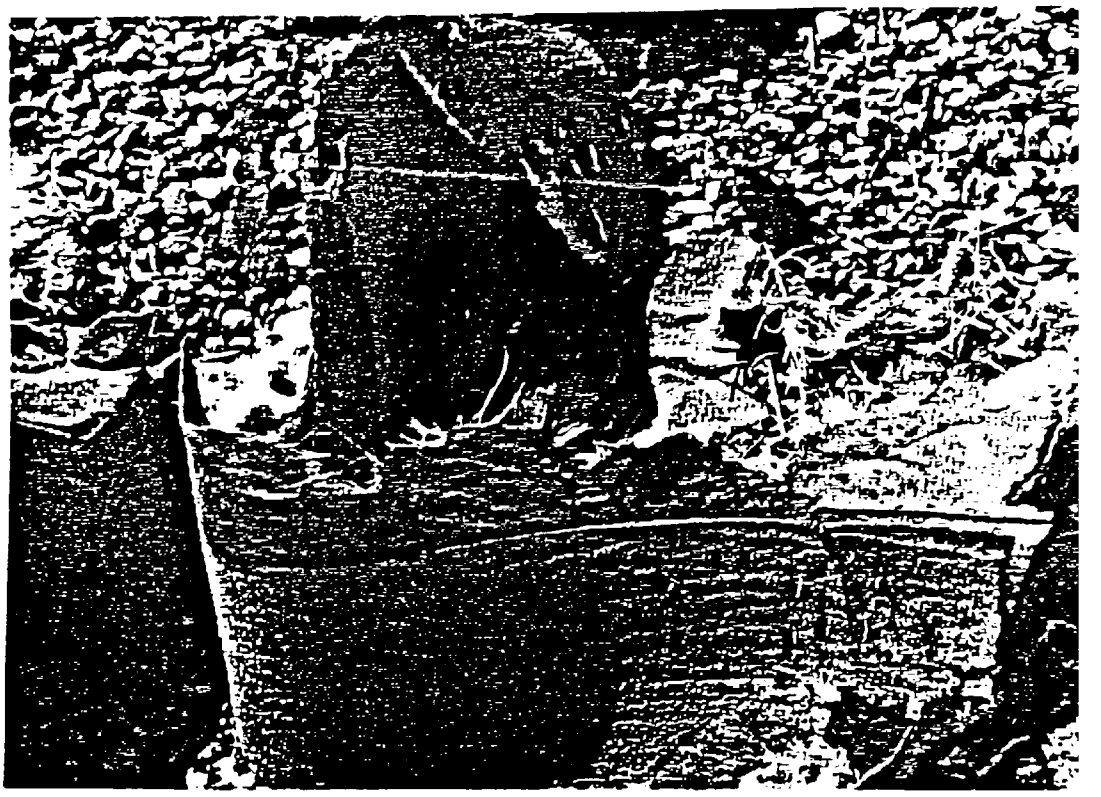


Figure 3. Asphalt roofing felts which are in poor condition. Notice the fibers protruding along the edge of this roofing felt.

Category II Nonfriable ACM

Asbestos Cement Pipe and Sheet Products

Asbestos-cement (A-C) pipe has been widely used for water and sewer mains and occasionally used as electrical conduits, drainage pipe, and vent pipes. A-C sheet, manufactured in flat or corrugated panels and shingles (transite board), has been used primarily for roofing and siding, but also for cooling tower fill sheets, canal bulkheads, laboratory tables, and electrical switching gear panels. If these ACM are crumbled, pulverized or reduced to a powder, they are friable and thus covered by the Asbestos NESHAP. Broken edges of these materials typically are friable. The fractured surface should be rubbed to see if it produces powder.

If Category II nonfriable ACM has not crumbled, been pulverized or reduced to powder and will not become so during the course of demolition/renovation operations, it is considered nonfriable and therefore is not subject to the Asbestos NESHAP. However, if during the demolition or renovation activity it becomes crumbled, pulverized or reduced to powder, it is covered by the Asbestos NESHAP.

APPENDIX A

ASBESTOS NESHAP COORDINATORS (FOR DEMOLITION/RENOVATION ACTIVITIES

Asbestos NESHAP Coordinator
Air Management Division
U.S. EPA Region I
JFK Federal Building
Boston, MA 02203
(617) 565-3265
CT, MA, ME, NH, RI, VT

Asbestos NESHAP Coordinator
Air & Waste Management Division
U.S. EPA Region II
26 Federal Plaza
New York, NY 10278
(212) 264-6770
NJ, NY, PR, VI

Asbestos NESHAP Coordinator
Air Management Division
U.S. EPA Region III
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-6550
DC, DE, MD, PA, VA, WV

Asbestos NESHAP Coordinator
Air Management Division
U.S. EPA Region IV
345 Courtland Street, N.E.
Atlanta, GA 30365
(404) 347-5014
AL, FL, GA, KY, MS, NC, SC, TN

Asbestos NESHAP Coordinator
Air Management Division
U.S. EPA Region V
230 South Dearborn Street
Chicago, IL 60604
(312) 886-6819
IL, IN, MI, MN, OH, WI

Asbestos NESHAP Coordinator
Air, Pesticides & Toxics Division
U.S. EPA Region VI
1445 Ross Avenue
Dallas, TX 75202-2733
(214) 655-7223
AR, LA, NM, OK, TX

Asbestos NESHAP Coordinator
Air & Toxics Management Division
U.S. EPA Region VII
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7618
IA, KS, MO, NE

Asbestos NESHAP Coordinator
Air & Toxics Division
U.S. EPA Region VIII
999 18th Street
Suite 500
Denver, CO 80202-2405
(303) 293-7685
CO, MT, ND, SD, UT, WY

Asbestos NESHAP Coordinator
Air and Toxics Division
U.S. EPA Region IX
75 Hawthorne Street
San Francisco, CA 94105
(415) 774-5569
American Samoa, AZ, CA, Guam, HI
Northern Marianas, Trust Territories

Asbestos NESHAP Coordinator
Air & Toxics Management Division
U.S. EPA Region X
1200 Sixth Avenue
Seattle, WA 98101
(205) 442-1757
AK, ID, OR, WA

APPENDIX B

REGIONAL ASBESTOS COORDINATORS (FOR SCHOOLS)

Regional Asbestos Coordinator
U.S. EPA Region I
JFK Federal Building
Boston, MA 02203
(617) 565-3835
CT, MA, ME, NH, RI, VT

Regional Asbestos Coordinator
U.S. EPA Region II
Woodbridge Avenue
Raritan Depot, Building 5
Edison, NJ 08837
(201) 321-6671
NJ, NY, PR, VI

Regional Asbestos Coordinator
U.S. EPA Region III
841 Chestnut Building
Philadelphia, PA 19107
(215) 597-3160
DC, DE, MD, PA, VA, WV

Regional Asbestos Coordinator
U.S. EPA Region IV
345 Courtland St. N.E.
Atlanta, GA 30365
(404) 347-5014
AL, FL, GA, KY, MS, NC, SC, TN

Regional Asbestos Coordinator
U.S. EPA Region V
230 South Dearborn Street
Chicago, IL 60604
(312) 886-6003
IL, IN, MI, MN, OH, WI

Regional Asbestos Coordinator
U.S. EPA Region VI
1445 Ross Avenue
Dallas, TX 75202-2733
(214) 655-7244
AR, IA, NM, OK, TX

Regional Asbestos Coordinator
U.S. EPA Region VII
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7020
IA, KS, MO, NE

Regional Asbestos Coordinator
U.S. EPA Region VIII
1 Denver Place
999 18th Street
Suite 500
Denver, CO 80202-2413
(303) 293-1442
CO, MT, ND, SD, UT, WY

Regional Asbestos Coordinator
U.S. EPA Region IX
75 Hawthorne Street
San Francisco, CA 94105
(415) 556-5406
American Samoa, AZ, CA Guam,
Northern Marianas, Trust Territories

Regional Asbestos Coordinator
U.S. EPA Region IV
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-4762
AK, ID, OR, WA

ITEM 3

Asbestos/NESHAP Adequately Wet Guidance

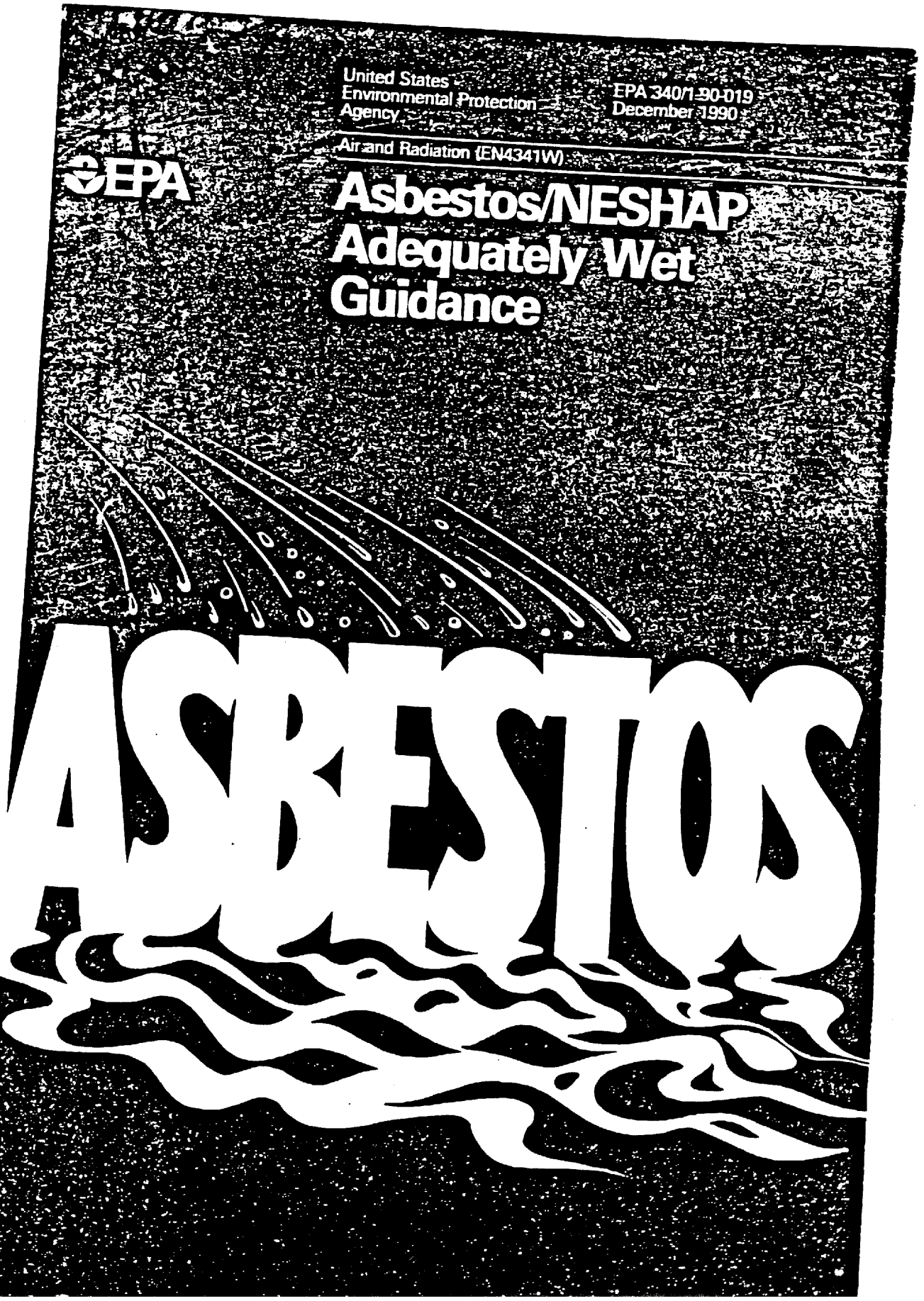
United States
Environmental Protection
Agency

EPA 340/1-90-019
December 1990

Air and Radiation (EN4341W)

EPA

Asbestos/NESHAP Adequately Wet Guidance



EPA340/1-90-019

ASBESTOS NESHAP

ADEQUATELY WET GUIDANCE

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and
Standards
Stationary Source Compliance Division
Washington, DC 20460

December 1990

CONTENTS

Section		Page
1	INTRODUCTION	1
2	IMPORTANT TERMS	2
	• Adequately Wet	2
	• Friable Asbestos Material	3
	• Nonfriable Asbestos-containing Materials	3
3	FRIABLE AND NONFRIABLE ASBESTOS CONTAINING MATERIALS	4
4	REQUIREMENTS FOR ADEQUATELY WETTING ASBESTOS-CONTAINING MATERIALS	5
5	EXCEPTIONS TO ADEQUATELY WETTING ASBESTOS-CONTAINING MATERIALS	9
6	TECHNIQUES FOR WETTING ASBESTOS-CONTAINING MATERIALS	11
	• General Information	11
7	PROCEDURES FOR WETTING ASBESTOS-CONTAINING MATERIALS	12
	• Thermal System Insulation	12
	• Asbestos-Containing Surfacing Materials	18
	• Miscellaneous Asbestos-Containing Materials	18
8	INSPECTION PROCEDURES	21

Appendices

A	Asbestos NESHAP Coordinators (for Demolition/Renovation Activities)	A-1
B	Regional Asbestos Coordinators (for Schools)	B-1

ACKNOWLEDGEMENTS

This document was written by Alliance Technologies, Inc., based on discussions with a work group from EPA. The group consisted of the Regional Asbestos NESHAP Coordinators, Ron Shafer, Scott Throwe, and Omayra Salgado of the Stationary Source Compliance Division, Charles Garlow and Elise Hoerath of the Air Enforcement Division and Sims Roy of the Standards Development Branch. We thank the individuals who reviewed an earlier draft and provided comments, many of which are incorporated in the final version. Their input is gratefully acknowledged.

1. INTRODUCTION

The Clean Air Act (CAA) of 1970 requires the U.S. Environmental Protection Agency (EPA) to develop and enforce regulations to protect the general public from exposure to airborne contaminants that are known to be hazardous to human health. In accordance with Section 112 of the CAA, EPA established National Emissions Standards for Hazardous Air Pollutants (NESHAP) to protect the public. Asbestos was one of the first hazardous air pollutants regulated under Section 112. The Asbestos NESHAP (40 CFR 61, Subpart M) addresses milling, manufacturing and fabricating operations, demolition and renovation activities, waste disposal issues, active and inactive waste disposal sites and asbestos conversion processes.

The Asbestos NESHAP requires facility owners and/or operators involved in demolition and renovation activities to control emissions of particulate asbestos to the outside air because no safe concentration of airborne asbestos has ever been established. The primary method used to control asbestos emissions is to adequately wet the Asbestos Containing Material (ACM) with a wetting agent prior to, during and after demolition/renovation activities.

The purpose of this document is to provide guidance to asbestos inspectors and the regulated community on how to determine if friable ACM is adequately wet as required by the Asbestos NESHAP.

The recommendations made in this guidance are solely recommendations. They are not the exclusive means of complying with the Asbestos NESHAP requirements. Following these recommendations is not a guarantee against findings of violation. Determinations of whether asbestos materials are adequately wetted are made by EPA inspectors on site.

2. IMPORTANT TERMS

Adequately Wet

EPA defines "adequately wet" to mean "sufficiently mix or penetrate with liquid to prevent the release of particulates. If visible emissions are observed coming from asbestos-containing material (ACM), then that material has not been adequately wetted. However, the absence of visible emission is not sufficient evidence of being adequately wet (Section 61.141, Definitions). Amended water is often used to wet ACM during repair/removal operations.

Friable Asbestos Material

Friable asbestos material is any material containing more than 1 percent asbestos as determined using Polarized Light Microscopy (PLM), that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

Asbestos-Containing Waste Materials (ACWM)

EPA defines ACWM to mean mill tailings or any waste that contains commercial asbestos and is generated by a source subject to the provisions of this subpart. This term includes filters from control devices, friable asbestos waste material, and bags on other similar packaging contaminated with commercial asbestos. As applied to demolition and renovation operations, this term also includes friable asbestos waste and Category II nonfriable ACM waste that becomes crumbled, pulverized, or reduced to powder by forces that acted on the material during the course of demolition and renovation operations regulated by this subpart, and materials contaminated with asbestos including disposal equipment and clothing.

Nonfriable Asbestos-containing Materials

Nonfriable asbestos-containing material is any material containing more than 1 percent asbestos as determined using Polarized Light Microscopy (PLM) that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

Regulated Asbestos-Containing Material (RACM)

Is (a) friable asbestos material, (b) Category I nonfriable ACM that has become friable, (c) Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting or abrading, or (d) Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the force expected to act on the material in the course of demolition or renovation operations.

3. FRIABLE AND NONFRIABLE ASBESTOS-CONTAINING MATERIALS

The Asbestos NESHAP defines two categories of nonfriable ACM: Category I nonfriable ACM (asbestos-containing packings, gaskets, resilient floor covering and asphalt roofing products) and Category II nonfriable ACM (any nonfriable material not designated as Category I).

The Agency requires that, where the Asbestos NESHAP is applicable, friable ACM and Category II and nonfriable ACM that is likely to become disturbed or damaged so that the material could be

crumbled, pulverized or reduced to powder during a demolition or renovation be removed, from a facility prior to its demolition/ renovation. The fibrous or fluffy spray-applied asbestos materials found in many buildings for fireproofing, insulating, sound-proofing, or decorative purposes are generally considered friable. Pipe and boiler wrap found in numerous buildings is also considered friable.

Nonfriable ACM, such as vinyl-asbestos floor tile, generally emits low levels of airborne fibers unless subjected to burning or to sanding, grinding, cutting or abrading operations. Other materials, such as asbestos cement sheet and pipe, can emit asbestos fibers if the materials are crumbled, pulverized or reduced to powder during demolition/renovation activities. Whenever nonfriable materials are going to be damaged to the extent that they are crumbled, pulverized or reduced to powder, they must be handled in accordance with the Asbestos NESHAP.

4. REQUIREMENTS FOR ADEQUATELY WETTING ASBESTOS-CONTAINING MATERIALS

The NESHAP regulation requires that RACM be adequately wetted during the following activities:

a. During cutting or disjoining operations when a facility component which is covered or coated with friable ACM is being removed from that facility as units or in sections (Section 61.145 (c)(2)(i)).

During demolitions or renovations a contractor may choose to remove an entire boiler, a section of pipe, or other facility components without first removing the asbestos insulation from these structures. Any ACM which will be disturbed during cutting or disjoining operations must be adequately wet.

b. During stripping operations when a facility component containing RACM remains in place in the facility. (Section 61.145 (c)(3)).

Stripping operations are the most common form of asbestos removal during renovation activities, since most items that are covered with asbestos are facility components or structural members which will not be removed. Stripping off all of the RACM can generate significant asbestos emissions if the ACM is not adequately wet during removal.

Friable spray-on ACM, which includes fire-proofing materials found on decking and support I-beams, is normally easy to wet throughout because of the absorbing property of the cellulose mixing/binding

agent. The Asbestos NESHAP requires that these materials be fully penetrated with the wetting agent during demolition/renovation activities.

Other ACM, however, such as "thermal-block" insulation used on pipes and boilers, certain ceiling and floor tile applications, etc., which do not absorb water readily may be hard to penetrate by water or a wetting agent. For such materials, adequate wetting consists of coating the surfaces of the materials with water or a wetting agent prior to, during, and, in most cases, after removal activities in order to prevent asbestos emissions. Whenever such materials are broken during the removal process, the exposed, dry surfaces must be wetted immediately to reduce emissions.

If pieces of dry ACM are accidentally disturbed, they should be immediately wetted and kept wet until collected for disposal. Removal personnel are commonly assigned to keep the fallen RACM wet prior to its being collected for disposal.

c. After the RACM has been stripped from a facility component, it must remain adequately wet until it has been collected and contained or treated in preparation for disposal. (Section 61.145 (c)(6)(i))

After removal, adequately wetted ACWM must be sealed in leak-tight containers or wrapping which must be labeled as specified by the Occupational Health and Safety Administration (OSHA) under 29 CFR 1910.1001(j)(2) or 1926.58(k)(2)(iii). Such waste materials destined for off-site transport must additionally be labeled with the name of the generator and location of the waste generation site (Section 61.150 (a)(1)(iv and v)).

d. In demolitions where the RACM was not removed prior to demolition (Section 61.145 (c)(1)(i)(ii)(iii)(iv))

- RACM on a facility component encased in concrete or other similarly hard material must be adequately wet whenever exposed during demolitions (Section 61.145 (c)(1)(ii));
- RACM which was not accessible for testing and, due to demolition, cannot be safely removed, must be kept adequately wet at all times until disposed of (Section 61.145 (c)(1)(iii)):
- The portion of a facility ordered demolished that contains RACM must be adequately wet during the wrecking operation (Section 61.145 (c)(9)).

In each of the above situations, ACWM generated must be kept adequately wet during handling and loading for transport to the disposal site. In cases where ACWM can't be segregated from the debri pile it must be disposed of as ACWM. Such ACWM does not have to be sealed in leak-tight containers or wrapping, but may be transported and disposed of in bulk (Section 61.150 (a)(3)).

5. EXCEPTIONS TO ADEQUATELY WETTING ASBESTOS-CONTAINING MATERIALS

The Asbestos NESHAP allows two exceptions to wetting RACM during a demolition or renovation project:

- **When the temperature at the point of wetting is below 0°C (32°F) (Section 61.145 (c)(7)(i)).**

  The owner/operator must remove facility components coated or covered with friable ACM as units or sections to the maximum extent possible and meet subsequent requirements of 61.145, including the wetting requirements.

  During periods when wetting operations are suspended due to freezing temperatures, the owner/operator must record the temperature in the area containing the facility components at the beginning, middle, and end of each workday and keep daily temperature records available for inspection by the Administratorduring normal business hours at the demolition or renovation site. The owner or operator shall retain the temperature records for at least 2 years.

- **When the use of water would unavoidably damage equipment or present a safety hazard (Sec. 61.145 (c)(3)(i)(A)).**

  The owner/operator must first obtain written approval from the Administrator for an alternative work practice, prior to renovation activities and utilize a local exhaust ventilation and collection system designed to capture particulate asbestos released during removal operations. (Section 61.145 (c)(3)(i)(B)(1)); or a glove bag system or a leak-tight wrapping which can contain the particulate asbestos materials produced by stripping ACM. (Section 61.145 (c)(3)(i)(B)(2)and (3))

6. TECHNIQUES FOR WETTING ASBESTOS-CONTAINING MATERIALS

General Information

Adequate wetting of ACM is typically accomplished by repeatedly spraying it with a liquid or a wetting agent, usually amended water (water to which surfactant chemicals have been added), until it can absorb no more. However, this does not necessarily mean that the ACM will be soaked throughout. Surfactant chemicals reduce the surface tension of the water, thereby increasing its ability to penetrate the ACM and surround the asbestos fibers. Although amending agents are not required by the Asbestos NESHAP (the NESHAP only requires the use of a liquid), EPA, in its "Guidance for Controlling Asbestos-Containing Materials in Buildings", EPA-560/5-85-024 (Purple Book), recommends the use of a 50:50 mixture of polyoxyethylene ester and polyoxyethylene ether, or the equivalent, in a 0.16 percent solution (1 ounce to 5 gallons) of water.

Wetting agents may be applied with garden sprayers or hoses. Garden sprayers are hand-held, portable, and have a one- to five-gallon capacity. Water hoses are usually attached to a faucet tap, fire hydrant or water tank. Generally, the hose has a nozzle attached which spreads the water stream so that a fine mist is created.

An engineering control often used is a misting unit which can be used to create a high level of humidity within a removal area. It is believed that fibers emitted into a saturated environment will absorb the wetting agent and fall out of the air faster, thus reducing airborne fiber levels.

7. PROCEDURES FOR WETTING ASBESTOS-CONTAINING MATERIALS

The following procedures describe methods of adequately wetting various applications of ACM.

Thermal System Insulation

Molded Pipe Insulation

The recommended wetting procedure for this type of RACM is to saturate the outer surface with amended water, strip off the wet canvas coating and then rewet the surface in order to thoroughly saturate the ACM. The metal bands supporting the RACM should be removed and the half-round sections carefully separated. While this occurs, the interior side and edges of the sections should be saturated with amended water. If a section breaks during removal, the exposed surfaces should be wetted immediately. A misting

sprayer may also be used to keep the air in the removal area or containment area saturated with amended water to attempt to reduce airborne asbestos fiber levels.

Corrugated Paper Pipe Insulation

The outer surface of the corrugated paper ("air-cell") pipe insulation, usually a canvas wrap, should be saturated with a wetting agent and then removed. Wetting should continue until all the insulation is permeated with amended water. Metal bands holding the insulation in place should be removed and the corrugated RACM insulation stripped. Any unsaturated surfaces exposed during the stripping operation must be wetted immediately to reduce asbestos emissions. A misting sprayer may also be used to keep the air in the removal area saturated with amended water to attempt to reduce airborne asbestos fiber levels. Inadequately wetted and adequately wetted corrugated paper pipe insulation can be seen in Figures 1 and 2.

Figure 1. Inadequately wetted corrugated paper, pipe insulation. (Note the fibrous material adjacent to the lagging clamp.)

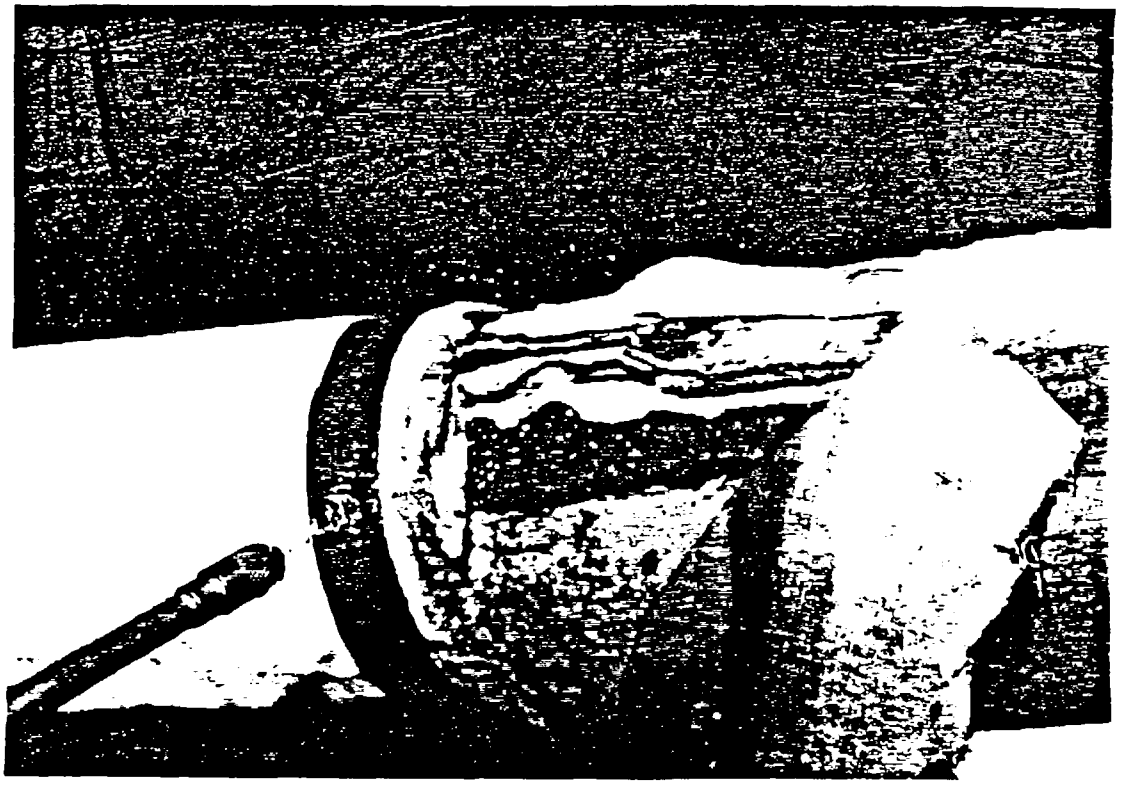


Figure 2. Adequately wetted corrugated paper, pipe insulation. (Note the saturated material adjacent to the lagging clamp.)

Boiler and Water Tank Thermal Block Insulation

Asbestos-containing preformed block insulation has been used as thermal insulation on boilers, hot water tanks and heat exchangers in industrial, commercial, institutional and residential applications. The blocks are commonly chalky in nature and may be held in place by chicken wire or expanded metal lath. A plaster-saturated canvas was often applied as a final covering or wrap.

Due to the number, thickness and varying absorbencies of these layers of materials, adequate wetting may be accomplished only by continually wetting the materials with amended water as the various layers are stripped.

One person may be assigned to spray the materials as they are stripped, and a misting sprayer may be used in an attempt to reduce airborne asbestos fiber levels.

Cementitious Fitting Insulation

Wetting of cementitious fitting insulation is similar to that used when removing asbestos-containing thermal block insulation. The outer surface is saturated with amended water and the outer covering (if applicable) is removed. The fitting insulation is then rewetted and the insulation stripped. To ensure that the fitting remains adequately wet during the removal operation, a person is often assigned to spray the ACM as it is stripped. A misting sprayer may be used to reduce airborne asbestos fiber levels. Inadequately wetted cementitious fitting insulation can be seen in Figure 3.

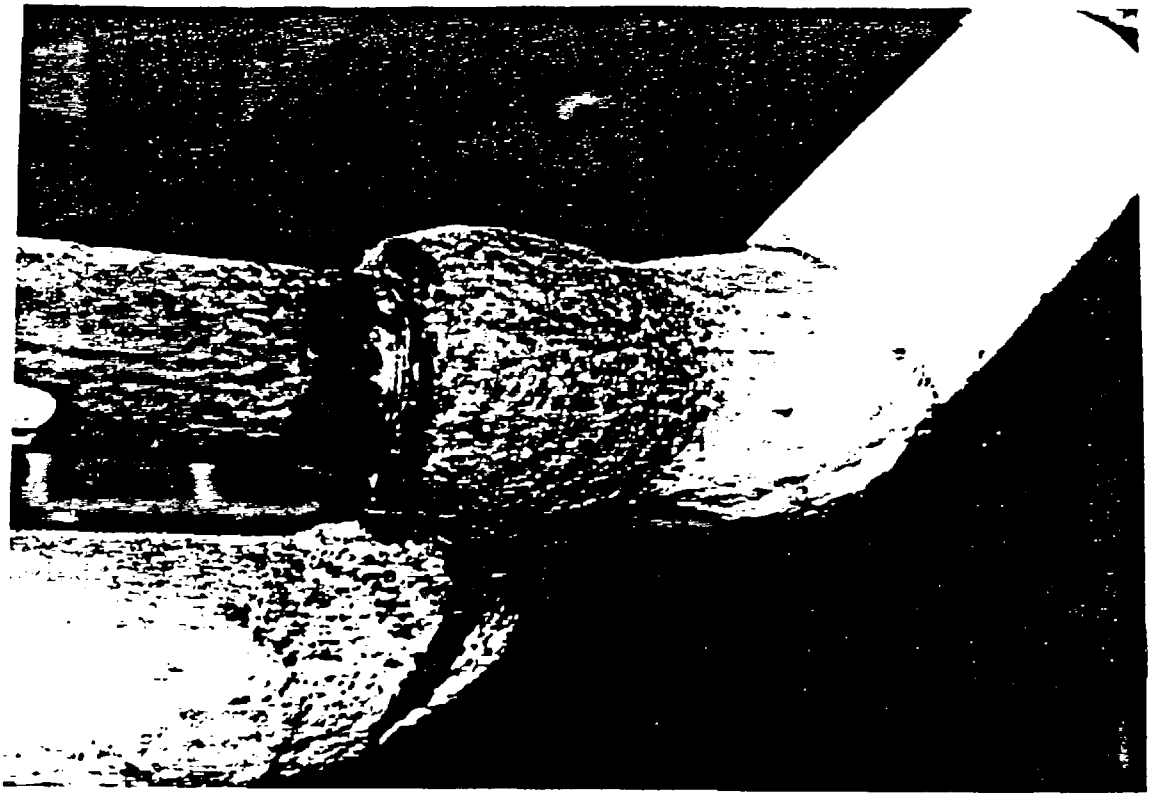


Figure 3. Inadequately wetted cementitious fitting insulation. (Note that the part of the insulation which has been wetted is dark grey in color, whereas the dry section remains white.)

Asbestos-Containing Surfacing Materials

"Surfacing Material" is a generic term designated by the Asbestos Hazard Emergency Response Act (AHERA; Asbestos Containing Materials in Schools, 40 CFR Part 763, Subpart E) to mean any wall or ceiling material that is sprayed-on or troweled-on, such as acoustical plaster or fireproofing. The recommended wetting method

for this type of RACM is to saturate the surfaces, begin the stripping operation and continue to wet the RACM as it is being removed. A misting sprayer may also be used to keep the air saturated while the removal occurs. Since surfacing materials vary in their ability to absorb a wetting agent, inspectors must consider the type of surfacing material that is being removed in order to determine the required extent of penetration by the amended water. Surfacing materials which easily absorb a wetting agent need to be fully penetrated or permeated to be considered adequately wet, whereas only the exposed surfaces of materials which do not absorb water readily need to be wetted.

The use of high pressure water to remove asbestos-containing surfacing materials, either through a steam-cleaning device or a diesel powered hydroblasting water applicator, should be avoided since such use may unduly disturb RACM and contribute to higher airborne asbestos fiber levels. However, if this removal method is used, contractors must adequately wet the ACM prior to and during the removal.

Miscellaneous Asbestos-Containing Materials

Both friable and nonfriable forms of other asbestos-containing building materials exist. Friable materials include asbestos-containing paper (commonly found beneath wooden floors), wallpaper, and joint compound. It has been estimated that 5 to 10 percent of the ceiling tiles currently installed in the U.S. contain asbestos.

Nonfriable miscellaneous ACM includes floor tiles, asbestos cement sheet (transite board), siding shingles, asphalt roofing shingles, laboratory benchtops and even chalkboards. These materials may become friable with age, and under harsh conditions. Category I nonfriable ACM must be carefully examined to determine if the material is in poor condition, that is, if the binding material is losing its integrity, exhibited by peeling, cracking or crumbling; and is also friable. When Category I nonfriable ACM has become friable it is subject to the NESHAP.

If Category I or II ACM is sanded, ground, cut or abraded it is also covered by the NESHAP. Category II nonfriable ACM which is damaged to the extent that it has or will become crumbled, pulverized or reduced to powder due to demolition/ renovation activities, is subject to the Asbestos NESHAP.

Miscellaneous materials are wetted in manners similar to those used to wet other categories of RACM. Coverings are saturated with a wetting agent before removal and the asbestos-containing portions fully penetrated with the agent prior to, during and after their

removal, while stored in the removal area, and while being placed into disposal containers. Miscellaneous materials that don't absorb water readily (e.g., asbestos-concrete products, and floor tiles) are only required to have wetted surfaces. A misting sprayer may be used to diminish airborne asbestos fiber levels.

8. INSPECTION PROCEDURES

The intent of the following guidelines is to provide GUIDANCE ONLY, to the regulated community regarding the inspection procedures recommended to Asbestos NESHAP inspectors for determining compliance with the "Adequately Wet" requirements of the Asbestos NESHAP. The purpose of the wetting provisions is to require as much wetting as is necessary to prevent airborne emissions of asbestos fibers. In order to achieve this result, RACM and ACWM must be wetted and maintained wet until collected for disposal. The determination of whether RACM or ACWM has been adequately wetted is generally based on observations made by the inspector at the time of inspection. Observations probative of whether a material is adequately wet include but are not limited to, the following:

1. Is there a water supply in place?

2. Is water or a wetting agent observed being sprayed onto the RACM or ACWM both during stripping or removal and afterwards while the material awaits proper disposal? If yes, carefully note the method of application used (e.g., misting, fogging, spraying of surface area only or drenching to penetrate the ACM throughout).

3. If water or a wetting agent is being used, what equipment is used to apply it (e.g., garden hose, plant mister)?

4. If water or a wetting agent is not being used, determine why it is not and document the reason. Possible (although not necessarily valid) reasons include:

   - prior permission obtained from the Administrator (safety hazard, potential equipment damage);
   - no water source at the facility;
   - temperature at the point of wetting below 32 degrees F;
   - portable water supply ran out and contractor continued to work; or
   - contractor prepared the area earlier, etc.

5. Examine a stripped or removed piece of ACWM or RACM which wets readily. Does it appear to be wetted throughout? If it does not, adequately wet the sample. Describe and photograph how the physical characteristics of the material change upon wetting (e.g., color, weight, texture, etc.). Take samples, as necessary, to document the presence of asbestos in the suspect material.

6. When examining materials that do not readily absorb water or a wetting agent (e.g., premolded thermal system insulation, ceiling tiles, floor tiles) inspectors should note whether all exposed surfaces of these materials have been wetted as required.

7. Is there visible dust (airborne or settled), or dry ACWM debris in the immediate vicinity of the operation? Inspectors should collect samples of such materials for analysis of their possible asbestos content.

8. Examine ACWM in bags or other containers using the procedures that follow, to determine if the material has been adequately wetted?

   1. Randomly select bags or the containers for inspection.

   2. Lift the bag and assess its overall weight. (A bag of dry ACWM can generally be lifted easily by one hand. A bag filled with well-wetted material would be substantially heavier.)

   3. If the bag or other container is transparent:

      - Visually inspect the contents of the unopened bag for evidence of moisture (e.g., water droplets, water in the bottom of the bag, a change in the color of the material due to water).

      - Without opening the bag, squeeze chunks of debris to ascertain whether moisture droplets are emitted.

      - If the material appears dry or not penetrated with liquid or a wetting agent, open the bag using the additional steps described in step 9 below, and collect a bulk sample of each type of material in the bag ascertaining

variations in size, patterns, color and textures.

9. If the waste material is contained in an opaque bag or other container, or if the material is in a transparent bag which appears to be inadequately wetted:

- Carefully open the bag (in the containment area, if possible). If there is no containment area at the site, a glove bag may be used to enclose the container prior to opening it to minimize the risk of any fiber release.

- Examine the contents of the bag for evidence of moisture as in 8 above, and if the material appears dry or it is not fully penetrated with water or a wetting agent, collect a bulk sample.

- Reseal the bag immediately after evaluating and sampling its contents.

APPENDIX A

ASBESTOS NESHAP COORDINATORS (FOR DEMOLITION/RENOVATION ACTIVITIES)

Asbestos NESHAP Coordinator
Air Management Division
U.S. EPA Region I
JFK Federal Building
Boston, MA 02203
(617) 565-3265
CT, MA, ME, NH, RI, VT

Asbestos NESHAP Coordinator
Air & Waste Management Division
U.S. EPA Region II
26 Federal Plaza
New York, NY 10278
(212) 264-6770
NJ, NY PR, VI

Asbestos NESHAP Coordinator
Air Management Division
U.S. EPA Region III
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-6550
DC, DE, MD, PA, VA, WV

Asbestos NESHAP Coordinator
Air Management Division
U.S. EPA Region IV
345 Courtland Street, N.E.
Atlanta, GA 30365
(404) 347-5014
AL, FL, GA, KY, MS, NC, SC, TN

Asbestos NESHAP Coordinator
Air Management Division
U.S. EPA Region V
230 South Dearborn Street
Chicago, IL 60604
(312) 886-6793
IL, IN, MI, MN, OH, WI

Asbestos NESHAP Coordinator
Air, Pesticide & Toxics Division
U.S. EPA Region VI
1445 Ross Avenue
Dallas, TX 75202-2733
(214) 655-7223
AR, LA, NM, OK, TX

Asbestos NESHAP Coordinator
Air & Toxics Management Division
U.S. EPA Region VII
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7618
IA, KS, MO, NE

Asbestos NESHAP Coordinator
Air & Toxics Division
U.S. EPA Region VIII
999 18th Street
Suite 500
Denver, CO 80202-2405
(303) 293-1767
CO, MT, ND, SD, UT, WY

Asbestos NESHAP Coordinator
Air Management Division (A-3-3)
U.S. EPA Region IX
75 Hawthorne Street
San Francisco, CA 94105
(415) 556-5569
AS, AZ, CA, GU, HI, NV,
Northern Marianas, TT

Asbestos NESHAP Coordinator
Air & Toxics Management Division
U.S. EPA Region X
1200 Sixth Avenue
Seattle, WA 98101
(205) 442-1757
AK, ID, OR, WA

APPENDIX B

REGIONAL ASBESTOS COORDINATORS (FOR SCHOOLS)

Regional Asbestos Coordinator
EPA Region I
Air & Management Division
JFK Federal Building
Boston, MA 02203
(617) 565-3835
CT, MA, ME, NH, RI, VT

Regional Asbestos Coordinator
EPA Region II
Woodbridge Avenue
Raritan Depot, Building 5
Edison, NJ 08837
(201) 321-6671
NJ, NY, PR, VI

Regional Asbestos Coordinator
EPA Region III
841 Chestnut Building
Philadelphia, PA 19107
(215) 597-3160
DC, DE, MD, PA, VA, WV

Regional Asbestos Coordinator
EPA Region IV
345 Courtland St. N.E.
Atlanta, GA 30365
(404) 347-5014
AL, FL, GA, KY, MS, NC, SC, TN

Regional Asbestos Coordinator
EPA Region V
230 South Dearborn Street
Chicago, IL 60604
(312) 886-6003
IL, IN, MI, MN, OH, WI

Regional Asbestos Coordinator
EPA Region VI
1445 Ross Avenue
Dallas, TX 75202-2733
(214) 655-7244
AR, LA, NM, OK. TX

Regional Asbestos Coordinator
EPA Region VII
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7020
IA, KS, MO, NE

Regional Asbestos Coordinator
EPA Region VIII
1 Denver Place
999 18th Street
Suite 500
Denver, CO 80202-2413
(303) 293-1442
CO, MT, ND, SD, UT, WY

Regional Asbestos Coordinator
EPA Region IX
75 Hawthorne Street
San Francisco, CA 94105
(415) 556-5406
AS, AZ, CA GU, HI, NV,
Northern Marianas, TT

Regional Asbestos Coordinator
EPA Region X
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-4762
AK, ID, OR, WA

ITEM 4

Reporting and Recordkeeping Requirements For Waste Disposal (A Field Guide)

United States
Environmental Protection
Agency

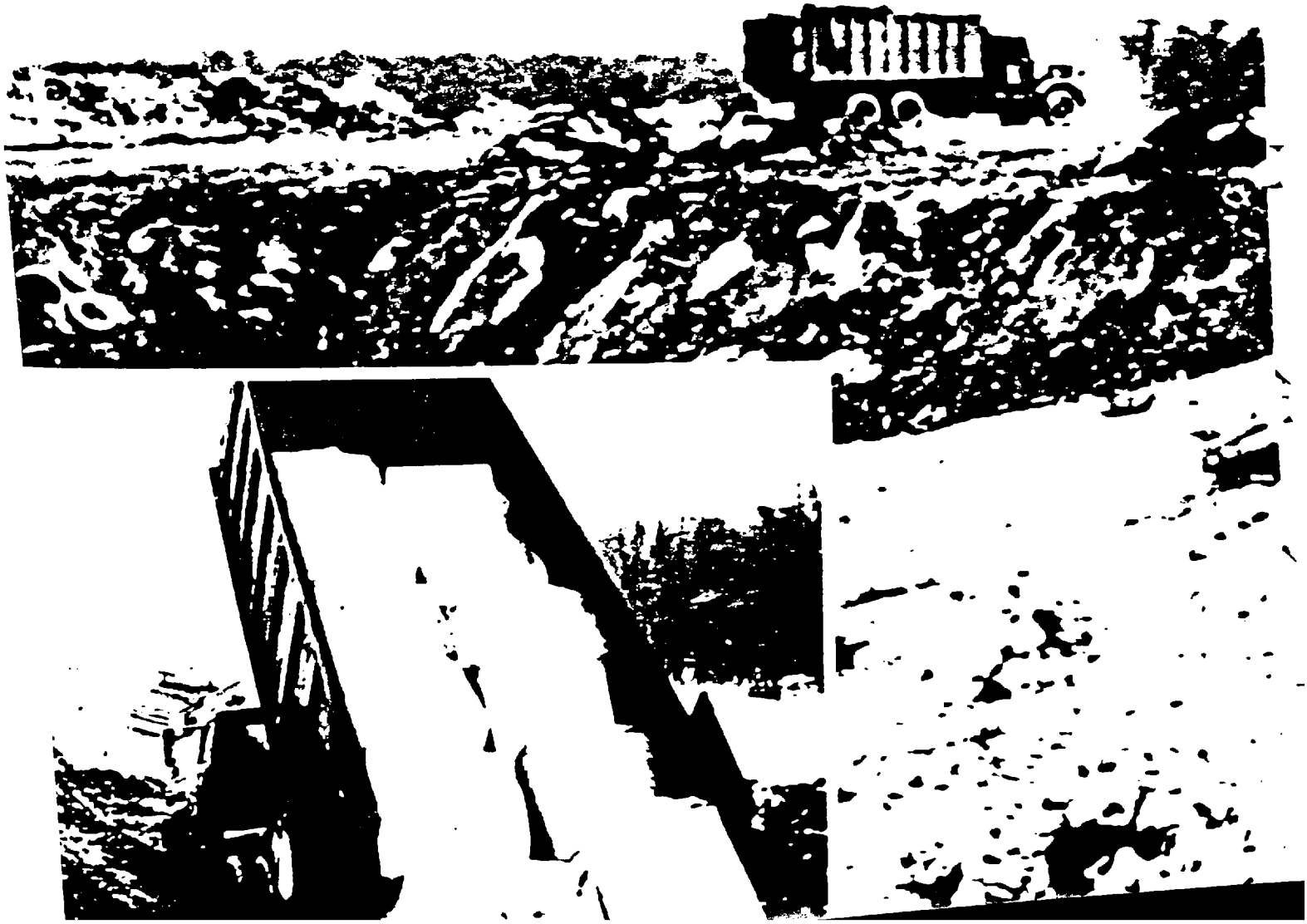
Air And Radiation
(EN-341)

EPA 340/1-90-016
November 1990

EPA

Reporting And Recordkeeping Requirements For Waste Disposal

A Field Guide



DISCLAIMER

This manual was prepared by Entropy Environmentalist, Inc. for the Stationary Source Compliance Division of the U.S. Environmental Protection Agency. It has been completed in accordance with EPA Contract No. 68-02-4462, Work Assignment No. 90-123. This document is intended for information purposes ONLY, and may not in any way be interpreted to alter or replace the coverage or requirements of the asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR Part 61, Subpart M. Any mention of product names does not constitute endorsement by the U.S. Environmental Protection Agency.

EPA

Reporting And Recordkeeping Requirements For Waste Disposal

A Field Guide

FIELD GUIDE

REPORTING AND RECORDKEEPING REQUIREMENTS FOR WASTE DISPOSAL

This is a guide to help you comply with the new reporting and recordkeeping requirements of the asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP). The specific responsibilities of waste generators, transporters and waste disposal site operators are addressed, as well as detailed explanations of how to complete the new forms accurately and efficiently. This field guide is organized into four main sections as follows:

- Waste Shipment Record
- Reporting Requirements
- Recordkeeping Requirements
- Source Reporting Requirements for Disposal Site Operators

I. WASTE SHIPMENT RECORD

After (the effective date of this rule), all shipments of asbestos containing waste material must be accompanied by a Waste Shipment Record (WSR) similar to the sample shown in Figure 1. When it is signed by the generator, the transporter and the waste disposal site operator, the WSR documents the movement and ultimate disposition of asbestos waste. The WSR consists of three parts and requires three signatures, those of the generator, the transporter and the disposal site operator.

A. Waste Generator

Waste generator means any owner or operator of a source covered by this rule whose activities produce asbestos-containing waste materials. Included are asbestos mills, manufacturers, fabricators, demolitions, renovations and spraying operations [40 CFR 61.149 and 150]. Generators are responsible for filling out Items 1-9 of the WSR. The original should be turned over to the transporter along with the waste shipment, although the generator should retain a copy of the WSR signed by the transporter acknowledging receipt of the waste shipment (Item 10) for his records.

Directions for filling out the WSR form are found in Figure 1. Items 1-4 and 6 provide important reference information. In Item 5, Category I nonfriable materials (asbestos-containing packings, gaskets, resilient floor covering and asphalt roofing products) should be considered nonfriable if they have not been sanded, ground, burned, or abraded; and Category II materials such as asbestos-cement products taken out before demolition may be reported as nonfriable also.

Item 7 asks for the quantity of waste in cubic meters or cubic yards. You may report in the units that you are most comfortable using, but you are expected to make a good faith effort to report correctly. Some helpful conversion factors are provided below:

- Drums and barrels used as asbestos-waste containers are typically of 35 gallons capacity. Gallons can be converted to cubic yards by multiplying gallons by 0.00379. In our example, 35 gallons x 0.00379 = 0.133 cubic yards for the volume of a drum or barrel.

- Plastic bags have a nominal volume of 0.1 cubic yards, but when they contain asbestos waste their volume is assumed to be about 0.075 cubic yards.

- Cubic yards can be changed to cubic meters by multiplying cubic yards by 0.765. The drum for which we calculated a volume of 0.133 cubic yards would have a volume of 0.133 x 0.765 = 0.102 cubic meters.

Follow the instructions given in Figure 1 to complete Items 8 and 9. When you turn the waste over to the transporter, require the transporter to acknowledge receipt of the asbestos waste by signing the WSR at Item 10: retain a copy of the WSR signed by the transporter for your files.

B. Transporter

At the time that you take possession of the load of waste, ask the generator for a WSR. Acknowledge receipt of the asbestos waste by signing the WSR at Item 10; return a copy of it to the generator. If you turn the shipment over to a second transporter require him to

acknowledge receipt of the shipment by signing the WSR at Item 11. It is recommended that you retain a copy of the signed document for your files when you surrender the WSR to a second transporter. The transporter who delivers the waste shipment to the waste disposal site should surrender the WSR to the disposal site operator. It is recommended that you keep a copy of the WSR signed by the disposal site operator for your files as a matter of good business practice.

C. Waste Disposal Site Operator

Waste disposal site operators are not expected to open bags or other containers to verify that the material is asbestos: if a WSR accompanies the shipment, that is sufficient verification. You must complete Items 12 and 13 of the WSR according to the instructions in Figure 1 and send a copy of the WSR according to the name and address listed in Item 2 of the WSR. The disposal site operator should check to see that the numbers of containers reported in WSR Item 6 and the quantities reported in WSR Item 7 appear to be correct. Any discrepancy should be noted in Item 12.

If the WSR indicates a truckload of asbestos waste, ask the driver if he knows the truck's cargo capacity. If he cannot tell you the capacity, estimate it by multiplying the length by the width by the height of the cargo compartment (all in feet) and divide by 27 cubic feet to obtain cubic yards. If you know the capacity of a truck—say 20 cubic yards—and you judge it to be half-full, estimate the load as 10 cubic yards.

Item 12 is also used to note improperly enclosed or uncovered waste.

II. REPORTING REQUIREMENTS

The revised NESHAP now includes reporting requirements for generators and waste disposal site operators. Generators are required to submit exception reports if they do not receive a copy of the WSR signed by the disposal site owner or operator within 45 days of the date the shipment was accepted by the first transporter. Disposal site operators must file reports of discrepancies between the quantities of waste indicated on the WSR and the quantities actually received, as well as reports of improperly enclosed or uncovered waste.

A. Exception Report

If you as a generator of a shipment of asbestos waste do not receive a copy of the WSR signed by the disposal site operator within 35 days after you turned the waste over to the first transporter, you must take steps to locate the waste shipment.

First, contact the transporter and verify the fact that the waste was delivered to the waste disposal site specified in Item 3 of the WSR. If the transporter has not delivered the shipment, determine the reason for the delay, and when it will be delivered. If the transporter has delivered the waste to the specified waste disposal site, inquire if a copy of the WSR signed by the disposal site operator can be made available to you. (The transporter is not required to obtain or keep a copy signed by the disposal site operator: however, some may do so as a matter of good business practice.) Next contact the disposal site operator and determine why you have not received a copy of the WSR signed by him. Request that the disposal site operator send a signed copy of the WSR to you immediately.

If you have not received a signed WSR from the disposal site operator within 45 days after you turned the waste over to the initial transporter, you must submit a written exception

report to the responsible NESHAP program agency (see Appendix A for a list of agencies and their jurisdictions). The report should include a copy of the WSR in question as well as a cover letter that explains what you have done to locate the shipment, and the results of your search.

B. Discrepancy Report

As a waste disposal site operator, you will be checking the WSR that accompanies each asbestos waste shipment that arrives at your site to make sure that the information on the WSR accurately describes the waste shipment. If you see that there is a discrepancy between the number of containers shown on the WSR and the number that you count in the truck you should note this in Item 12 of the WSR and contact the generator to determine if there is a reasonable explanation for the discrepancy. If you are able to reconcile the apparent discrepancy, make a note of it on the WSR and forward it to the generator as you would normally do.

If you are unable to resolve the discrepancy within 15 days of accepting the waste, you must send a written discrepancy report immediately to the responsible agency in whose jurisdiction the generator of the waste is located. The discrepancy report should describe the discrepancy in question and the steps you have taken to obtain an explanation for it, such as how and when you attempted to reach the generator. A copy of the shipment's WSR must accompany the discrepancy report.

C. Report of Improperly Enclosed or Uncovered Waste

Disposal site operators will check asbestos waste shipments arriving at their sites and are expected to look for significant amounts of improperly enclosed or uncovered waste before the material is disposed of. If significant amounts of improperly enclosed or uncovered waste are discovered in a shipment (see discussion under WSR), note it in Item 12 of the WSR and send, by the following working day, a written report of the problem to the specific agency responsible for administering the NESHAP program for the jurisdiction where the job site is located (identified on the WSR). If the disposal site is located in a different jurisdiction than the job site, you should also send a copy of the WSR to the agency responsible for the disposal site. The written report should describe the improperly enclosed or uncovered waste in sufficient detail that the responsible agency can determine the urgency of the situation and what action to take. A copy of the WSR must be submitted along with the written report.

III. RECORDKEEPING REQUIREMENTS

New requirements for recordkeeping are set for waste generators and waste disposal sites. Generators must keep copies of all WSR's for at least 2 years. In addition to keeping WSR's for at least 2 years, active waste disposal sites must also keep records of the asbestos-containing waste material located within the site.

A. Waste Generator

As a waste generator, you must retain copies of all WSR's, including WSR's signed by the owner or operator of the waste disposal site where the waste was deposited for at least 2 years. The WSR's should be kept in chronological order in a secure, water-tight file. You are expected to provide copies of WSR's upon request of the responsible agency and to make the WSR file available for inspection during normal business hours.

B. Active Waste Disposal Site Operator

You, the waste disposal site operator, are required to keep copies of WSR's that you have received for at least 2 years. The WSR's should be kept in chronological order in a secure, water-tight file. You are expected, further, to provide copies of WSR's upon request of the responsible agency and to make the WSR file available for inspection during normal business hours.

Another new requirement is that you now must maintain up-to-date records that indicate the location, depth and area, and quantity of asbestos containing waste material within the disposal site on a map or diagram of the disposal area.

You have the option of either restricting the asbestos waste to specified areas within the disposal site or depositing it throughout the site. In making this decision you should consider the future use of the property after the disposal site has been closed. By restricting the area where asbestos waste is deposited you will be able to preserve more of the property for future use. However, if you choose to deposit asbestos waste throughout the site, the responsible agency would consider that the entire disposal area contains asbestos.

When you open a new trench (or area) for asbestos waste disposal, place stakes in the ground at the corners of the trench. Take precautions to see that the stakes are kept where they are originally positioned and are not broken during the time that the trench is being filled. When you have filled the trench, call in a land surveyor. The surveyor will use the stakes to determine the location of the asbestos deposit within the disposal site. Ask the surveyor to prepare a map or diagram of the disposal site that shows the location(s) and surface dimensions of the asbestos deposit.

Before beginning to fill a new trench with asbestos waste, measure the maximum depth of the trench, record it, and save it to put on the map provided by the surveyor. Use the data provided in Item 7 of the WSR's to obtain the quantity of asbestos-containing waste material. Add up the cubic yards (cubic meters) of waste indicated on the WSR's for all of the asbestos waste shipments that are deposited in the trench up until the time that it is full and is closed. Also, put the total quantity of asbestos-waste deposited at the site on the map provided by the surveyor.

The map should be kept current until the time that the waste disposal site is closed. At closure you must submit a copy of records of asbestos waste disposal locations and quantities to the agency responsible for administering the NESHAP program in your area. The surveyor's map or diagram of the disposal site with the location and surface dimensions of the asbestos deposit(s), maximum depth of the deposit(s) and asbestos waste quantities fulfills this requirement and should be submitted to the Administrator. See Figure 2 for an example of a map.

Within 60 days of closing your waste disposal site you must record on the deed to the waste disposal site the following information:

- The land has been used for the disposal of asbestos-containing waste material,

- The survey plot and record of the location and quantity of asbestos containing waste disposed of within the disposal site have been filed with (name of responsible agency), and

- The site is subject to 40 CFR 61 Subpart M.

In some states, a Notation of Deed form can be used to add this information to a deed, while in others it may be easier to prepare a new deed than it is to annotate an existing deed. You should contact the Register of Deeds at the county seat of the county in which your disposal site is located to learn the rules that cover deeds and for instructions on how to proceed.

IV. SOURCE REPORTING REQUIREMENTS FOR DISPOSAL SITE OPERATORS

Another new requirement is that, within 90 days of the effective date of this rule, you are required to report certain information about your asbestos waste disposal operations to the responsible asbestos NESHAP program agency (see Appendix A for a list of agencies). Section 61.153 of the asbestos NESHAP requires that you report the following information:

- A brief description of the waste disposal site, which would include such information as the location and size of the disposal facility.

- A description of the method or methods that will be used to comply with the asbestos NESHAP, or a description of alternative methods that will be used. Methods to be used, such as covering asbestos waste daily with 6 inches of nonasbestos cover or the use of dust suppressants should be reported. Other information that might be reported includes procedures to prevent public access to the asbestos waste disposal area, such as the use of warning signs and fencing. You must report this information using the format in Appendix A of Part 61 of Title 40 of the Code of Federal Regulations (40 CFR).

In addition to the information listed above, you as the waste disposal site operator, must also report the following information required by the source reporting requirements of Section 61.10 of Subpart, Part 61 of 40 CFR.

- Name and address of the owner or operator.
- The location of the source.
- The type of hazardous pollutants emitted by the stationary source.

- A brief description of the nature, size, design, and method of operation of the stationary source including the operating design capacity of the source. Identify each point of emission for asbestos.

- The average weight per month of asbestos being processed by the source over the last 12 months preceding the date of the report.

If there is a change in any of the information listed above, you must report the changes to the appropriate agency within 30 days after they occur.

Generator	1. Work site name and mailing address	Owner's name	Owner's telephone no.
	2. Operator's name and address		Operator's telephone no.
	3. Waste disposal site (WDS) name, mailing address, and physical site location		WDS phone no.
	4. Name, and address of responsible agency		
	5. Description of materials	6. Containers No. Type	7. Total quantity m^3 (yd^3)
	8. Special handling instructions and additional information		
	9. OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and government regulations.		
	Printed/typed name & title	Signature	Month Day Year
Transporter	10. Transporter 1 (Acknowledgment of receipt of materials)		
	Printed/typed name & title Address and telephone no.	Signature	Month Day Year
	11. Transporter 2 (Acknowledgment of receipt of materials)		
	Printed/typed name & title Address and telephone no.	Signature	Month Day Year
Disposal Site	12. Discrepancy indication space		
	13. Waste disposal site owner or operator: Certification of receipt of asbestos materials covered by this manifest except as noted in item 12.		
	Printed/typed name & title	Signature	Month Day Year

(Continued)

Figure 1. Waste Shipment Record

INSTRUCTIONS

Waste Generator Section (Items 1-9)

1. Enter the name of the facility at which asbestos waste is generated and the address where the facility is located. In the appropriate spaces, also enter the name of the owner of the facility and the owner's phone number.

2. If a demolition or renovation, enter the name and address of the company and authorized agent responsible for performing the asbestos removal. In the appropriate spaces, also enter the phone number of the operator.

3. Enter the name, address, and physical site location of the waste disposal site (WDS) that will be receiving the asbestos materials. In the appropriate spaces, also enter the phone number of the WDS. Enter "on-site" if the waste will be disposed of on the generator's property.

4. Provide the name and address of the local, State, or EPA Regional office responsible for administering the asbestos NESHAP program.

5. Indicate the types of asbestos waste materials generated. If from a demolition or renovation, indicate the amount of asbestos that is

   - Friable asbestos material
   - Nonfriable asbestos material

6. Enter the number of containers used to transport the asbestos materials listed in item 5. Also enter one of the following container codes used in transporting each type of asbestos material (specify any other type of container used if not listed below):

   DM - Metal drums, barrels
   DP - Plastic drums, barrels
   BA - 6 mil plastic bags or wrapping

7. Enter the quantities of each type of asbestos material removed in units of cubic meters (cubic yards).

8. Use this space to indicate special transportation, treatment, storage or disposal or Bill of Lading information. If an alternate waste disposal site is designated, note it here. Emergency response telephone numbers or similar information may be included here.

NOTE: The waste generator must retain a copy of this form.

(continued)

Figure 1. Waste Shipment Record

9. The authorized agent of the waste generator must read and then sign and date this certification. The date is the date of receipt by transporter.

Transporter Section (Items 10 & 11)

10. & 11. Enter name, address, and telephone number of each transporter used, if applicable. Print or type the full name and title of person accepting responsibility and acknowledging receipt of materials as listed on this waste shipment record for transport. Enter date of receipt and signature.

NOTE: The transporter must retain a copy of this form.

Disposal Site Section (Items 12 & 13)

12. The authorized representative of the WDS must note in this space any discrepancy between waste described on this manifest and waste actually received as well as any improperly enclosed or contained waste. Any rejected materials should be listed and destination of those materials provided. A site that converts asbestos-containing waste material to nonasbestos material is considered a WDS.

13. The signature (by hand) of the authorized WDS agent indicates acceptance and agreement with statements on this manifest except as noted in item 12. The date is the date of signature and receipt of shipment.

NOTE: The WDS must retain a completed copy of this form. The WDS must also send a completed copy to the operator listed in item 2.

Figure 1. Waste Shipment Record

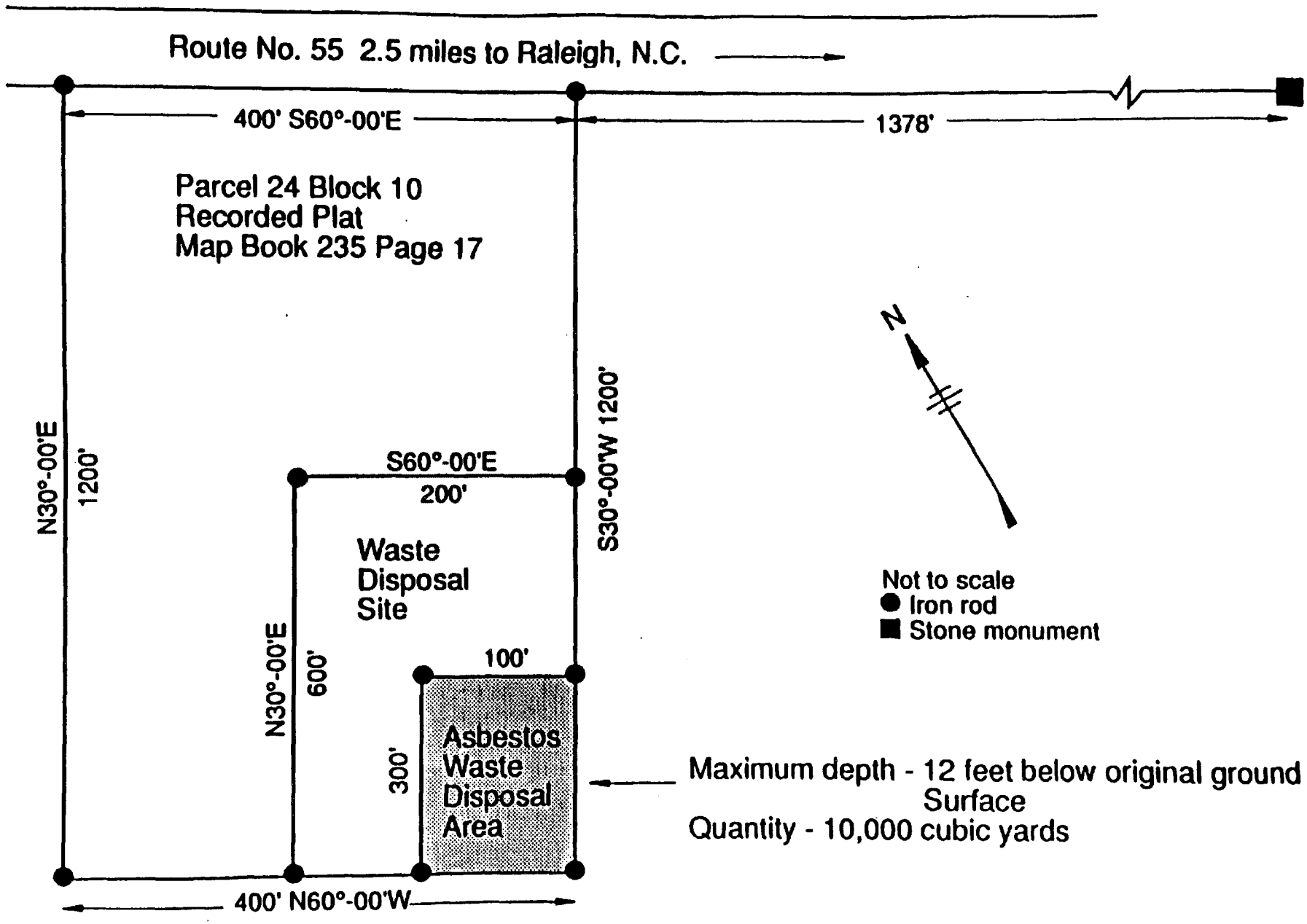


Figure 2. Example plat of waste disposal site showing asbestos waste disposal area.

Appendix A
Local, State, and EPA Regional Agencies Responsible for Administering The Asbestos NESHAP Program

EPA Regions

Region 1

Asbestos NESHAP Coordinator
Air Management Division
U.S. EPA
JFK Federal Building
Boston, MA 02203
(617) 565-3265

States: CT, MA, ME, NH, RI, VT

Region 2

Asbestos NESHAP Coordinator
Air & Waste Management
Division
U.S. EPA
26 Federal Plaza
New York, NY 10278
(212) 264-6770

States: NJ, NY, PR, VI

Region 3

Asbestos NESHAP Coordinator
Air, Toxics & Radiation
Management Division
U.S. EPA
841 Chestnut Building
Philadelphia, PA 19107
(215) 597-6550

States: DC, DE, MD, PA, VA, WV

Region 4

Asbestos NESHAP Coordinator
Air, Pesticide & Toxic Division
U.S. EPA
345 Courtland Street, N.E.
Atlanta, GA 30365
(404) 347-5014

States: AL, FL, GA, KY, MS, NC,
SC, TN

Region 5

Asbestos NESHAP Coordinator
Air & Radiation Division
U.S. EPA
230 South Dearborn Street
Chicago, IL 60604
(312) 353-6793

States: IL, IN, MI, MN, OH, WI

Region 6

Asbestos NESHAP Coordinator
Air, Pesticides & Toxics Division
U.S. EPA
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733
(214) 655-7223

States: AR, LA, NM, OK, TX

Region 7

Asbestos NESHAP Coordinator
Air & Toxics Division
U.S. EPA
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7018

States: IA, KS, MO, NE

Region 8

Asbestos NESHAP Coordinator
Air & Toxics Division
U.S. EPA
One Denver Place
999 18th Street, Suite 500
Denver, CO 80202-2405
(303) 294-7685

States: CO, MT, ND, SD, UT, WY

Region 9

Asbestos NESHAP Coordinator
Air & Toxics Division
U.S. EPA
75 Hawthorne Street
San Francisco, CA 94105
(415) 744-1135

States: AZ, CA, HI, NV

Region 10

Asbestos NESHAP Coordinator
Air & Toxics Division
U.S. EPA
1200 6th Avenue
Seattle, WA 98101
(206) 442-1757

States: AK, ID, OR, WA

REGION 1

Connecticut
Damien Houlihan
U.S. EPA
JFK Federal Building, Room 2313
Boston, MA 02203
(617) 565-3265

Maine
Bruce Buck
Dept. of Environmental Protection
State House, Station 17
Augusta, ME 04333
(207) 582-8740

Massachusetts

Metro Boston and North
John MacAuley
Dept. of Environmental Protection
5 Commonwealth Avenue
Woburn, MA 01801
(617) 935-2160

Southeast
Vacant. Inquiries are being temporarily handled by the Metro Boston and North office (above)

Central
Greg Levins
Dept. of Environmental Protection
75 Grove Street
Worcester, MA 01605
(508) 792-7692

Western
Roberta Ken
Dept. of Environmental Protection
436 Dwight Street
Springfield, MA 01103
(413) 784-1100

ew Hampshire
John Le Febvre
Air Resources Division
Dept. of Environmental Services
64 N. Main St., Caller Box 2033
Concord, NH 03302-2033
(603) 271-1370

ode Island
Damien Houlihan
U.S. EPA
JFK Federal Building, Room 2313
Boston, MA 02203
(617) 565-3265

mont
Damien Houlihan
U.S. EPA
JFK Federal Building, Room 2313
Boston, MA 02203
(617) 565-3265

REGION 2

New Jersey
Robert Fitzpatrick
U.S. EPA
Air and Waste Management Division
26 Federal Plaza
New York, NY 10278
(212) 264-6770

New York
Robert Fitzpatrick
U.S. EPA
Air and Waste Management Division
26 Federal Plaza
New York, NY 10278
(212) 264-6770

Puerto Rico
Commonwealth of Puerto Rico
Environmental Quality Board
P.O. Box 11785
Santurce, PR 00910

U.S. Virgin Islands
U.S. Virgin Islands Dept. of Conservation and Cultural Affairs
P.O. Box 578
Charlotte Amalie, St. Thomas
U.S. Virgin Islands 00801

REGION 3

Delaware

New Castle County
Jim Walmer
Dept. of Natural Resources and Environmental Control
715 Grantham Lane
New Castle, DE 19720
(302) 323-4542

Kent or Sussex County
Dave Burke
Delaware Dept. of Natural Resources
89 Kings Highway
P.O. Box 1401
Dover, DE 19903
(302) 739-4791

District of Columbia
John Holmes
DC Dept. of Consumer and Regulatory Affairs
2100 Martin Luther King Avenue S.E.
Washington, DC 20020
(202) 783-3181

Maryland

John McQuade
Air Management Administration
Maryland Dept. of the Environment
2500 Broening Highway
Baltimore, MD 21224
(301) 631-3200

Pennsylvania

Dean Van Orden
Division of Hazardous Air Pollutants
Bureau of Air Quality Control
Dept. of Environmental Resources
P.O. Box 2357
Harrisburg, PA 17105-2357
(717) 787-9257

Allegheny County (Pittsburgh)
Fred Ebel
Bureau of Air Pollution Control
Allegheny County Health Dept.301 39th Street
Pittsburgh, PA 15201
(412) 578-8133

Philadelphia
Ed O'Neil
Air Management Services
Dept. of Public Health
500 South Broad Street
Philadelphia, PA 19146
(215) 875-5678

Virginia

Charles King
Virginia Air Pollution Control Board
9th Street Office Building, Room 801
Richmond, VA 23219
(804) 786-6079

For Notifications
Virginia Dept. of Labor and Industry
Division of Occupational Health Enforcement
P.O. Box 12064
Richmond, VA 23241
(804) 786-8009

est Virginia

Paul Rader
West Virginia Air Pollution Control Commission
1558 Washington Street, East
Charleston, WV 25311
(304) 348-4022

REGION 4

Alabama

Ludwig C. Hoffmann, III
Air Division
Alabama Dept. of Environmental Management
1751 W.L. Dickinson Drive
Montgomery, AL 36109
(205) 271-7861

Jefferson County
Gerald Coker
Jefferson County Dept. of Health
P.O. Box 2648
Birmingham, AL 35202
Contact: Joe Wilson
(205) 930-1210

Huntsville
Charles Terrell
Natural Resources and Environmental Management Dept.
City of Huntsville
2033-C Airport Road
Huntsville, AL 35801
(205) 883-3645

Florida

Ed Palagyi
Bureau of Air Regulation
Florida Dept. of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32301
(904) 488-1344

Duval County
Pat Patterson
Div. of Bio-Environmental Services
Duval County Dept. of Health, Welfare, and Bio-Environmental Sciences
421 West Church Street, Suite 412
Jacksonville, FL 32202
(904) 630 3638

Hillsborough County
Sheila Luce
Hillsborough County Environmental Protection Commission
1410 North 21st Street
Tampa, FL 33605
(813) 272-5530

Palm Beach County
Jim Hearn
Air Pollution Control
Palm Beach County Health Dept.
901 Evernia Street
West Palm Beach, FL 33402
(407) 355-3070

Broward County
Bill Hahne
Broward County Environmental Quality Control Board
621 South Andrews
Fort Lauderdale, FL 33301
(305) 765-4441

Dade County
Frank Echanique or Peter Basil
Dade County Dept. of Environmental Resource Management
Metro Government Ctr., Suite 1310
111 Northwest First Street
Miami, FL 33128
(305) 858-0601

Pinellas County
Eric Fehrmann
Division of Air Quality
Pinellas County Dept. of Environmental Management
16100 Fairchild Drive
Building V102
Clearwater, FL 34622
(813) 530-6522

Georgia

Marvin Bradford
Asbestos Licensing and Certification Unit
Environmental Protection Division
Georgia Dept. of Natural Resources
156 Trinity Avenue, Suite 315
Atlanta, GA 30303
(404) 656-4999

Kentucky

Parker Moore
Division for Air Quality Control
Frankfort Office Park
18 Reilly Road
Frankfort, KY 40601
(502) 564-2150

Jefferson County
Jerry Schlatter
Jefferson County Air Pollution Control District
850 Barrett Avenue
Louisville, KY 40204
(502) 625-6000

Mississippi

Jimmy Asbill
Office of Pollution Control
Mississippi Dept. of Environmental Quality
P.O. Box 10385
Jackson, MS 39289-0385
(601) 961-5171

North Carolina

Pat Curran
Division of Environmental Management
Asbestos Hazard Management Branch P.O. Box 27687
Raleigh, NC 27611
(919) 733-0820

Mecklenburg County
Dan Hardin
Air Quality Section
Environmental Management Division
Mecklenburg County Dept. of Environmental Protection
1200 Blythe Boulevard
Charlotte, NC 28203
(704) 376-4603

Forsyth County
Robert Fulp, Director
Forsyth County Environmental Affairs Dept.
537 North Spruce Street
Winston-Salem, NC 27101
Contact: Michael Hastings
(919) 727-8060

Western North Carolina
Ronald Boone, Director
Western North Carolina Regional Air Pollution Control Agency
Buckingham County Courthouse
P.O. Box 7215
Asheville, NC 28801-3569
Contact: David Brigman
(704) 255-5655

South Carolina

Dick Sharpe
South Carolina Dept. of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201
Contact: Jean Wheeler
(803) 734-4750

Tennessee

Robert Foster
Division of Air Pollution Control
Tennessee Dept. of Public Health
Customs House, 4th Floor
701 Broadway
Nashville, TN 37247-3101
Contact: Jackie Waynick
(615) 741-3931

Chattanooga-Hamilton County
J. Wayne Cropp, Director
Chattanooga-Hamilton County
Air Pollution Control Bureau
3511 Rossville Boulevard
Chattanooga, TN 37404
Contact: Jim Weyler
(615) 867-4321

Memphis-Shelby County
Helen Keith, Manager
Air Pollution Control
Memphis-Shelby County Health Dept.
814 Jefferson Avenue
Memphis, TN 38105
Contact: Jinneal Clark
(901) 576-7653

Nashville-Davidson County
Paul Bontrager, Director
Metropolitan Health Dept.
Pollution Control Division
Nashville-Davidson County
311 Twenty-Third Avenue, North
Nashville, TN 37203
Contact: Fred Huggins
(615) 340-5653

Knox County
Terry Harris, Director
Knox County Dept. of Air Pollution Control
400 Main Avenue
City/County Building, Room 459
Knoxville, TN 37902
Contact: Lynne Liddington
(615) 521-2488

REGION 5

Illinois

Otto Klein
Division of Air Pollution Control
Illinois Environmental Protection Agency
P.O. Box 19276
Springfield, IL 62794-9276
(217) 785-1743

Indiana

Frank Profit
Asbestos Section
Office of Air Management
Indiana Dept. of Environmental Management
P.O. Box 6015
Indianapolis, IN 46206-6015
Contact: Deborah Dubenetzky
(317) 232-8373

Michigan

Keshav Singh
Air Quality Division
Michigan Dept. of Natural Resources
P.O. Box 30028
Lansing, MI 48909
(517) 335-1588

Minnesota

David Crowell or Steve Giddings
Division of Air Quality
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 296-7653/296-7513

Ohio

Tom Hadden
Division of Air Pollution Control
Ohio Environmental Protection Agency
P.O. Box 1049
Columbus, OH 43266-0149
(614) 644-2270

Wisconsin

Joe Brehm
Bureau of Air Management
Wisconsin Dept. of Natural Resources
P.O. Box 7921
Madison, WI 53707
(608) 267-7541

REGION 6

Arkansas

Arkansas Dept. of Pollution Control and Ecology
8001 National Drive, P.O. Box 9583
Little Rock, AR 72219
Contact: Jeff Purtle
(501) 562-7444

Louisiana

Asbestos Unit Coordinator
Louisiana Dept. of Environmental Quality
P.O. Box 44096
Baton Rouge, LA 70804-4096
Contact: Chris Roberie
(504) 342-9056

New Mexico

Bernalillo County
Air Pollution Control Division
Environmental Health and Energy Dept.
P.O. Box 1293
Albuquerque, NM 87103
Contact: Steve Walker
(505) 768-2637

Outside Bernalillo County
Air Quality Bureau
NM Environmental Improvement Division
P.O. Box 968
Santa Fe, NM 87504-0968
Contact: Bill Hargraves
(505) 827-0062

Oklahoma

Air Quality Service
Oklahoma State Dept. of Health
P.O. Box 53551
Oklahoma City, OK 73152
Contact: Tom Hudson
(405) 271-5220

Oklahoma City-County
Air Quality Section
Oklahoma City-County Health Dept.
921 N.E. 23rd Street
Oklahoma City, OK 73105
Contact: Curt Goeller
(405) 427-8651

Tulsa City-County
Air Pollution Control Program
Tulsa City-County Health Dept.
4616 East 15th Street
Tulsa, OK 74112
Contacts: Ray Bishop or Grady Baron
(918) 744-1000

Texas

Director of Compliance Division
Texas Air Control Board
6330 Highway 290 East
Austin, TX 78723
Contact: Jeanne Philquist
(512) 451-5711
(Submit notifications to Texas regional offices)

Texas Municipal Offices

Dallas
Air Pollution Control Program
Environmental Health Division
Dept. of Health and Human Services
320 E. Jefferson, LL-13
Dallas, TX 75203
Contacts: Gary Burlbaw or Roger Jayroe
(214) 948-4435

El Paso
Air Pollution Control Program
El Paso City Health Dept.
222 South Campbell
El Paso, TX 79901
Contact: Jesus J. Reynoso
(915) 543-3646

Galveston County
Environmental Control Services
Galveston County Health District
P.O. Box 939
LaMarque, TX 77568
Contact: Karen Alexander
(409) 938-7221

Houston
Bureau of Air Quality Control
Houston City Health and Human Services Dept.
7411 Park Place Blvd.
Houston, TX 77087
Acting Contact: Henry H. Branham
(713) 640-4200

Fort Worth
Environmental Health Division
Fort Worth Public Health Dept.
1800 University Drive
Fort Worth, TX 76107
Contact: Gene Rattan
(817) 870-7281
Contact: Gerald Bearden
(817) 870-7289

Texas Air Control Board Regional Offices

Region 1
Archer, Baylor, Brown, Callahan, Childress, Clay, Coleman, Comanche, Cottle, Eastland, Fisher, Foard, Hardeman, Haskell, Jack, Jones, Kent, Knox, Mitchell, Montague, Nolan, Runnels, Scurry, Shackelford, Stephens, Stonewall, Taylor, Throckmorton, Wichita, Wilbarger and Young Counties
Winona Henry, Director
Commerce Plaza Office Building
1290 South Willis, Suite 205
Abilene, TX 79605
(915) 698-9674

Region 2
Armstrong, Bailey, Briscoe, Carson, Castro, Cochran, Collingsworth, Crosby, Dallam, Deaf Smith, Dickens, Donley, Floyd, Garza, Gray, Hale, Hall, Hansford, Hartley, Hemphill, Hockley, Hutchinson, King, Lamb, Lipscomb, Lynn, Lubbock, Moore, Motley, Ochiltree, Oldham, Parmer, Potter, Randall, Roberts, Sherman, Swisher, Terry, Wheeler and Yoakum Counties
Gerald Hudson, Director
Briercroft South #1
5302 South Avenue Q
Lubbock, TX 79412
(806) 744-0090

Region 3
Bastrop, Bell, Blanco, Bosque, Brazos, Burleson, Burnet, Caldwell, Coryell, Falls, Fayette, Freestone, Grimes, Hamilton, Hays, Hill, Lampasas, Lee, Leon, Llano, Limestone, Madison, McClennan, Milam, Mills, Robertson, Travis, Washington and Williamson Counties
Eugene Fulton, Director
500 Lake Air Drive, Suite 1
Waco, TX 76710-5887
(817) 772-9240

Region 4
Cameron, Hidalgo, Jim Hogg, Starr, Webb, Willacy and Zapata Counties
Robert Guzman, Director
Matz Building, Room 204
513 East Jackson
Harlingen, TX 78550
(512) 425-6010

Region 5
Aransas, Bee, Brooks, Calhoun, Dewitt, Duval, Goliad, Jackson, Jim Wells, Kennedy, Kleberg, Lavaca, Live Oak, McMullen, Nueces, Refugio, San Patricio, and Victoria Counties
Tom Palmer, Director
1231 Agnes St., Suite #103
Corpus Christi, TX 78401
(512) 882-5828

Region 6
Andrews, Borden, Coke, Concho, Crane, Crockett, Dawson, Ector, Gaines, Glasscock, Howard, Irion, Loving, Martin, McCulloch, Menard, Midland, Pecos, Reagan, Reeves, San Saba, Schleicher, Sterling, Sutton, Terrell, Tom Green, Upton, Ward, and Winkler Counties
Charley Sims, Director
1901 East 37th Street, Suite 101
Odessa, TX 79762
(915) 367-3871

Region 7
Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Harris, Liberty, Matagorda, Montgomery, Walker, Waller, and Wharton Counties
Herbert W. Williams, Jr., Director
5555 West Loop, Suite 300
Bellaire, TX 77401
(713) 666-4964

Region 8
Collin, Cooke, Dallas, Denton, Ellis, Erath, Fannin, Grayson, Hood, Hunt, Johnson, Kaufman, Palo Pinto, Parker, Rockwall, Somervell, Tarrant, and Wise Counties
Melvin Lewis, Director
6421 Camp Bowie Blvd., Suite 312
Fort Worth, TX 76116
(817) 732-5531

Region 9
Atascosa, Bandera, Bexar, Comal, Dimmit, Edwards, Frio, Gillespie, Gonzales, Guadelupe, Karnes, Kendall, Kerr, Kimble, Kinney, La Salle, Mason, Maverick, Medina, Real, Uvalde, Val Verde, Wilson, and Zapata Counties
James Menke, Director
4335 Piedras West, Suite 101
San Antonio, TX 78228
(512) 734-7981

Region 10
Angelina, Hardin, Houston, Jasper, Jefferson, Nacogdoches, Newton, Orange, Polk, Sabine, San Augustine, San Jacinto, Shelby, Trinity, and Tyler Counties
Vic Fair, Director
4605-B Concord Road
Beaumont, TX 77703
(409) 838-0397

Region 11
Brewster, Culbertson, El Paso, Hudspeth, Jeff Davis, and Presidio Counties
Manuel Aguirre, P.E., Director
1200 Golden Key Circle, Suite 369
El Paso, TX 79925
(915) 591-8128

Region 12
Anderson, Bowie, Camp, Cass, Cherokee, Delta, Franklin, Gregg, Harrison, Henderson, Hopkins, Lamar, Marion, Morris, Panola, Rains, Red River, Rusk, Smith, Titus, Upshur, Van Zandt, Upshur and Wood Counties
Richard Leard, P.E., Director
1304 South Vine Avenue
Tyler, TX 75701
(214) 595-2639

Region 7 State Contacts

REGION 7

Iowa

Kurt Eskew
Air and Toxic Division
U.S. EPA
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7618

Kansas

Gary Miller
Asbestos Control Program
Kansas Dept. of Health and Environment
Forbes Field, Building 740
Topeka, KS 66620-0001
(913) 296-1550

Missouri

Mike Tharpe
Chief of Enforcement
Air Pollution Control Program
Missouri Dept. of Natural Resources
P.O. Box 176
Jefferson City, MO 65102
(314) 751-4817

Greene County-Springfield
Ron Boyer or Bryan Adams
Air Pollution Control Health Unit
Greene County-City of Springfield Health Dept.
227 East Chestnut Expressway
Springfield, MO 65802
(417) 864-1663

Kansas City
Paul Stablein or Jennifer Logan
Kansas City Air Quality Program
414 East Twelfth Street, 21st Floor
Kansas City, MO 64106
(816) 274-2501

St. Louis
Ronald Steinkamp
Division of Air Pollution Control
City Hall, Room 419
St. Louis, MO 63103
(314) 662-3334

St. Louis County
Dan Overton
St. Louis County Air Pollution Branch
111 South Meramec Avenue
Clayton, MO 63105
(314) 854-6912

Nebraska

Nebraska Dept. of Environmental Control
P.O. Box 94877
State House Station
Lincoln, NE 68509
(402) 471-2186

Jacqueline Fiedler
Division of Asbestos Control
Nebraska Dept. of Health
301 Centennial Mall South
P.O. Box 94877
Lincoln, NE 68509-5007
(402) 471-2541

Lincoln-Lancaster County
Gary Walsh
Air Pollution Control Section
Division of Environmental Health
Lincoln-Lancaster County Health Dept.
2200 St. Marys Avenue
Lincoln, NE 68502
(402) 471-8039

Omaha
Chester Black
Air Quality Control Division
5600 South 10th Street
Omaha, NE 68107
(402) 444-6015

REGION 8

Colorado

Alan Saville or Steve Fine
Compliance Monitoring and Enforcement Section
Air Pollution Control Division
Stationary Sources Program
Colorado Dept. of Health
4210 East 11th Avenue
Denver, CO 80220
(303) 331-8509

Denver
Jack Bendixon
Denver Dept. of Health and Hospitals
605 Bannock
Denver, CO 80204
(303) 893-6243

Montana

Warren Norton
Air Quality Bureau
Dept. of Health and Environmental Sciences
Cogswell Building
Helena, MT 59620
(406) 444-3454

North Dakota

Ken Wangler
State Dept. of Health and Consolidated Laboratories
1200 Missouri Avenue
P.O. Box 5520
Bismarck, ND 58502-5520
(701) 224-2348

South Dakota

Office of Air Quality and Solid Waste
Division of Water and Natural Resources
Joe Foss Building
Pierre, SD 57501
(605) 773-3153

tah

Kent Bott
Bureau of Air Quality
Dept. of Health
P.O. Box 16690
Salt Lake City, UT 84116-0690
(801) 538-6108

Salt Lake City County
Donald K. Horsley
Salt Lake City County Health Dept.
610 South 200 East
Salt Lake City, UT 84111
(801) 534-4516

›ming

F. Gerald Blackwell
Air Quality Division
Dept. of Environmental Quality
122 West 25th Street
Cheyenne, WY 82002
(307) 777-7391

REGION 9

Arizona

Wayne Hunt
Office of Air Quality
Arizona Dept. of Environmental Quality
2005 North Central Avenue
Room 603C
Phoenix, AZ 85004
(602) 257-2276

Pima County
John Bartlett
Pima County AQCD
150 West Congress Street
Tucson, AZ 85701

Maricopa County
Stephen Olson
Maricopa County APCD
P.O. Box 2111
Phoenix, AZ 85001
(602) 258-6381 x506

California

California Air Resources Board
1101 "R" Street
Sacramento, CA 95812
Contact: Francis Mateo
(916) 322-3976

For Information:
Charles Kersey
CARB Compliance Division
P.O. Box 2815
Sacramento, CA 95812
(916) 322-8272

Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, South Sonoma and South Solano Counties
Public Information
Bay Area AQMD
939 Ellis Street
San Francisco, CA 94109
(415) 771-6000 x210

Fresno County
Bob Bashian
Fresno County APCD
P.O. Box 11867
Fresno, CA 93775
(209) 445-3239

Humboldt, Del Norte, Trinity Counties
Leonard Herr
North Coast Unified AQMD
5630 South Broadway
Eureka, CA 95501
(707) 443-3093

Kern County
Jon Adams
Kern County APCD
2700 "M" Street, Suite 275
Bakersfield, CA 93301
(805) 861-3682

Kings County
Mark Poindexter or Chuck Hanna
Kings County APCD
330 Campus Drive
Hanford, CA 93230
(209) 584-1411

Lake County
John Thompson
Lake County AQMD
883 Lakeport Blvd.
Lakeport, CA 95453
(707) 263-7000

Los Angeles, Orange, Riverside, and San Bernardino (except Desert Portion) Counties
Paul Aunchman
South Coast AQMD
9150 Flair Drive
El Monte, CA 91731
(818) 572-6195

Madera County
Bill Sturk
Madera County APCD
135 West Yosemite Avenue
Madera, CA 93637
(209) 675-7823/24/25

Mendocino County
Philip Towle
Mendocino County APCD
Courthouse
Ukiah, CA 95482
(707) 463-4354/5458

Merced County
John Lathrop
Roland Brooks, Asst. APCO
Environmental Health
Merced County APCD
385 East Thirteenth Street
Merced, CA 95340
(209) 385-7391

Modoc County
Clinton B. Greenbank
Modoc County APCD
202 West Fourth Street
Alturas, CA 96101
(916) 233-3939 x401

Mono, Inyo, and Alpine Counties
Larry Cameron or Duane Ono
Great Basin Unified APCD
157 Short Street
Bishop, CA 93514
(619) 872-8211

Monterey County
Ed Kendig
Monterey Bay Unified APCD
1164 Monroe Street, Suite 10
Salinas, CA 93906-3596
(408) 443-1135

Northern Sonoma County
George Erdman
Northern Sonoma County APCD
109 North Street
Healdsburg, CA 95448
(707) 433-5911

Sacramento County
Asbestos Coordinator
Sacramento Metropolitan AQMD
8475 Jackson Road, Suite 215
Sacramento, CA 95826
(916) 386-6650

San Bernardino County (Desert Portion)
Richard Wales or Steve Jenkins
San Bernardino County APCD
15428 Civic Drive, Suite 200
Victorville, CA 92392
(619) 243-8200

San Diego County
Jimmy Cooksey
San Diego County APCD
9150 Chesapeake Drive
San Diego, CA 92123
(619) 694-3340

San Joaquin County
San Joaquin County APCD
P.O. Box 2009
Stockton, CA 95201
ATTN: Lakhmir Grewal
APCD Director
(209) 468-3400
Contact: Jim Czarnecki
(209) 468-3476

San Luis Obispo County
San Luis Obispo County APCD
2156 Sierra Way, Suite B
San Luis Obispo, CA 93401
(805) 549-5912

Santa Barbara County
George F. Tise, II
Santa Barbara County APCD
240 East Highway 246, Suite 207
Buellton, CA 93427
(805) 686-5012

Stanislaus County
Mark Macedo
Stanislaus County APCD
1716 Morgan Road
Modesto, CA 95351
(209) 525-4152

Tulare County
Joel Martins
Environmental Health Division
Tulare County APCD
Health Building
County Civic Center
Visalia, CA 93291
(209) 733-6441

Ventura County
Jay Nicholas
Ventura County APCD
800 South Victoria Avenue
Ventura, CA 93009
(805) 654-5031

Yolo and Northern Solano Counties
Bill Schuldt
Yolo-Solano County APCD
P.O. Box 1006
Woodland, CA 95695
(916) 666-8146/47

vaii

Ken Hall
Clean Air Branch
Hawaii Dept. of Health
P.O. Box 3378
2611 Kilihau Street
Honolulu, HI 96801
(808) 543-8200

ıda

Washoe County
Brian Wright
Environmental Health/Air Quality
Washoe County District Health Dept.
P.O. Box 11130
1001 East Ninth Street
Reno, NV 89520
(702) 328-2620

Clark County
Harold Glasser
Air Pollution Control Division
Clark County Health District
P.O. Box 4426
Las Vegas, NV 89127
(702) 383-1276

REGION 10

Alaska

For Notification
Tom Wilson
Alaska Operations Office
U.S. EPA
Room 537, Federal Building
222 W. 7th Ave. #19
Anchorage, AK 99513-7588
(907) 271-5083

For Disposal
Alaska Dept. of Environmental Conservation
3601 C Street, Suite 1350
Anchorage, AK 99503
(907) 563-6529

Idaho

Tim Trumbull
U.S. EPA
422 W. Washington Street
Boise, ID 83702
(208) 334-1626

Oregon

Sara Armitage
State Asbestos Program
Oregon Dept. of Environmental Quality
811 S.W. 6th Avenue
Portland, OR 97204
(503) 229-5186

Lane County
Tom Freeman
Lane Regional Air Pollution Control Authority (LRAPA)
225 North 5th Street, Suite 501
Springfield, OR 97477
(503) 726-2514

Washington

Ken Fukutomi
Washington Dept. of Ecology
4350 150th Avenue NE
Redmond, WA 98502
(206) 867-7107

Tri-Counties
J. Phillip Cooke
Tri-Counties Air Pollution Control Authority
650 George Washington Way
Richland, WA 99352
(509) 946-4489

Northwest
Terry Nyman
Northwest Air Pollution Authority
302 Pine Street, Suite 207
Mount Vernon, WA 98273
(206) 428-1617

Olympic
Chuck Peace
Olympic Air Pollution Control Authority
120 East State Avenue
Olympia, WA 98103
(206) 586-0593 x100

Puget Sound
Joe Eng
Puget Sound Air Pollution Control Agency
200 West Mercer Street, Room 205
Seattle, WA 98119-3958
(206) 296-7335

Southwest
Richard Serdoz
Southwest Air Pollution Control Authority
1308 N.E. 134th St., Suite D
Vancouver, WA 98685-2747
(206) 574-3058
(800) 633-0709

Spokane
Ron Edgar
Spokane County Air Pollution Control Authority
W. 1101 College Avenue, Room 230
Spokane, WA 99201
(509) 456-4727 x105

Yakima County
Yakima County Clean Air Authority
County Courthouse
Yakima, WA 98901
(509) 575-4116

State Index

	Page
Alabama	14
Alaska	22
Arizona	20
Arkansas	17
California	20
Colorado	20
Connecticut	13
Delaware	13
District of Columbia	13
Florida	14
Georgia	15
Hawaii	22
Idaho	22
Illinois	16
Indiana	16
Iowa	19
Kansas	19
Kentucky	15
Louisiana	17
Maine	13
Maryland	14
Massachusetts	13
Michigan	16
Minnesota	16
Mississippi	15
Missouri	19
Montana	20
Nebraska	19
Nevada	22
New Hampshire	13
New Jersey	13
New Mexico	17
New York	13
North Carolina	15
North Dakota	20
Ohio	16
Oklahoma	17
Oregon	22
Pennsylvania	14
Puerto Rico	13
Rhode Island	13
South Carolina	15
South Dakota	20
Tennessee	16
Texas	17
Utah	20
Vermont	13
U.S. Virgin Islands	13
Virginia	14
Washington	23
West Virginia	14
Wisconsin	16
Wyoming	20

ITEM 5

Common Questions On The Asbestos NESHAP

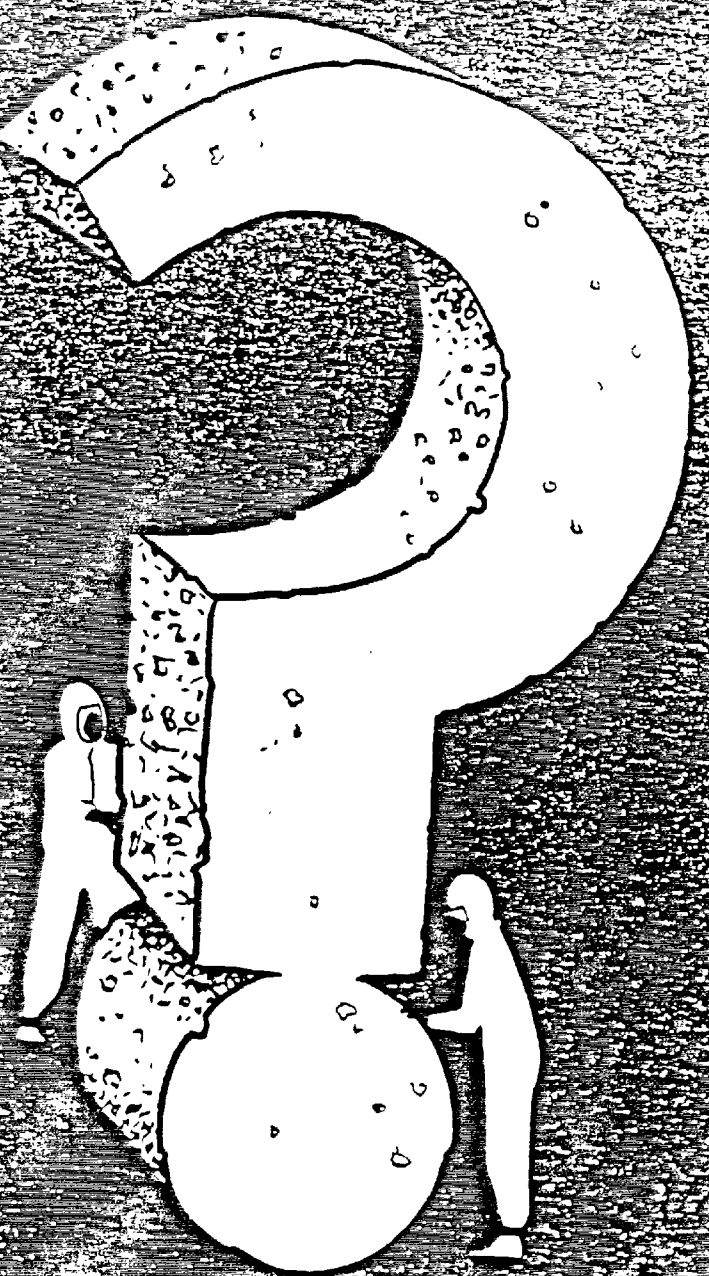
United States
Environmental Protection
Agency

Air and
Radiation
(EN-341)

EPA-340/1-90-021
December 1990

EPA

Common Questions On The Asbestos NESHAP



Common Questions On The Asbestos NESHAP

United States
Envrionmental Protection Agency
Office Of Air Quality Planning and Standards
Stationary Source Compliance Division

December 1990

Common Questions on the Asbestos NESHAP

Contents

Introduction 1

General Information 2

NESHAP Jurisdiction 3

Notifications 6

Removal 9

Ordered Demolitions 10

Friable and Non-Friable Asbestos 11

Transport and Disposal 12

Monitoring and Sampling 14

Inspections 15

Training 17

Violations and Penalties 17

NARS 19

Additional Information 21

Glossary of Terms 22

AHERA and NESHAP Coordinators 24

DISCLAIMER

This manual was prepared by Entropy Environmentalist, Inc. for the Stationary Source Compliance Division of the U.S. Environmental Protection Agency. It has been completed in accordance with EPA Contract No. 68-02-4462, Work Assignment No. 90-123. This document is intended for information purposes ONLY, and may not in any way be interpreted to alter or replace the coverage or requirements of the asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR Part 61, Subpart M. Any mention of product names does not constitute endorsement by the U.S. Environmental Protection Agency.

Common Questions on the Asbestos NESHAP

Introduction

The Clean Air Act (CAA) requires the U. S. Environmental Protection Agency (EPA) to develop and enforce regulations to protect the general public from exposure to airborne contaminants that are known to be hazardous to human health. In accordance with Section 112 of the CAA, EPA established National Emissions Standards for Hazardous Air Pollutants (NESHAP) to protect the public. Asbestos was one of the first hazardous air pollutants regulated under Section 112. On March 31, 1971, EPA identified asbestos as a hazardous pollutant, and on April 6, 1973, EPA first promulgated the Asbestos NESHAP in 40 CFR Part 61.

In 1990, a revised NESHAP regulation was promulgated by EPA. Information contained in this pamphlet is consistent with the amended regulation.

This pamphlet answers the most commonly asked questions about the Asbestos NESHAP for demolitions and renovations. Many of the questions included in this pamphlet have been raised by demolition and renovation contractors in recent years. Most questions relate to how a demolition or renovation contractor or building owner can best comply with the regulation. The responses assume that the questioner has a basic understanding of the Asbestos NESHAP and demolition and renovation practices. A brief glossary of terms is also included at the back of the pamphlet.

The Asbestos NESHAP regulations protect the public by minimizing the release of asbestos fibers during activities involving the processing, handling, and disposal of asbestos-containing material. Accordingly, the Asbestos NESHAP specifies work practices to be followed during demolitions and renovations of all structures, installations, and buildings (excluding residential buildings that have four or fewer dwelling units). In addition, the regulations require the owner of the building and/or the contractor to notify applicable State and local agencies and/or EPA Regional Offices before all demolitions, or before renovations of buildings that contain a certain threshold amount of asbestos.

For more information about the Asbestos NESHAP or for answers to questions not covered in this pamphlet, contact the delegated State or local agency or the appropriate EPA Regional Office listed on page 24.

General Information

What is the purpose of the Asbestos NESHAP regulation?

The purpose is to protect the public health by minimizing the release of asbestos when facilities which contain asbestos-containing materials (ACMs) are demolished or renovated.

How much regulated asbestos-containing material (RACM) is disposed of annually from demolition/renovation operations?

Approximately 5.7 million cubic feet of RACM is disposed of annually. In accordance with the regulation, most RACM is taken to landfills, where it is covered by soil or other debris in order to keep it from releasing asbestos fibers.

What is the difference between demolishing a facility and renovating it?

"Demolition" and "renovation" are defined in the regulation. You "demolish" a facility when you remove or wreck any load-supporting structural member of that facility or perform any related operations; you also "demolish" a facility when you burn it. You "renovate" a facility when you alter any part of that facility in any other manner. Renovation includes stripping or removing asbestos from the facility.

What percentage of asbestos related activities involve demolitions?

Demolitions comprise approximately 10% of all reported asbestos-related activities.

Is there a numeric emission limit for the release of asbestos fibers during renovations or demolitions in the asbestos NESHAP regulation?

No, the Asbestos NESHAP relating to demolitions or renovations is a work practice standard. This means that it does not place specific numerical emission limitations for asbestos fibers on asbestos demolitions and removals. Instead, it requires specific actions be taken to control emissions. However, the Asbestos NESHAP does specify zero visible emissions to the outside air from activity relating to the transport and disposal of asbestos waste.

Who is responsible for enforcing the Asbestos NESHAP standards?

Under Section 112 of the Clean Air Act, Congress gave EPA the responsibility for enforcing regulations relating to asbestos renovations and demolitions. The CAA allows EPA to delegate this authority to State and local agencies. Even after EPA delegates responsibility to a State or local agency, EPA retains the authority to oversee agency performance and to enforce NESHAP regulations as appropriate.

How many States have primary responsibility for implementing the Asbestos NESHAP regulations?

As of October 1990, approximately 45 states.

NESHAP Jurisdiction

What is a facility?

As defined in the regulation, a "facility" is any institutional, commercial, public, industrial or residential structure, installation or building (including any structure, installation or building containing condominiums, or individual dwelling units operated as a residential cooperative, but excluding residential buildings having four or fewer dwelling units); any ship; or any active or inactive waste disposal site. Any building, structure or installation that contains a loft used as a dwelling is not considered residential. Any structure, installation, or building that was previously subject to the Asbestos NESHAP is not excluded, regardless of its current use or function.

If I renovate several two-family units, are the units defined as a "facility?"

Residential buildings which have four or fewer dwelling units are not considered "facilities" unless they are part of a larger installation (for example, an army base, company housing, apartment or housing complex, part of a group of houses subject to condemnation for a highway right-of-way, an apartment which is an integral part of a commercial facility, etc.).

Are mobile homes or mobile structures regulated by the Asbestos NESHAP?

Mobile homes used as single-family dwellings are not subject to Asbestos NESHAP. Mobile structures used for non-residential purposes are subject to NESHAP.

Are Federal facilities regulated by the Asbestos NESHAP?

Yes.

Are single-family private residences regulated by the Asbestos NESHAP?

No.

How much asbestos must be present before the Asbestos NESHAP work practice standards apply to renovation projects?

Asbestos NESHAP regulations must be followed for all renovations of facilities with at least 80 linear meters (260 linear feet) of regulated asbestos-containing materials (RACM) on pipes, or 15 square meters (160 square feet) of regulated asbestos-containing materials on other facility components, or at least one cubic meter (35 cubic feet) off facility components where the amount of RACM previously removed from pipes and other facility components could not be measured before stripping. These amounts are known as the "threshold" amounts.

How much asbestos must be present before the Asbestos NESHAP work practice standards apply to demolition projects?

Asbestos NESHAP regulations must be followed for demolitions of facilities with at least 80 linear meters (260 linear feet) of regulated asbestos-containing materials (RACM) on pipes, 15 square meters (160 square feet) of regulated asbestos-containing materials on other facility components, or at least one cubic meter (35 cubic feet) off facility components where the amount of RACM previously removed from pipes and other facility components could not be measured before stripping.

However, all demolitions must notify the appropriate regulatory agency, even if no asbestos is present at the site, and all demolitions and renovations are "subject" to the Asbestos NESHAP insofar as owners and operators must determine if and how much asbestos is present at the site.

Are homes that are demolished or renovated to build non-residential structures regulated by the Asbestos NESHAP?

Yes. For example, homes which are demolished as part of an urban renewal project, a highway construction project, or a project to develop a shopping mall are regulated by the Asbestos NESHAP.

A single home which is converted into a non-residential structure is also regulated by the Asbestos NESHAP. For example, if someone buys a house and converts it into a store, the renovation is subject to the Asbestos NESHAP.

If a renovation site is abandoned, is the site still regulated by the Asbestos NESHAP?

Yes. Even after a renovation site is abandoned, it is still regulated by the Asbestos NESHAP.

What is encapsulation, and is it regulated by the Asbestos NESHAP?

Encapsulation is the application of a material with a sealant to stop it from releasing fibers. Normally, encapsulation is not regulated by the Asbestos NESHAP unless it involves removing or stripping asbestos. However, if encapsulation is done using methods that damage asbestos and release fibers it would be covered. For example, high pressure spraying to apply encapsulant could damage asbestos. Also, if friable RACM is encapsulated, the RACM is still covered by the Asbestos NESHAP if renovation or demolition occurs.

Are offshore oil rigs regulated in terms of asbestos removal and demolition?

Yes. Federal jurisdiction extends to the continental shelf (100 miles). When EPA delegates authority to State or local agencies, the State and local agencies are usually considered to have authority only in territorial waters (12 miles). The Department of the Interior is still evaluating whether States may extend their jurisdiction beyond territorial waters. EPA currently enforces the NESHAP between territorial waters and the continental shelf.

Notifications

What is a notification?

A notification is a written notice of intent to renovate or demolish. Notifications must contain certain specified information, including but not limited to, the scheduled starting and completion date of the work, the location of the site, the names of operators or asbestos removal contractors, methods of removal and the amount of asbestos, and whether the operation is a demolition or renovation.

See Section §61.145(b) of the Asbestos NESHAP regulation.

Whom do I notify?

You should notify the delegated State/Local Pollution Control Agency in your area and/or the EPA Regional Office of the demolition or renovation operations subject to NESHAP. Some EPA Regions require that both the EPA Regional Office and the local delegated agency be notified, while some require notice only to the delegated State or local agency. If the program is not delegated, notify the EPA Regional Office.

How do I notify?

Mail or hand-deliver the notification to the appropriate agency.

Are telefaxed or telephone notifications acceptable?

No. Telefaxed notifications are not accepted. Telephone notifications are only acceptable in emergency situations at the discretion of the EPA Regional Office or delegated agency and must be followed with a written copy by the following working day.

Who is responsible for submitting a notification – the owner of the building which is being demolished or renovated, or the contractor?

The NESHAP regulation states that either the owner of the building or operator of the demolition or renovation operation can submit the notification. Usually, the two parties decide together who will notify. If neither provide adequate notice, EPA can hold either or both parties liable.

When a condominium complex is being renovated, who as owner, is responsible for submitting a notification?

While owners and operators share responsibility for proper notification, the condominium or co-op board is responsible as the owner. The board should ensure that they are told when work takes place on individual units, so that they can comply with notification (and other EPA) requirements, especially if multiple operators are involved.

Is there a form or format for notifications?

Yes, there is a suggested form for notifications. You can obtain a form, and instructions on how to fill it out, from your delegated State or local agency or from your EPA Regional Office.

Do demolitions of facilities in which no asbestos is present require notification?

Yes. All demolitions that meet the definition of facility must notify.

When I notify regarding a renovation, what date do I consider the start date?

For a renovation, the start date is the day that the removal of asbestos-containing material, or any other asbestos-handling activities, including precleaning, construction of containment, or other activities that could disturb the asbestos, will begin.

When I notify regarding a demolition, do I give the start date of the demolition or of the asbestos removal? Which date do I use to determine whether I've met the 10-day waiting period?

For a demolition, the start date is the date that the removal or related activity begins. The date the demolition starts also must be reported. The waiting period should be calculated based on the start date of the removal or the demolition, if no removal is required. The waiting period is necessary to give inspectors time to visit the site before activity begins.

Does the 10-day notification requirement refer to "calendar" days or "working" days?

The Asbestos NESHAP regulation specifies "working days." Holidays that fall between Monday and Friday count as "working days."

What is a "nonscheduled renovation operation"?

A "nonscheduled renovation operation" is a renovation operation that is caused by the routine failure of equipment which is expected to occur based on past operating experience, but for which an exact date cannot be predicted.

Do I have to notify for non-scheduled operations? When?

Yes, if you can predict based on past experience that renovations will be necessary during the calendar year and the amount of asbestos is likely to exceed the jurisdictional amount, notification is required. This notification must be submitted at least 10 working days before the end of the calendar year preceding the year for which notice is being given.

Note: Single renovation projects which exceed the threshold amount are not covered by this type of notice. A separate notification is required for these projects.

Must I notify the agency again if I know that a specific renovation project involving more than the threshold amount (including the work covered by the calendar year notice for non-scheduled operations) is about to occur at a specific time?

Yes.

What constitutes an emergency renovation?

An emergency renovation is a renovation that was not planned, but results from a sudden, unexpected event that either immediately produces unsafe conditions, or that, if not quickly remedied, could be reasonably foreseen to result in an unsafe or detrimental effect on health or is necessary to protect equipment and avoid unreasonable financial burden. The term includes renovations necessitated by non-routine equipment failures. For example, the explosion of a boiler in a chemical plant might require emergency renovations, since such an explosion would disrupt

normal operations. However, renovations involving routine repairs are not emergencies.

Under what conditions must I notify for emergency renovations? When must I notify?

First, inspect the facility and determine the amount of RACM that may have to be removed or disturbed to repair the facility. (If you don't have the time to have samples analyzed, you should assume that all insulation is RACM.) Then, if the amount of RACM is in excess of the threshold amount, you should mail or deliver a notification as soon as possible, but certainly no later than the following workday. A notification which is postmarked more than one working day after the emergency will be considered in violation of the notification requirements. EPA recommends that you send the notice by overnight express mail, and that you phone in a notification as well to the delegated agency and/or EPA Regional Office.

When does a notification need to be revised?

A notification must be revised if information contained in the original notice has changed. For example, you must revise the notification if you change the start date of an operation. If the change relates to the amount of RACM involved, you need only revise the notification if the amount changes by more than 20 percent.

When do I submit a revised notification?

You should telephone EPA as soon as possible after you realize the revision is necessary, and should then mail or hand deliver a written notice. If you delay the start date of a project, EPA must receive the revised notification no later than the original start date. If you plan to begin work before the date specified in the original notice, EPA must receive the revised notice at least 10 working days before the revised start date.

emoval

Does the Asbestos NESHAP require a building owner or operator to remove damaged or deteriorating asbestos-containing material?

No. Not unless a renovation of the facility is planned which would disturb the ACM and it exceeds the threshold amount.

What does "adequately wet" mean?

To "adequately wet" ACM means to sufficiently mix or penetrate the material with liquid to prevent the release of particulates. If visible emissions are observed coming from ACM, then the material has not been adequately wetted. However, the absence of visible emissions is not evidence of being adequately wet.

If a contractor puts water in the bottom of a bag, then strips the friable asbestos material dry and lets it fall into the water, is this a violation of the Asbestos NESHAP standards?

Yes. The regulation states that friable asbestos-containing material must be "adequately wet" during stripping operations. The material must remain wet until disposal.

Section 61.145(c)(6)(iii) states that the operator must "transport the materials to the ground via dust tight chutes or containers if it has been removed or stripped more than 50 feet above ground level." Can a room sealed with plastic and a negative air system be considered a dust tight chute?

No, the area in which removal is being conducted (the containment area) cannot be considered a dust tight chute in order to comply with §61.145(c)(6)(iii).

Ordered Demolitions

If a facility is being demolished under an order of a State or local government because the facility is structurally unsound and therefore unsafe, do all the normal regulations covering demolitions apply?

No. The regulations which do apply are specified in §61.145 (a)(3) of the regulation.

If a facility is being demolished under an order of a State or local government, must all the debris be treated as asbestos-contaminated waste?

If, for safety reasons, the RACM in the facility is not removed prior to demolition, the RACM must be kept adequately wet during the wrecking operations. After wrecking, all the contaminated debris must be kept adequately wet until disposal.

All contaminated debris which cannot be segregated and cleaned should be disposed of as asbestos waste.

Friable and Non-Friable Asbestos

What is friable asbestos-containing material?

Friable ACM is any material containing more than one percent asbestos (as determined by Polarized Light Microscopy) that, when dry, may be crumbled, pulverized, or reduced to powder by hand pressure.

What is non-friable ACM?

Non-friable ACM is any material containing more than one percent asbestos (as determined by Polarized Light Microscopy) that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure. Under the Asbestos NESHAP, non-friable ACM is divided into two categories. Category I non-friable ACM are asbestos-containing resilient floor coverings (commonly known as vinyl asbestos tile (VAT)), asphalt roofing products, packings and gaskets. These materials rarely become friable. All other non-friable ACM are considered category II non-friable ACM.

Must I remove category I non-friable material prior to demolition or renovation?

Under normal circumstances, category I non-friable materials need not be removed prior to demolition or renovation, because generally these materials do not release significant amounts of asbestos fibers, even when damaged. This is not, however, a hard and fast rule. If category I materials have become friable or are in poor condition, they must be removed. Also, if you sand, grind, abrade, drill, cut or chip any non-friable materials, including category I materials, you must treat the material as friable, if more than the jurisdictional amount is involved.

Must I remove category II non-friable materials prior to demolition or renovation?

These materials should be evaluated on a case-by-case basis. If category II non-friable materials are likely to become crushed, pulverized or reduced to powder during demolition or renovation, they should be removed before demolition or renovation begin. For example, A/C (asbestos cement) siding on a building that is

going to be demolished with a wrecking ball should be removed, because it is likely that the siding will be pulverized by the wrecking ball.

Does non-friable waste, if broken, damaged, etc., have to be wetted and contained?

Non-friable ACM that has been damaged during a demolition or renovation operation such that some portions of the material are crumbled, pulverized or reduced to powder is covered by the Asbestos NESHAP if the facility contains more than the threshold amount of RACM. However, category II non-friable ACM that has a high probability of being damaged by the demolition or renovation forces expected to act on the materials such that it will be crumbled, pulverized, or reduced to powder must be removed prior to the demolition or renovation operation. It is the owner's or operator's responsibility to make these determinations.

Transport and Disposal

How should I handle bulk waste from a facility that contained RACM and that was not found until after demolition began?

The demolition debris must be treated as asbestos-containing waste. Adequately wet the demolition debris until collected for disposal and during loading, transport it in covered vehicles and emit no visible emissions to the outside air as required by §61.150. The waste must be deposited at an acceptable waste disposal site.

Can I transport bulk asbestos waste without placing it in containers as long as I keep the waste pile wet?

No. After wetting, seal all asbestos-containing waste material in leak-tight containers while wet and label with the appropriate signs and labels. If the waste will not fit into containers, it must be placed in leak-tight wrapping.

However, for facilities that are demolished without removing the RACM and for ordered demolitions, the material must be adequately wet after the demolition has occurred and again when loading the material for transport to a disposal site. RACM covered by this paragraph may be transported in bulk without being placed in leak-tight containers or wrapping.

How should I label asbestos-containing waste that is being taken away from the facility?

You should label the containers or wrapped materials with the name of the waste generator and the location at which the waste was generated. An OSHA warning label must also be used.

Does EPA license landfills for asbestos waste?

The EPA does not license asbestos landfills under the Clean Air Act.. However, it has established asbestos disposal requirements for active and inactive disposal sites under the NESHAP, and general requirements for solid waste disposal under the Resource Conservation and Recovery Act (RCRA). In addition, State and/or local agencies usually require asbestos landfills to be approved or licensed.

Where can I obtain a list of licensed landfills?

State and local agencies which require handling or licensing procedures can supply a list of "approved" or licensed asbestos disposal sites upon request. Solid waste control agencies are listed in local telephone directories under State, county or city headings.

What should the owner or operator of a waste disposal site do if it is determined that there is a discrepancy between the amount of waste that left the facility and the amount of waste that was delivered to the site?

The waste site owner or operator must contact the demolition/renovation owner or operator, and attempt to reconcile the discrepancy. If they cannot do so within 15 days after the waste was received, the waste site owner or operator must notify both the delegated agency responsible for the facility from which the waste was removed, and the delegated agency responsible for the area in which the waste was disposed.

Can water be considered "six-inch compacted non-asbestos cover"? In other words, could asbestos covered components be dropped in the ocean?

Monitoring and Sampling

Does the NESHAP regulation require air monitoring during renovation or removal?

No.

Does the Asbestos NESHAP regulation require me to inspect my property for asbestos?

No, not unless demolition or renovation is planned. The only Federal regulation which requires general inspections are the AHERA regulations, which mandate that schools must be inspected for asbestos. The NESHAP regulation requires that you inspect for asbestos before demolition or renovation.

What is the acceptable exposure/ambient air standard for asbestos?

EPA does not specify an acceptable exposure/ambient air standard.

What is a bulk sample?

A bulk sample is a solid quantity of insulation, floor tile, building material, etc., that is suspected of containing asbestos fibers that will be analyzed for the presence and quantity of asbestos.

Will EPA test my building for asbestos for me?

No. Owners and operators are responsible for getting their buildings tested.

How can I find someone to do the testing?

The National Institute of Standards and Technology (NIST) publishes a yearly listing of accredited laboratories enrolled in the National Voluntary Laboratory Accreditation Program (NVLAP). Then, on a quarterly basis NIST publishes updates to the master list detailing labs newly accredited, labs which have had their accreditation suspended, etc. Contact NIST NVLAP for a current listing of accredited labs. The NIST NVLAP number is listed at the end of this pamphlet, along with other contact numbers.

Does EPA accredit laboratories that test for asbestos?

No. EPA, under CFR Part 763, requires local education agencies to use laboratories accredited by the National Institute of Standards and Technology (NIST) in its National Voluntary Laboratory Accreditation Program (NVLAP). It is recommended for NESHAP related projects that NIST accredited laboratories be used.

How do laboratories analyze bulk samples?

Laboratories analyze bulk samples a number of ways. Most laboratories use Polarized Light Microscopy (PLM). Some laboratories use Transmission Electron Microscopy (TEM). However, there is currently no published method for bulk analysis using TEM.

How much does it cost to have a bulk sample analyzed?

The cost varies with the method. The cost of PLM analysis ranges from $20.00 to $100.00. The average cost is $30.00. TEM analysis is more expensive.

Inspections

Does an inspector have the right to enter any facility and the containment area?

Yes. All inspectors have the right under the Clean Air Act to inspect any facility and the containment area. Inspectors are trained and equipped to do this safely.

If I can see ACM dust inside the containment area or inside a glovebag, is this a violation of the Asbestos NESHAP?

The observation of ACM dust will be used as evidence of a violation of the "adequately wet" requirement. This is consistent with the definition of adequately wet that requires enough wetting "to prevent the release of particulates."

Is visible asbestos-containing debris on the ground outside a removal job considered a "visible emission," and a violation of the NESHAP?

Yes. Dry friable asbestos insulation on the ground violates the "adequately wet" requirement, and can be considered evidence of a visible emission.

Is it appropriate for an inspector to open any bags outside the designated contaminated area?

Yes. The inspector may open any bags outside the designated contaminated area to inspect them. The inspector may use a glovebag or other control techniques. The inspector will then properly reseal the bag, or request that the operator do so.

Must an inspector witness improper removal of more than 160 square feet or 260 linear feet of asbestos-containing material to prove a violation of the NESHAP regulation?

No. First, the inspector must gather information about the quantity of asbestos to prove that the project is subject to the NESHAP standards. Second, the inspector must prove that there has been improper removal. The two tasks are distinct from each other.

Are inspectors required to have medical examinations to ensure that they are medically fit to wear respirators?

Yes. Several Federal provisions under OSHA, EHSD, and NIOSH require people to be examined by a doctor and pronounced physically fit before they are permitted to wear respirators.

Must inspectors have personnel monitoring conducted on them during inspections to comply with OSHA requirements for workers?

No. The inspectors do not have to comply with the work practice safety standards required by OSHA for personnel monitoring.

Do inspectors need to follow facility training requirements including fit testing?

No.

Training

Do contractors and employees need to be accredited?

As of November 20, 1991, the Asbestos NESHAP requires a person trained in the provisions of this rule and the means of complying with them to be on-site when asbestos-containing material is stripped, removed, or disturbed. Under AHERA, all contractors and employees involved in the removal and disposal of asbestos-containing material from schools must be accredited. Additionally, many States require that all workers be accredited before they remove asbestos from any facility.

How can I qualify as an asbestos contractor/worker/consultant under AHERA?

You must attend and pass an EPA accredited training course. A list of training courses approved by EPA is published quarterly in the Federal Register, and is available through the TSCA hotline. The TSCA number is printed at the end of this pamphlet, along with other contact numbers. Contact your State or local agency for more information.

Do supervisors need to be trained?

Beginning on November 20, 1991, the Asbestos NESHAP requires at least one trained supervisor to be present at any site at which RACM is stripped, removed, or otherwise disturbed at any facility which is being demolished or renovated and is regulated by NESHAP. Evidence of the training must be posted and made available for inspection at the demolition or renovation site. Training includes, at a minimum: applicability, notification, material identification, control procedures, waste disposal, reporting and record keeping, asbestos hazards and worker protection. Completion of an AHERA accredited course constitutes adequate training. Every 2 years the trained individual is required to receive refresher training. Information about both the training and refresher courses is available through EPA or delegated State or local agencies.

Violations and Penalties

What will happen if I violate the Asbestos NESHAP?

Sanctions vary. In some cases, Notices of Deficiency (NOD) -- written warnings -- or Notices of Violation (NOV's) are issued to owners or operators who violate notification requirements. Or, depending upon the offense, EPA recommends fines up to $25,000 per day per violation.

Violators of the work practice or disposal standards may be subject to either written warnings, administrative orders or civil penalties up to $25,000 per day per violation, depending upon the seriousness of the violation. EPA may also bring criminal charges against violators. Some owners and operators who have knowingly violated the Asbestos NESHAP have been sentenced to prison terms.

For more information on penalties and enforcement, see the EPA Public Information Document entitled "Asbestos NESHAP Enforcement."

What is the maximum penalty which can be assessed for NESHAP violations?

$25,000 per day, per violation, with no absolute maximum. However, some NESHAP violators may also be liable under CERCLA, and if so, the maximum penalty may be much higher.

How are penalties calculated?

Penalties are computed on a case-by-case basis. The amount of asbestos involved, the number of previous violations, the duration of the offense, the economic benefit that accrued to the owner or operator as a result of the violation, and similar considerations are taken into account.

What is "contractor listing?"

Contractors who have shown a pattern of violation, or who have been convicted of a criminal violation, may be placed on a list of violators who are prohibited from contracting for any jobs involving Federal money (grants, contracts, sub-grants, etc.).

Can a corporation that has changed its name, but is owned by an individual who has been listed be subject to contractor listing?

Yes.

NARS

What is NARS?

NARS stands for "National Asbestos Registry System." NARS is a computerized database established by EPA in April, 1989. NARS stores data on the compliance history of firms doing demolition or renovation work subject to the Asbestos NESHAP.

What is the purpose of NARS?

NARS is used by EPA Regional Offices as well as State and local agencies to "target" inspections of contractors with poor compliance histories, and to monitor activity subject to the NESHAP regulations.

Can I get NARS information?

Yes. NARS information is available through EPA Regional Offices under the provisions of the Freedom of Information Act.

Are there any penalties for being listed in NARS as a violator?

No. NARS is only an information system. Contractors who have violations listed in NARS may, however, be inspected more frequently than contractors who have no violations.

Why does EPA recommend inspection targeting?

Delegated agencies receive over 60,000 notifications of planned renovation or demolition projects each year. Because all projects cannot be inspected, EPA recommends targeting inspections so that agencies can make better use of their inspection resources.

Can firms avoid future inspections based on past good performance?

Past performance is an important criterion for targeting inspections; however, other criteria are also used. As a result of EPA guidance to State and local air pollution agencies, many asbestos removal contractors will be inspected at least once per year.

How many contractors and owners are currently listed in NARS?

As of October 1990, there were approximately 7,000 contractors and owners in NARS.

How does information get into NARS?

Information on the number of notifications, inspections, and violations for each contractor or owner is submitted by delegated State and local air pollution agencies and is reported through the EPA Regional NARS Coordinators to EPA Headquarters where the report is compiled.

Additional Information

You can obtain more information about the Asbestos NESHAP by contacting your EPA Regional Office's NESHAP coordinator. You can obtain more information about AHERA by contacting your Regional Asbestos Coordinator (RAC). The addresses and phone numbers of both the RAC and NESHAP coordinators are listed at the end of this pamphlet.

You may also call the EPA Toxic Substances Control Act (TSCA) Hotline to ask general questions about asbestos, or to request asbestos guidance documents. The Hotline number is (202) 554-1404. The EPA Public Information Center can send you information on EPA regulations. You can reach the Center at (202) 382-2080 or (202) 475-7751.

The EPA has an Asbestos Ombudsman to provide information on the handling and abatement of asbestos in schools, the workplace and the home. Also, the EPA Asbestos Ombudsman can help citizens with asbestos-in-school complaints. The Ombudsman can be reached toll-free at (800) 368-5888, direct at (703) 557-1938 or 557-1939.

To obtain a current listing of accredited labs contact NIST NVLAP at (301)975-4016.

Glossary of Terms

AHERA	The Asbestos Hazard Emergency Response Act, passed by Congress in 1986
CAA	Clean Air Act
CERCLA	The Comprehensive Environmental Response Compensation and Liability Act. Also known as the "Superfund."
EPA	The United States Environmental Protection Agency
EHSD	Environmental Health and Safety Division, U.S. EPA
Friable Asbestos Material	Any material containing more than one percent asbestos, as determined using the method specified in Appendix A, subpart F 40 CFR part 763, section 1, Polarized Light Microscopy, that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure. If the asbestos content is less than 10 percent as determined by a method other than point counting by polarized light microscopy (PLM), verify the asbestos by point counting using PLM.
Glovebag	A sealed compartment with attached inner gloves used for the handling of asbestos-containing materials.
NARS	National Asbestos Registry System
NESHAP	The National Emission Standard for Hazardous Air Pollutants found in Title 40 CFR part 61 promulgated under Section 112 of the Clean Air Act.
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NVLAP	National Voluntary Laboratory Accreditation Program
OSHA	Occupational Safety & Health Administration
Particulate Asbestos Material	Finely divided particles of asbestos or material containing asbestos.
RACM	Regulated Asbestos-Containing Material. RACM means (a) Friable asbestos material, (b) Category I nonfriable ACM that has become friable, (c) Category I nonfriable

	ACM that will be or has been subjected to sanding, grinding, cutting, or abrading, or (d) Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations regulated by the Asbestos NESHAP.
RCRA	Resource Conservation and Recovery Act
TSCA	Toxic Substances Control Act
Visible Emissions	Any emissions, which are visually detectable without the aid of instruments, coming from RACM or asbestos-containing waste material, or from any asbestos milling, manufacturing, or fabricating operation.

AHERA and NESHAP Coordinators

Region	NESHAP	AHERA
Region 1 CT, MA, ME NH, RI, VT	Asbestos NESHAP Coordinator Air Management Division US EPA JFK Building Boston, MA 02203 (617) 565-3265	Regional Asbestos Coordinator US EPA JFK Federal Building Boston, MA 02203 (617) 565-3835
Region 2 NJ, NY PR, VI	Asbestos NESHAP Coordinator Air & Waste Management Div. US EPA 26 Federal Plaza New York, NY 10278 (212) 264-6770	Regional Asbestos Coordinator US EPA Woodbridge Avenue Edison, NJ 08837 (201) 321-6671
Region 3 DC, DE, MD PA, VA, WV	Asbestos NESHAP Coordinator Air and Toxics Division US EPA 841 Chestnut Street Philadelphia, PA 19107 (215) 597-8683	Regional Asbestos Coordinator US EPA 841 Chestnut Street Philadelphia, PA 19107 (215) 597-3160
Region 4 AL, FL, GA, KY, MS, NC, SC, TN	Asbestos NESHAP Coordinator Air, Pesticide & Toxics Div. US EPA 345 Courtland Street Atlanta, GA 30365 (404) 347-5014	Regional Asbestos Coordinator US EPA 345 Courtland Street Atlanta, GA 30365 (404) 347-5014
Region 5 IL, IN, MI MN, OH, WI	Asbestos NESHAP Coordinator Air & Radiation Division US EPA 230 South Dearborn Street Chicago, IL 60604 (312) 353-6793	Regional Asbestos Coordinator US EPA 230 South Dearborn St. Chicago, IL 60604 (312) 353-6003

AHERA and NESHAP Coordinators

Region	NESHAP	AHERA
Region 6 AR, LA, NM OK, TX	Asbestos NESHAP Coordinator Air, Pesticides & Toxics Div. US EPA 1445 Ross Avenue Suite 1200 Dallas, TX 75202-2733 (214) 655-7233	Regional Asbestos Coordinator US EPA 1445 Ross Avenue Suite 1200 Dallas, TX 75202-2733 (214) 655-7244
Region 7 IA, KS MO, NE	Asbestos NESHAP Coordinator Air & Toxics Division US EPA 726 Minnesota Avenue Kansas City, KS 66101 (913) 551-7618	Regional Asbestos Coordinator US EPA 726 Minnesota Avenue Kansas City, KS 66101 (913) 551-7020
Region 8 CO, MT, ND SD, UT, WY	Asbestos NESHAP Coordinator Air & Waste Management Div. US EPA One Denver Place 999 18th Street Suite 500 Denver, CO 80202-2405 (303) 294-7685	Regional Asbestos Coordinator US EPA One Denver Place 999 18th Street Suite 500 Denver, CO 80202-2405 (303) 293-1442
Region 9 AS, CA, HI, NV, AZ, GU, TT	Asbestos NESHAP Coordinator Air Management Division US EPA 75 Hawthorne Street San Francisco, CA 94105 (415) 744-1135	Regional Asbestos Coordinator US EPA 75 Hawthorne Street San Francisco, CA 94105 (415) 744-1128
Region 10 AK, ID OR, WA	Asbestos NESHAP Coordinator Air & Toxics Management Div. US EPA 1200 6th Avenue Seattle, WA 98101 (206) 442-1757	Regional Asbestos Coordinator US EPA 1200 6th Avenue Seattle, WA 98101 (206) 442-4762

ITEM 6
The Asbestos/NESHAP Demolition Decision Tree

Asbestos/NESHAP Demolition Decision Tree

U.S. ENVIRONMENTAL PROTECTION AGENCY
Manufacturing, Energy, and Transportation Division
Office of Compliance

June 1994

DISCLAIMER

The policies in this document are intended solely as guidance. EPA may decide to follow this guidance or act at variance therewith, based on an analysis of individual circumstances. Furthermore, although this guidance is directed toward EPA asbestos NESHAP inspectors, it may also be appropriate for State and local regulatory inspectors. However, this guidance should be used only as a supplement to any existing State and local program requirements.

Although this guidance is directed toward EPA asbestos NESHAP inspectors, it may also be appropriate for State and local regulatory inspectors. However, this guidance should be used only as a supplement to any existing program requirements, particularly State or local requirements.

The guidance document was prepared in the SSCD by Jeffery KenKnight with assistance from Tom Ripp and the Regions.

Attachment

cc: Asbestos NESHAP Coordinators
Regions I-X

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 29 1994

MEMORANDUM

SUBJECT: Asbestos NESHAP Demolition Decision Tree Guidance Document

FROM: John B. Rasnic, Director Richard Biondi /R
Manufacturing, Energy, and Transportation Division
Office of Compliance

TO: Air, Pesticides and Toxics Management Division Directors
Regions I and IV

Air and Waste Management Division Director
Region II

Air, Radiation and Toxics Division Director
Region III

Air and Radiation Division Director
Region V

Air, Pesticides and Toxics Division Director
Region VI

Air and Toxics Division Directors
Regions VII, VIII, IX and X

Attached you will find the final version of the Asbestos NESHAP Demolition Decision Tree. Over the past few years, several demolition projects with unique issues were brought to the attention of the Stationary Source Compliance Division (SSCD). In order to maintain as much national consistency as possible, SSCD developed this guidance document addressing both normal and unique demolition projects and outlining a decision process that should be followed. The document is designed to help regulatory inspectors decide which of the regulatory requirements may be applicable to a given demolition.

Printed on Recycled Paper

TABLE OF CONTENTS

SECTION PAGE

I. INTRODUCTION 1

II. DEFINITIONS 2

III. DEMOLITION DECISION TREE 3

FLOW CHART 1 4
FLOW CHART 2 5
FLOW CHART 3 6
FLOW CHART 4 7

IV. INSPECTION OF FACILITIES UNDERGOING ORDERED DEMOLITION 3

V. STRUCTURALLY SOUND FACILITIES UNDERGOING NORMAL (other than intentional burning) DEMOLITION 8

A. Inspection of a Facility 8
B. Material Identification and Analysis 9
C. Removal of RACM Prior to Demolition 9
D. Discovery of RACM During Demolition 10
E. Evaluation of Unique Methods for Removing RACM 10
F. Isolating RACM Contaminated Debris 11
G. Site Assessment 11
H. Decontamination of Demolition Site 11

VI. DEMOLITION OF STRUCTURALLY UNSOUND FACILITIES 12

A. Demolition of Structurally Unsound Facilities 12
B. Inspection of a Facility 12
C. Material Identification and Analysis 13
D. Removal of RACM Prior to Demolition 14
E. Evaluation of Unique Methods for Removing RACM 14
F. Post Demolition Inspection for RACM Contaminated Debris 15
G. Isolating RACM Contaminated Debris 15
H. Site Assessment 15
I. Decontamination of Area Surrounding Demolition Site 16

VII. DEMOLITION OF A FACILITY BY INTENTIONAL BURNING 16

A. Inspection of a Facility 16
B. Material Identification and Analysis 16
C. Removal of RACM Prior to Demolition 16

APPENDICES

A Case Study
Bainbridge Naval Training Center, Maryland A-1

B Case Study
Jewel Lake Condominium, Anchorage, Alaska B-1

I. INTRODUCTION

This guidance has been prepared to help asbestos NESHAP inspectors provide guidance to the regulated community and to build stronger enforcement cases through more thorough and effective inspection practices. The guidance touches on difficult situations inspectors may encounter while conducting an asbestos inspection. In order to limit the scope of this document it concentrates on affected facilities undergoing demolition and deals only with EPA guidance regarding the asbestos NESHAP.

The primary focus of this document is the application of a demolition decision tree that is designed to help inspectors decide which of the NESHAP regulatory requirements are applicable to a given situation. Determining compliance with these requirements is addressed in the inspection checklist found in Guidelines for Asbestos NESHAP Demolition and Renovation Inspection Procedures (EPA 340/1-90-007, Revised November 1990).

Regardless of the current status of a facility (e.g., a partially burned structure, a structurally sound facility, etc.), regulatory inspectors utilizing the decision tree should always begin with Flow Chart 1. For example, if a facility is an ordered demolition, the inspector must first determine if the order was made by a qualified agency. An inspector should then determine if the demolition is ordered because the facility is structurally unsound and in danger of imminent collapse. If this is true, the decision process will proceed to Flow Chart 2, which details a chain of decisions an inspector should consider when conducting an asbestos NESHAP compliance inspection. Facilities that are <u>not</u> structurally unsound and will not be demolished by intentional burning (normal demolition) will proceed from Flow Chart 1 to Flow Chart 3 and possibly to Flow Chart 4. Demolition by intentional burning is covered in Flow Chart 1.

The decision tree is accompanied by a list of pertinent definitions and a detailed explanation of the process including examples of situations that may be encountered. Two case studies have been included in the appendices to the guidance that demonstrate how the demolition decision tree can be applied to real life situations.

II. DEFINITIONS

Installation means any building or structure or any group of buildings or structures at a single demolition or renovation site that is under the control of the same owner or operator (or owner or operator under common control).

Asbestos Containing Waste Material includes regulated asbestos-containing material waste and materials contaminated with asbestos including disposable equipment and clothing.

Regulated Asbestos Containing Material (RACM) is defined as (a) friable material, (b) Category I non-friable material that has become friable, (c) Category I non-friable material that will be or has been subjected to sanding, grinding, cutting or abrading, or (d) Category II non-friable material that has a high probability of becoming or has become crumbled, pulverized or reduced to powder by the forces expected to act on it during the course of the demolition.

Facility means any institutional, commercial, public, industrial, or residential structure, installation, or building (including any structure, installation, or building containing condominiums or individual dwelling units operated as a residential cooperative, but excluding residential buildings having four or fewer dwelling units); any ship; and any active or inactive waste disposal site. For purposes of this definition, any building, structure, or installation that contains a loft used as a dwelling, is not considered a residential structure, installation, or building. Any structure, installation or building that was previously subject to this subpart is not excluded, regardless of its current use or function.

Ordered Demolition* means a demolition that is mandated by order of a qualified State or local governmental agency because a facility is either structurally unsound and in danger of imminent collapse or it is being demolished as part of a government project (e.g., urban renewal project or road project).

Qualified State or Local Governmental Agency* means the governmental agency that has legal authority to inspect a facility and declare it structurally unsound and in imminent danger of collapse. Generally, these responsibilities will be held by the local building department or local engineering department. In order for such an agency to make declarations concerning a building's structural soundness and risk of collapse, the persons making such determinations must have appropriate training and/or experience.

Suspect RACM* means any material that is believed to contain asbestos that is either friable or Category I or II nonfriable material that has or will become regulated by actions that are expected to act upon the material.

Unique Methods* means any method of removing RACM that is not normally or has not been previously considered but when implemented will allow the owner/operator to remove RACM in situations otherwise thought too dangerous or impossible (i.e., the removal of material from a structurally unsound facility).

* Definitions to be used only for the purposes of this document.

III. Demolition Decision Tree

The demolition decision tree provided in flow charts 1-4 is designed to help regulatory inspectors determine which of the NESHAP regulatory requirements are applicable to a given demolition. The decision tree is a series of decisions that an inspector should go through when evaluating the demolition of a regulated facility. Use of the flow charts is explained in the following discussions.

IV. INSPECTION OF FACILITIES UNDERGOING ORDERED DEMOLITION

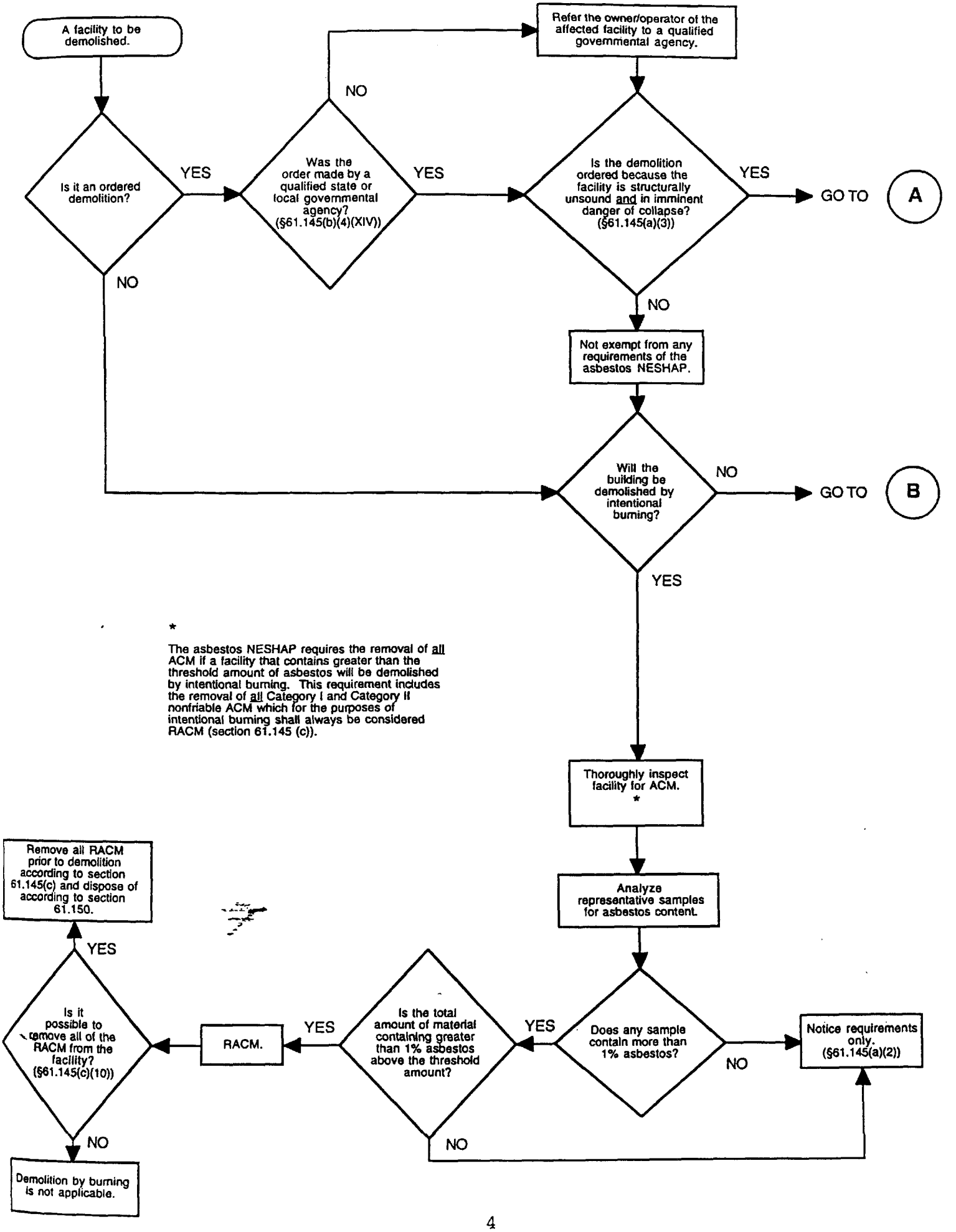
[Refer to Flow Chart 1]

Regulatory inspectors sent out to make asbestos NESHAP inspections of facilities undergoing demolition must first confirm whether or not the demolition is an ordered demolition and if so, the reason for the order and its origin. This information should be included on the notification.

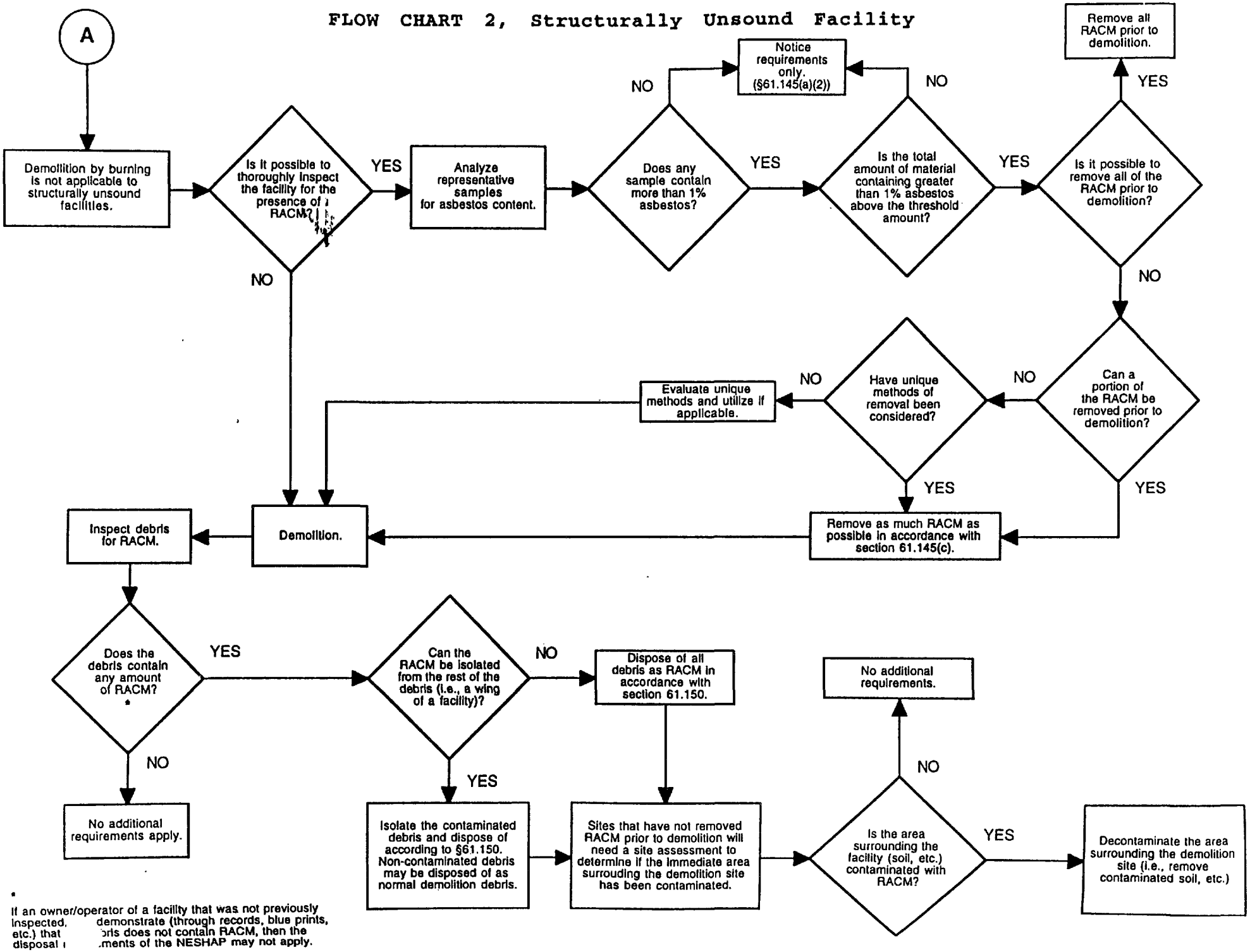
It is important to make a distinction between ordered demolitions that are made because the facility is structurally unsound and in danger of imminent collapse and those that are ordered as part of one common project, such as a highway right of way or an urban renewal project, because the former allows for some exemptions from the requirements of the asbestos NESHAP.

Demolitions ordered as part of one common project may in fact include facilities that are structurally sound. These facilities are not exempt from any of the requirements of the asbestos NESHAP. The owner/operator of such a facility is required to follow <u>all</u> the requirements of the asbestos NESHAP including inspection and notification and if applicable, abatement.

FLOW CHART 1

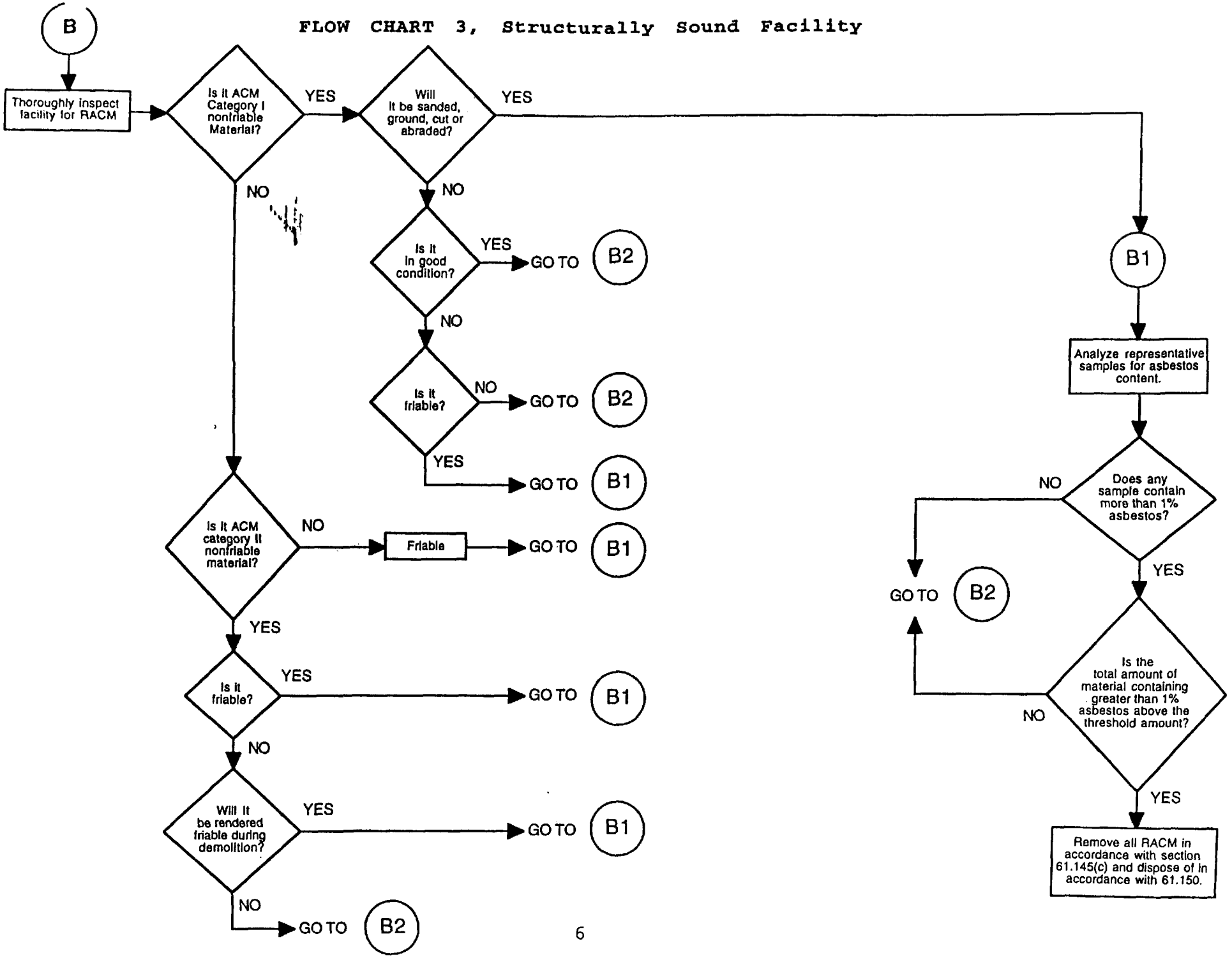

A facility to be demolished.
Is it an ordered demolition?
YES
NO
Was the order made by a qualified state or local governmental agency? (§61.145(b)(4)(XIV))
NO
YES
Refer the owner/operator of the affected facility to a qualified governmental agency.
Is the demolition ordered because the facility is structurally unsound and in imminent danger of collapse? (§61.145(a)(3))
YES
GO TO A
NO
Not exempt from any requirements of the asbestos NESHAP.
Will the building be demolished by intentional burning?
NO
GO TO B
YES
*
The asbestos NESHAP requires the removal of all ACM if a facility that contains greater than the threshold amount of asbestos will be demolished by intentional burning. This requirement includes the removal of all Category I and Category II nonfriable ACM which for the purposes of intentional burning shall always be considered RACM (section 61.145 (c)).
Thoroughly inspect facility for ACM. *
Analyze representative samples for asbestos content.
Does any sample contain more than 1% asbestos?
YES
NO
Notice requirements only. (§61.145(a)(2))
Is the total amount of material containing greater than 1% asbestos above the threshold amount?
YES
NO
RACM.
Is it possible to remove all of the RACM from the facility? (§61.145(c)(10))
YES
NO
Remove all RACM prior to demolition according to section 61.145(c) and dispose of according to section 61.150.
Demolition by burning is not applicable.

FLOW CHART 2, Structurally Unsound Facility

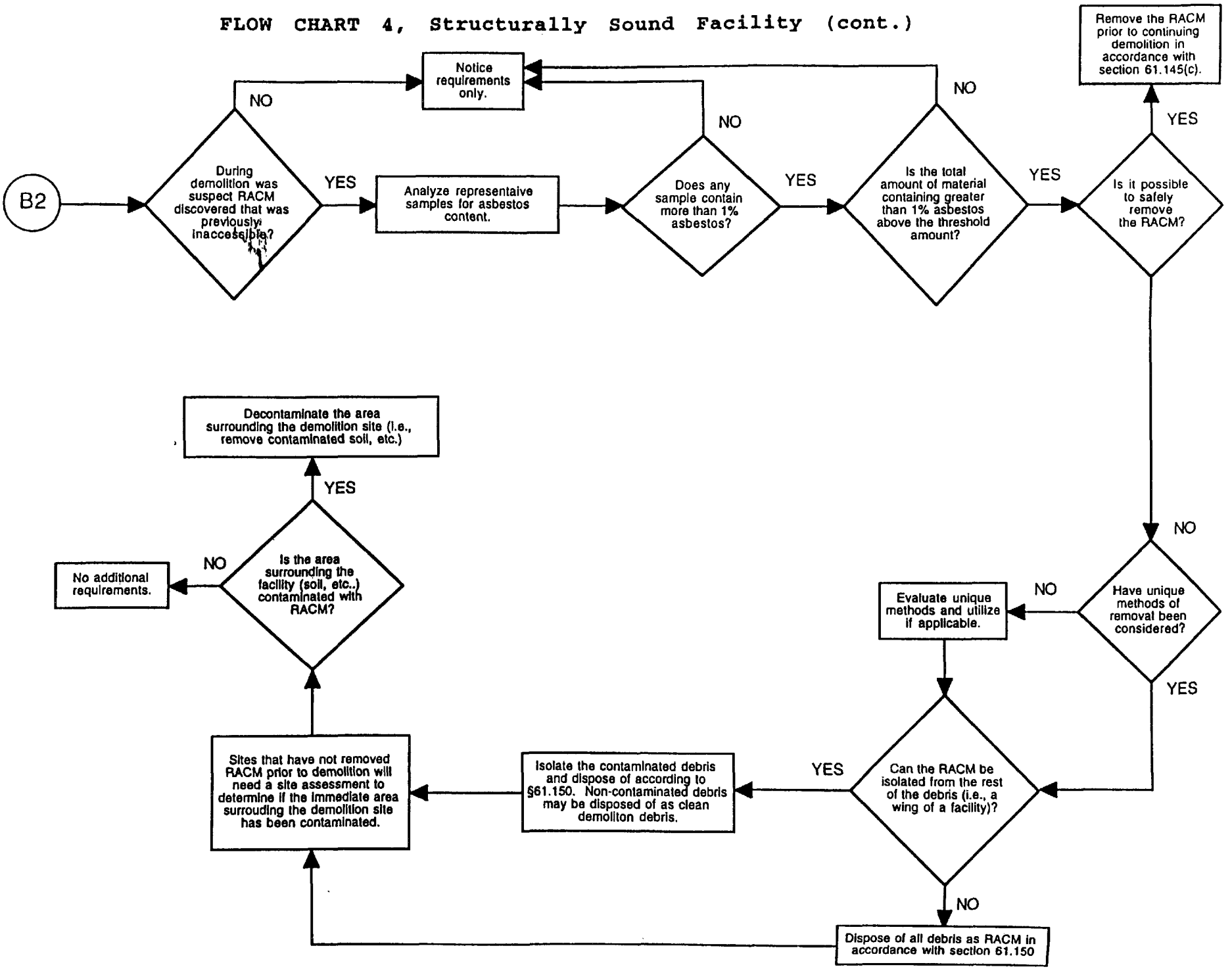


* If an owner/operator of a facility that was not previously inspected, demonstrate (through records, blue prints, etc.) that ris does not contain RACM, then the disposal ments of the NESHAP may not apply.

FLOW CHART 3, Structurally Sound Facility



FLOW CHART 4, Structurally Sound Facility (cont.)



inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations). However, according to 40 CFR 61.05, the establishment of an active waste site requires prior approval from EPA or the delegated State program. To clean up the site to background levels, it will probably be necessary to remove all the asbestos contaminated soil. The contaminated soil should be treated and disposed of as asbestos-containing waste material.

VI. DEMOLITION OF STRUCTURALLY UNSOUND FACILITIES

[Refer to Flow Chart 2]

A. Demolition of Structurally Unsound Facilities

Facilities declared unsafe and in danger of imminent collapse as a result of some emergency such as a fire, earthquake or other disaster can not be demolished by means of fire because of the inability to properly inspect such facilities for the presence of asbestos.

A representative from a qualified governmental agency typically makes this declaration.

B. Inspection of Facility

Facilities declared unsafe because of some emergency such as fire, earthquake or other disaster can often be dangerous if not impossible for regulatory inspectors to enter and EPA would not expect an inspector to enter such an environment.

Some facilities that are too dangerous to enter may contain suspect RACM (e.g., roofing, siding, etc.) that can be easily identified without entering the facility.

In some cases, a facility is declared unsafe when only one wall or a portion of a facility is unsound. Occasionally a facility is made unsound when the key structural load supporting members from the facility are intentionally removed to avoid the inspection and removal (if applicable) requirements of the asbestos NESHAP. In such cases the owner/operator of that facility can:

- Make the facility safe to enter by knocking down the portion that is unsafe or temporarily shoring up the structure, thus allowing the inspector to go in to conduct a thorough inspection, subsequently triggering abatement if applicable.

- Identify materials in the safe portion of the facility that are suspect and abate if applicable. Unsafe portions of the facility (portions that can not be safely inspected) should be carefully pulled down while applying adequate amounts of water to control any visible emissions.

- Assume the entire facility or the portion that was not thoroughly inspected to be asbestos and properly handle and dispose of all the demolition debris as asbestos-containing waste material.

Any portion of a facility that can be safely entered should be thoroughly inspected. A thorough inspection includes identifying all asbestos containing materials present including Category I and II nonfriable ACM and the quantities to be affected, the nature of the demolition and the steps that will be taken to control any release of fibers.

EPA requires that inspectors in the regulated community attend and pass the 3-day Building Inspectors Course under 40 CFR Part 763, the revised Asbestos Model Accreditation Plan (MAP) as mandated by section 15(a)(3) of the Asbestos School Hazard Abatement Reauthorization Act (ASHARA).

C. Material Identification and Analysis

Before demolition may begin, all suspect ACM (all material that can be safely examined) must be identified, including Category I and II nonfriable material. Once all suspect RACM is identified, and it is determined that a facility contains greater than the threshold amount (260 linear feet, 160 square feet or 35 cubic feet), the material(s) should be assumed to be RACM, or sampled (in the safe portion of the facility) and analyzed to verify that RACM is or is not present.

Category I nonfriable material that has not been or will not be subjected to sanding, cutting or abrading and will not become friable during demolition and subsequent clean-up is not subject to the handling requirements of the asbestos NESHAP.

Category II nonfriable material that is not friable and has not or will not become friable (crumbled, pulverized, or reduced to powder) during demolition and subsequent clean-up is not subject to the handling requirements of the asbestos NESHAP.

If either the suspect amount of asbestos is below the threshold amount or the asbestos content of the representative sample(s) contains less than one percent, only the notice requirements listed at 40 CFR 61.145(a)(3) apply.

D. Removal of RACM Prior to Demolition

RACM that exists in quantities above the threshold amount (that can be safely removed) must be removed prior to demolition. RACM may include Category I nonfriable material that is friable or is likely to be subjected to sanding, grinding, cutting, or abrading during demolition. Most normal demolition techniques will not require the removal of Category I nonfriable ACM that is not in poor condition and is not friable prior to the demolition. However, waste consolidation methods both at the demolition site and at the disposal site may render these materials friable. RACM may also include Category II nonfriable material that has a high probability of becoming crumbled, pulverized or reduced to powder by the forces expected to act on the material during demolition. Most if not all Category II nonfriable ACM is expected to become RACM during demolition. EPA recommends that all Category II nonfriable ACM be removed prior to demolition to avoid any further requirements of the asbestos NESHAP.

E. Evaluation of Unique Methods for Removing RACM

When RACM is difficult or "impossible" to remove, innovative methods of removal should be evaluated and used if applicable. These unique methods might include the use of equipment such as cranes or a specially adapted grappling bucket (Bainbridge Case Study, see appendix A). If unique methods have not been considered by the contractor, the demolition should not continue while the RACM remains in place until unique methods have been considered and determined to be infeasible.

When the asbestos cannot be safely removed, the asbestos-containing material must be kept wet and the entire asbestos contaminated waste pile (or the portion that is contaminated) must be disposed of as asbestos-containing waste material in accordance with 40 CFR 61.150.

F. Post Demolition Inspection for RACM Contaminated Debris

Demolition debris from a facility that is demolished without an inspection or demolished with RACM in place must be inspected. All ACM material must be identified and treated properly.

Debris that is inspected and found to contain any amount of RACM is assumed to be entirely contaminated unless the owner/operator of the facility can demonstrate through building and/or maintenance records that the facility either contains no asbestos or that the quantities are less than the threshold amount or the contaminated debris can be sufficiently isolated from the majority of the demolition debris.

G. Isolating RACM Contaminated Debris

Sometimes RACM is identified in only one room of a facility or a wing of a facility. Contaminated debris that can be isolated should be disposed of in accordance with section 61.150 of the asbestos NESHAP while the remainder of the debris (non-contaminated debris) can be disposed of as normal "clean" demolition debris. This determination should be based on a visual inspection and sampling and analysis of the debris. If any asbestos contamination is found in an area (even below one percent), the waste must be disposed of in accordance with section 61.150, unless the owner/operator of the affected facility can demonstrate that the intact material contained less than one percent.

H. Site Assessment

Any facility that undergoes demolition without removing all of the RACM should undergo a site assessment to determine if the immediate area surrounding the facility has been contaminated with asbestos.

A site assessment should include but is not limited to a visual evaluation and a comprehensive soil sampling scheme to determine compliance with the asbestos NESHAP. The degree of testing should be evaluated on a case-by-case basis.

I. Decontamination of Area Surrounding Demolition Site

If a site assessment detects contamination of soil surrounding a demolition site, the site must be cleaned up to background levels of asbestos contamination. Alternatively, the site may be operated in accordance with 40 CFR 61.154 (Standard for active waste disposal sites) and closed in accordance with 40 CFR 61.151 (Standard for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations). However, according to 40 CFR 61.05, the establishment of an active waste site requires prior approval from EPA or the delegated State program. To clean up the site to background levels, it will probably be necessary to remove all the asbestos contaminated soil. The contaminated soil should be treated and disposed of as asbestos-containing waste material.

VII. DEMOLITION OF A FACILITY BY INTENTIONAL BURNING

[Refer to Flow Chart 1]

A. Inspection of Facility

In order for a facility to be demolished by burning, section 61.145 requires a thorough inspection of the affected facility prior to demolition.

EPA requires inspectors in the regulated community to attend and pass the 3-day Building Inspectors Course under 40 CFR Part 763, the revised Asbestos Model Accreditation Plan (MAP) as mandated by section 15(a)(3) of the Asbestos School Hazard Abatement Reauthorization Act (ASHARA).

B. Material Identification and Analysis

Before intentionally burning a facility, <u>all</u> suspect ACM must be identified including all Category I and II nonfriable material.

C. Removal of RACM Prior to Demolition

The asbestos NESHAP requires the removal of <u>all</u> ACM if a facility will be demolished by intentional burning. This requirement includes the removal of <u>all</u> Category I and II nonfriable ACM which for the purposes of intentional burning shall always be considered RACM (section 61.145(c)).

Appendix A.

CASE STUDY
The Bainbridge Naval Training Center

Background

The Bainbridge Naval Training Center (BNTC) near Port Deposit, Maryland, is a federal facility owned by the U.S. Navy occupying approximately 1,300 acres in a residential and rural area in northeast Maryland.

The BNTC was an active Navy facility from the early 1940s until 1976. On November 3, 1986, the U.S. Congress authorized the Secretary of the Navy to dispose of the Bainbridge facility by sale to private parties or transfer to other government agencies. Over 700 abandoned buildings and structures in various stages of dilapidation existed on the site. Congress specified that before any sale, the Secretary of the Navy was required to "restore such property to a condition that meets all applicable Federal and State of Maryland environmental protection regulations" Public Law 99-956.

Site Description

The buildings at the BNTC were mainly one to three story wood frame structures. A few of the buildings were masonry and several of the wood frame structures had concrete grade slabs. Some of the buildings contained friable asbestos in the form of boiler wrap and pipe lagging, while most buildings had asbestos-cement transite board (Category II non-friable ACM) on the exterior, the interior, or in both areas. Because of the age of the buildings, the lack of maintenance, exposure to the elements, and vandalism, the buildings at BNTC were in various stages of dilapidation. Some of the structures had collapsed entirely, while nearly all the other structures to be demolished had sustained some structural damage making thorough inspections difficult and in some cases impossible.

Navy's Preliminary Agreement with the State of Maryland

The Navy decided to turn the BNTC site over to the State of Maryland. In doing so, the Navy agreed as mandated by Congress to "restore the property to a condition that meets all applicable Federal and State of Maryland environmental protection regulations." The restoration activities included demolition and clean-up at the BNTC site. The Navy contracted a private demolition company to demolish and clean-up the BNTC site. Before EPA's involvement, most buildings that were standing at the BNTC had only friable asbestos insulation removed prior to demolition.

Buildings declared unsafe (ordered by a State or local governmental agency) and in danger of collapse as a result of some emergency such as a fire, earthquake or other disaster, must typically be demolished immediately and cannot await an inspection by EPA. Section 61.145 (a)(3) of 40 CFR gives certain exemptions to the requirements of the asbestos NESHAP only when the facility is structurally unsound and in danger of imminent collapse. However, with respect to the procedures for emission control, ordered demolitions are subject to paragraphs (c)(4) through (c)(9) of section 61.145. Additionally, paragraphs (b)(1), (b)(2), (b)(3)(iii), (b)(4) (except(b)(4)(viii)), and (b)(5) of section 61.145 still apply to ordered demolitions.

To discourage abuse of this provision, the notification that is submitted must identify the government representative who ordered the demolition, the date the order was issued and the date demolition was ordered to begin. Representatives from a qualified governmental agency typically make those determinations.

If the appropriate agency is unable to make such a determination (e.g., due to lack of resources or personnel) it may be appropriate for that agency to retain the services of a private contractor or State regulatory agency to make the determination.

Conversely, it would be inappropriate for the owner/operator of a facility to retain the services of a private contractor or use in-house professionals to make such a determination because it would be in their best interest to have the building categorized as being structurally unsound in order to gain the exemptions and subsequent cost savings from not having to adhere to all of the requirements of the asbestos NESHAP.

V. Structurally Sound Facilities Undergoing Normal (other than intentional burning) Demolition

[Refer to Flow Charts 3 & 4]

A. Inspection of a Facility

A majority of inspections will be of structurally sound facilities undergoing normal (other than intentional burning) demolition. Guidance for demolitions can be found in A Guide to Normal Demolition Practices Under the Asbestos NESHAP (EPA 340/1-92-013, September 1992). Section 61.145 requires a thorough inspection of the affected facility prior to

demolition. The responsibility to thoroughly inspect lies with the owner/operator of the affected facility.

A thorough inspection includes identifying all asbestos containing materials present including Category I and II nonfriable ACM and the quantities to be affected, the nature of the demolition and the steps that will be taken to control any release of fibers. Guidance for inspections can be found in EPA's Guidelines for Asbestos NESHAP Demolition and Renovation Inspection Procedures (EPA 340/1-90-007, November 1990, (Revision)).

EPA requires inspectors in the regulated community to attend and pass the 3-day Building Inspectors Course under 40 CFR Part 763, the revised Asbestos Model Accreditation Plan (MAP) as mandated by section 15(a)(3) of the Asbestos School Hazard Abatement Reauthorization Act (ASHARA).

B. Material Identification and Analysis

Category I nonfriable material that has not been or will not be subjected to sanding, cutting or abrading and will not become friable during demolition and subsequent clean-up and disposal is not subject to the handling requirements of the asbestos NESHAP.

Category II nonfriable material that is not friable and will not become friable (crumbled, pulverized, or reduced to powder) during demolition and subsequent clean-up is not subject to the handling requirements of the asbestos NESHAP.

Once all suspect RACM is identified, and it is determined that the facility contains greater than the threshold amount (260 linear feet, 160 square feet or 35 cubic feet), the material(s) should be assumed to be RACM, or sampled and analyzed to verify that RACM is or is not present.

If either the suspect amount of asbestos is below the threshold amount or the asbestos content of the representative sample(s) contain less than one percent, only the notice requirements listed at 40 CFR 61.145(a)(3) apply.

C. Removal of RACM Prior to Demolition

If RACM exists in quantities above the threshold amount, then all the RACM must be removed prior to demolition. RACM may include Category I nonfriable material that is friable or

is likely to be subjected to sanding, grinding, cutting, abrading, or burning during demolition. Most normal demolition techniques will not require the removal of Category I nonfriable ACM that is not in poor condition and is not friable prior to the demolition. However, waste consolidation methods both at the demolition site and at the disposal site may render these materials friable. RACM may also include Category II nonfriable material that has a high probability of becoming crumbled, pulverized or reduced to powder by the forces expected to act on the material during the course of the demolition. Most Category II nonfriable ACM is expected to become RACM during demolition. EPA recommends that all Category II nonfriable ACM be removed prior to demolition to avoid any further requirements of the asbestos NESHAP.

D. Discovery of RACM During Demolition

Suspect RACM that is discovered during demolition which was previously inaccessible must be sampled and analyzed for its asbestos content when the combined amount of suspect RACM (the amount of RACM identified during the initial inspection and the amount of newly discovered suspect material) is above the threshold amount.

If the threshold amount is exceeded and the samples tested contain more than one percent asbestos, all of the RACM must be removed if possible. If the asbestos cannot be safely removed, the asbestos-containing material must be kept wet and the entire waste pile (or the portion that contains asbestos-containing waste material) must be disposed of as asbestos-containing waste material in accordance with 40 CFR 61.150. The cost of disposing of the entire contaminated waste pile as asbestos waste should discourage contractors from this as a means to avoid the removal requirements of the asbestos NESHAP.

When the combined amount of suspect RACM (the combined amount of RACM identified during the inspection and the amount of newly discovered material) is less than the threshold amount or the samples of intact material (not samples of contaminated waste) contain less than one percent of asbestos, only the notice requirements found in 40 CFR 61.145(a)(3) would apply to the demolition.

E. Evaluation of Unique Methods for Removing RACM

When newly discovered RACM is difficult or "impossible" to remove, innovative methods of removal should be evaluated and used if applicable. These unique methods might include

the use of equipment such as cranes, a specially adapted grappling bucket (Bainbridge Case Study, see Appendix A) or temporarily shoring up a structure. If unique methods have not been considered by the contractor, the demolition should not continue while the RACM remains in place until unique methods have been considered and determined to be infeasible.

When the asbestos cannot be safely removed, the asbestos-containing material must be kept wet and the entire asbestos contaminated waste pile (or the portion that is contaminated) must be disposed of as asbestos-containing waste material in accordance with 40 CFR 61.150.

F. Isolating RACM Contaminated Debris

Sometimes RACM is identified in only one room of a facility or a wing of a facility. Contaminated debris that can be isolated must still be disposed of in accordance with 40 CFR 61.150 of the asbestos NESHAP while the remainder of the debris (non-contaminated) may be disposed of as normal "clean" demolition debris. This determination should be made based on a visual inspection and analyses of samples of the waste. If any asbestos contamination is found in an area (even below one percent) then the waste must be disposed of in accordance with section 61.150, unless the owner/operator of the affected facility can demonstrate that the intact material contained less than one percent.

G. Site Assessment

Any facility that undergoes demolition without removing all of the RACM should undergo a site assessment to determine if the immediate area surrounding the facility has been contaminated with asbestos.

A site assessment should include but is not limited to a visual evaluation and a comprehensive soil sampling scheme to determine compliance with the asbestos NESHAP. The degree of testing should be evaluated on a case-by-case basis.

H. Decontamination of Demolition Site

If the surrounding soil has been contaminated by the demolition activities at the site, the site must be cleaned up to background levels of asbestos contamination. Alternatively, the site may be operated in accordance with section 61.154 (Standard for active waste disposal sites) and closed in accordance with section 61.151 (Standard for

Regulatory Inspections

During several inspections of the BNTC site in 1991, EPA inspectors observed that the demolition activities were being conducted in violation of the notification, demolition, emission control, and disposal requirements of the asbestos NESHAP. The transite material found on the exterior and interior of most buildings was initially thought by the State of Maryland and the Navy to be exempt from the requirements of the asbestos NESHAP. The intent of EPA to regulate the demolition of buildings containing transite material (asbestos-cement material) is expressed in the preamble to the final promulgation of the asbestos NESHAP published November 20, 1990, 55 FR 48408. EPA's applicability determination of January 8, 1992, was made to further clarify what types of activities are likely to cause Category II nonfriable ACM to become RACM.

The Navy then conducted an inspection of the BNTC and concluded that all but four of the buildings were structurally unsound. The buildings were inspected by the Navy and categorized into four classes:

> Remedial Class 1: a building requiring removal of all friable asbestos (primarily insulation materials) but which will not be demolished.
>
> Remedial Class 2: a building requiring pre-demolition "removal of friable asbestos from parts of the structure that can be safely entered."
>
> Remedial Class 3: a building that has collapsed or is structurally unsound in its present condition and is to be demolished "as is," with the debris treated as asbestos-containing waste material.
>
> Remedial Class 4: a building requiring no action.

The Navy Categorized most of the buildings as remedial Class 3, therefore buildings were demolished "as is," with no abatement prior to demolition and the debris was treated as asbestos containing material.

Application of Demolition Decision Tree to the BNTC

The Demolition Decision Tree is written in a generic format so that it can be applied to various demolition scenarios. The BNTC site because of the number and variety of buildings is a good example of how the application of the Decision Tree may help inspectors decide which of the NESHAP regulatory requirements are applicable to a given demolition.

In applying the decision tree to the BNTC site (beginning with Flow Chart 1), the inspector should first determine whether the demolition is an ordered demolition. If the demolition is not an ordered demolition, the facility is not exempt from any of the requirements of the asbestos NESHAP. When demolitions are "ordered," the inspector should determine if the order was made by an appropriate governmental agency. Although EPA does not have any criteria for such determinations, they should be made at the request of the regulating agency by registered engineers or building inspectors who are trained (qualified) to make such decisions. Ordered demolitions typically come from a governmental agency that regulates building safety. The fact that a facility is off limits or has been declared unusable, is insufficient grounds for allowing certain exemptions (section 61.145(a)(3)) to the requirements of the asbestos NESHAP. Prior to the start of demolition at the BNTC site, the Navy conducted their own survey and concluded that the vast majority of the buildings were structurally unsound. It should be obvious from Flow Chart 1, that the initial survey which was conducted by the Navy was inappropriate. The appropriate procedure in this situation would have been for the State of Maryland, EPA, or an independent contractor (agreed to by the regulatory agency and the Navy) to conduct a comprehensive survey of the affected facilities.

Structurally Unsound Facilities (Flow Chart 2)

Facilities declared structurally unsound and in danger of imminent collapse would move from Flow Chart 1 to Flow Chart 2. The buildings declared structurally unsound at the BNTC site were categorized as Remedial Class 3 buildings by the Navy.

Regulatory inspectors should then determine if it is possible for the owner/operator to inspect a facility or the portion that is safe for the presence of asbestos. If facilities or safe portions of facilities contain suspect RACM in amounts greater than the threshold amount, representative samples should be sampled and analyzed for asbestos content. If the samples contain more than one percent asbestos, inspectors should investigate the possibilities of removing all the RACM or RACM from the safe portions (Remedial Class 2) of the facility. Whenever possible, all RACM should be removed prior to demolition. When RACM is identified in facilities that have been declared unsafe, inspectors should evaluate unique methods for removing the RACM. Unique methods may include the demolition of the portion deemed unsafe or temporarily shoring up the unsafe portion of the structure thereby creating a safe working environment allowing for proper inspection and abatement as applicable. Other unique methods might include the use of specially adapted demolition equipment. The demolition contractor at the BNTC site attempted to remove the transite siding with a modified grappling bucket. This method proved ineffective, forcing the demolition contractor

to remove as much of the transite material as deemed feasible by hand. If unique methods have not been considered by the contractor, the demolition should not continue while the RACM remains in place until unique methods have been considered and determined to be infeasible.

The lower portion of Flow Chart 2 should make it clear to an inspector that demolition debris from facilities not thoroughly inspected or debris from facilities demolished with RACM in place, must be thoroughly inspected. Debris containing any amount of asbestos (even below one percent) should be treated and disposed of as RACM in accordance with section 61.150. Non-contaminated material that can be isolated from asbestos contaminated waste may be disposed of as "clean" demolition debris in any landfill that normally accepts demolition material. Because the demolition techniques used at the BNTC site caused most if not all transite material (Category II nonfriable) to become RACM, the demolition debris was assumed to be entirely asbestos contaminated and was disposed of as RACM in accordance with the NESHAP. EPA inspectors observed that the demolition activities were being performed in violation of the emissions control requirements of the asbestos NESHAP (section 61.145(c)). The observed visible emissions at the BNTC site and the data obtained through air monitoring was enough evidence to expect some degree of contamination to the environment in and around the demolition sites. To fulfill its obligation to "restore such property to a condition that meets all applicable Federal and State of Maryland environmental protection regulations," the Navy was required to submit a comprehensive soil sampling protocol for determining possible site contamination levels at the BNTC site. The results of the soil sampling revealed contamination at those sites demolished with transite material in place. As a result of the contamination, the soil was removed and disposed of as asbestos containing waste material.

Lessons Learned

The BNTC case is a good example of how the application of the demolition decision tree would have prevented a lot of confusion as to which of the regulatory requirements were applicable to the demolition activities. Specifically, it could have made clear EPA's intent on regulating the demolition of buildings containing transite material.

Appendix B.

CASE STUDY
Jewel Lake Condominium
Anchorage, Alaska

Background

The Jewel Lake Condominium facility was a 20 unit, three-story structure that suffered extensive fire damage. The third floor and the main stairway were severely burned. Smoke and water damage were prevalent throughout the remainder of the building. It was declared a public nuisance and hazard by both the Alaska Department of Occupational Health and Safety (ADOHS) and the Municipality of Anchorage (MOA) Public Works Department, Division of Building Safety. It was condemned (ordered) by the MOA and declared unsafe due to the danger of imminent collapse.

A survey of the facility found extensive use of asbestos containing materials within the surviving portions of the building. The building contained 28 fire doors (containing Amosite) and 12,000 square feet of asbestos containing sprayed-on material (acoustical plaster).

The original demolition plan called for a complete knock-down of the structure. The plan also called for a backhoe to break up the debris before disposing of the entire debris pile as asbestos contaminated waste.

The building was located in a densely populated neighborhood and the work was to be conducted at temperatures below freezing which would make the application of adequate amounts of water impractical.

Application of Demolition Decision Tree

In applying the decision tree to the Jewel Lake Condominium site, an inspector should first confirm that the demolition was ordered by a qualified governmental agency. The Jewel Lake site was "ordered" by the ADOHS and the MOA. Both the ADOHS and the MOA conform with the definition of "qualified governmental agency." The inspector should then determine if the order was made because the facility is structurally unsound and in danger of imminent collapse. The Jewel Lake facility suffered extensive fire damage, causing the structure to become structurally unsound and in danger of imminent collapse as determined by a construction engineer working for the MOA. In addressing structurally unsound facilities in the Decision Tree move from Flow Chart 1 to Flow Chart 2.

A thorough inspection of the facility confirmed the presence of suspect asbestos containing materials in quantities above the

threshold amount. Subsequent analyses of the suspect materials confirmed the presence of asbestos. Using the middle section of Flow Chart 2 (unique methods), the inspector should determine if the utilization of unique methods will facilitate the removal of RACM before demolition. The "unique methods" used at the Jewel Lake site, included the knock-down and removal of only the damaged portion (unsafe portion) of the facility. This portion was removed with adequate amounts of water and disposed of entirely as asbestos contaminated material. The remaining intact portion of the facility was demolished and disposed of as normal debris after abatement of all the remaining RACM.

Lessons Learned

The application of the demolition decision tree to the Jewel Lake site would have clearly defined which portions of the asbestos NESHAP are applicable. The apparent confusion among the regulated and regulatory communities caused a five month delay in the demolition of the Jewel Lake facility. The Demolition Decision Tree guidance clearly states that even in cases where a facility is declared unsafe, all options of removing RACM should be considered. In the Jewel Lake case, the upper floor (the burned out portion) was removed, thereby creating a safe working environment. This allowed for the proper abatement of all the remaining RACM prior to the demolition. Removing the damaged portion of the Jewel Lake facility avoided the near certain contamination to the surrounding neighborhood that would have occurred considering the proposed work plan.

ITEM 7

Guidelines For Asbestos NESHAP Landfill Recordkeeping Inspections

United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Washington, DC 20460

EPA - 340/1-92-012
March 1992

Stationary Source Compliance Series

EPA

Guidelines for Asbestos NESHAP Landfill Recordkeeping Inspections

NESHAP

EPA - 340/1-92-012

Guidelines for Asbestos NESHAP Landfill Recordkeeping Inspections

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Stationary Source Compliance Division
Washington, DC 20460

March 1992

DISCLAIMER

This manual was prepared by Alliance Technologies Corporation for the Stationary Source Compliance Division of the U.S. Environmental Protection Agency. It has been completed in accordance with EPA Contract No. 68-02-4465, Work Assignment No. 92-220. This document is intended for information purposes **ONLY**, and may not in any way be interpreted to alter or replace the coverage or requirements of the asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR Part 61, Subpart M.

TABLE OF CONTENTS

Section		Page
INTRODUCTION		v
1	LANDFILL RECORDKEEPING AND REPORTING REQUIREMENTS	1
	Recordkeeping Requirements	1
	Reporting Requirements	2
2	PRE-INSPECTION ACTIVITIES	5
	Targeting Waste Disposal Sites	5
	Planning the Waste Disposal Site Recordkeeping Inspection	5
3	FIELD INSPECTION ACTIVITIES	11
	Preliminary Interview	11
	Reviewing Records	12
	Additional Activities	13
	Quality Assurance Check	14
	Post-Inspection Interview	14
4	POST-INSPECTION ACTIVITIES	15
	Inspection Followup	15
	Report Preparation	15
	Data Management	15
	Documentation	16
	Records Maintenance	16
5	ASBESTOS NESHAP ENFORCEMENT	17
	Landfill Recordkeeping Violations	17
	Landfill Reporting Violations	17

Appendices		Page
A	Asbestos Waste Disposal Site WSR Recordkeeping Requirements	A-1
B	Asbestos Waste Disposal Site Records Inspection Checklist	B-1

TABLES

Number		Page
2-1	Determination of Minimum Sample Size	9

THIS PAGE INTENTIONALLY LEFT BLANK

INTRODUCTION

The purpose of this guidance document is to assist asbestos NESHAP compliance inspectors in conducting active landfill recordkeeping inspections.

This manual details landfill recordkeeping requirements and includes step-by-step instructions for every phase of a landfill recordkeeping inspection. Pre-inspection activities (disposal site targeting, reviewing Agency records, developing an inspection plan), onsite inspection activities (interviewing, reviewing and records' sampling), and post-inspection activities (writing the inspection report, determining the need for enforcement action) are discussed. A landfill recordkeeping flowchart and inspection checklist are also included.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 1

LANDFILL RECORDKEEPING AND REPORTING REQUIREMENTS

The new requirements for waste disposal affect both generators of asbestos-containing waste material (ACWM) and waste disposal site operators. Generators must provide the waste disposal site a properly completed waste shipment form with every load of ACWM delivered, inform EPA when they cannot determine the disposition of their waste, and maintain copies of waste shipment records (WSRs) and associated correspondence in their files. Waste disposal site operators are required to verify information contained in the WSRs, inform generators that the ACWM has been received, inform EPA if efforts to resolve discrepancies have failed, and also maintain waste shipment information.

The following discussion provides detailed information concerning both recordkeeping and reporting requirements for owners/operators of asbestos landfills.

RECORDKEEPING REQUIREMENTS

The revised asbestos NESHAP requires waste disposal site operators to maintain both waste shipment and ACWM deposition information.

Waste Shipment Records

Landfill operators must check the WSR that accompanies each asbestos waste shipment that arrives at the facility to make sure that the information on the WSR accurately describes the waste shipment. The landfill operator must verify that the information in WSR Item 6 (Number and Type of Containers) coincides with the quantities reported in WSR Item 7 (Cubic meters or yards) and determine if the load contains a significant amount of improperly enclosed or uncovered waste. Any discrepancy seen must be noted in Item 12 of the WSR.

Waste disposal site operators need not open bags or other containers to verify that they contain ACWM; the WSR accompanying the load is sufficient verification. Once the load has been examined, and discrepancies noted, the waste disposal site operator must complete Item 13 (Certification of Receipt) of the WSR, return a copy to the generator (within 30 days), and maintain a file copy.

Copies of all WSR's must be kept for at least 2 years. To facilitate future reference, WSRs should be kept in chronological order in a secure, water-tight file. Copies of WSRs must be provided, upon request, to the agency(ies) responsible for implementation of the asbestos NESHAP and the file must be made available for inspection during normal business hours.

ACWM Deposition Information

Waste disposal site operators are also required to maintain up-to-date, accurate records that indicate the location, depth, area, and quantity of ACWM within the disposal site on a map or diagram of the disposal area.

REPORTING REQUIREMENTS

The revised asbestos NESHAP also subjects waste disposal site owners/operators to several new reporting requirements. Required reports concern stationary source information, WSR discrepancies, improperly-contained waste, disturbance of disposed ACWM, and disposal site closures.

Waste Site/Stationary Source Report (§§ 61.153, 61.10)

Within 90 days of the effective date of the revisions to the asbestos NESHAP (by February 18, 1991) for existing sources, or within 90 days of the initial startup date for sources having a startup date after the effective date, disposal site operators are required to submit the following information about their waste site operations to the agency responsible for administration of the asbestos NESHAP program:

- A brief description of the waste disposal site (location, size, etc.).
- A description of the method or methods that will be used to comply with the asbestos NESHAP, or a description of alternative methods that will be used. Methods to be used may include covering asbestos waste daily with six (6) inches of nonasbestos cover, or the use of a dust suppressant. Other information that might be reported includes procedures to prevent public access to the asbestos waste disposal area, such as the use of warning signs and fencing. This information must be reported using the format in Appendix A of Part 61 of Title 40 of the Code of Federal Regulations (40 CFR).

In addition to the information listed above, the waste disposal site operator also has to report (within the same time period) the following information to comply with the source reporting requirements of 40 CFR Part 61 Subpart A §61.10:

- Name and address of the owner or operator.
- Location of the source.
- Type of hazardous pollutants emitted by the stationary source.
- Brief description of the nature, size, design, and method of operation of the stationary source, including the operating design capacity of the source. Identify each point of emission for asbestos.

- The average weight per month of asbestos being processed by the source over the last 12 months preceding the date of the report.

- Whether the source can/cannot comply with the standard within 90 days of the effective date.

If there is a change in any of the information listed above, the waste disposal site owner/operator must report the changes to the appropriate agency within 30 days after they occur as required by 40 CFR § 61.10(c).

Discrepancy Reports (§ 61.54 (e)(3))

If there is a discrepancy between the number of containers shown on the WSR and the number counted in the load, waste disposal site operators must make note of this in Item 12 of the WSR and contact the generator to determine if there is a reasonable explanation for the discrepancy. If the discrepancy is resolved, the waste disposal site operator must note this on the WSR, send a signed copy of the WSR to the generator (within 30 days), and retain a file copy.

If the discrepancy cannot be resolved within 15 days of receipt of the ACWM, the waste disposal operator must send a written discrepancy report immediately to the agency which is responsible for the generator of the waste and, if different, the agency in whose jurisdiction the disposal site is located. The report must describe the discrepancy and steps taken to resolve it. Information provided should include how and when the waste disposal site operator attempted to reach the generator and the results of these efforts. A copy of the WSR in question must be submitted as well.

Improperly-Contained Waste Report (§ 61.154 (e)(1)(iv))

As disposal site operators check asbestos waste shipments that arrive at their facilities, they are required to note whether a significant amount of improperly enclosed or uncovered waste exists in the load. If such material is discovered, the waste disposal site operator must make note of this in Item 12 of the WSR and send, by the following working day, a written report of the problem to the agency responsible for administering the asbestos NESHAP program for the jurisdiction where the job site is located (identified on the WSR). If the disposal site is in a different jurisdiction than the job site, the written report must also be sent to the agency responsible for the disposal site.

The written report must include a copy of the WSR and a detailed description of the improperly enclosed or uncovered waste so that the Agency can determine the urgency of the situation and the course of action to pursue.

Excavation/Disturbance Report (61.151(d))

If an owner or operator of an asbestos landfill plans to excavate or otherwise disturb (e.g., drill methane vents) any ACWM that has been deposited and covered at a waste disposal site, the Administrator must be informed, in writing, at least 45 days prior to the disruptive activity. The following information must be contained in the notice:

- Scheduled starting and completion dates.
- Reason for disturbing the waste.
- Procedures to be used to control emissions during the excavation, storage, transport, and ultimate disposal of the excavated ACWM. (If deemed necessary, the Administrator may require changes in the emission control procedures to be used.)
- Location of any temporary storage site and the final disposition site.

If the excavation will begin on a date other than the one contained in the original notice, notice of the new start date must be provided to the Administrator at least 10 working days before excavation begins. In no event shall excavation begin earlier than the date specified in the original notification.

Closure Report (§ 61.151(e))

Agency Notification

Upon closure of a facility, the owner or operator of the site must submit to the Administrator a copy of the records of the location, depth and area and quantity (yd^3 or m^3) of ACWM within the disposal site which have been maintained on a map or diagram of the disposal area.

Deed Notation

In addition, within 60 days of closing a waste disposal site, the owner/operator must record, in accordance with State law, a notation on the deed to the facility property, and on any other instrument that would normally be examined during a title search, that:

- The land was used for the disposal of ACWM,
- The survey plot and record of the location and quantity of ACWM disposed of within the disposal site have been filed with the Administrator, and
- The site is subject to the National Emission Standards for Hazardous Air Pollutants: Asbestos (40 CFR part 61 subpart M).

SECTION 2

PRE-INSPECTION ACTIVITIES

In the 2 years following promulgation of the revised asbestos NESHAP, all waste disposal sites which accept ACWM should be visited for a baseline inspection. This inspection will provide the opportunity for disposal site operators to learn about reporting and recordkeeping requirements, help publicize EPA's intention to enforce the waste disposal requirements, and assist in the collection of information necessary for inspection targeting.

The following in-house activities should be conducted to ensure smooth performance of landfill recordkeeping inspections.

TARGETING WASTE DISPOSAL SITES

Targeting of waste disposal sites should be based on their size, the amount of asbestos waste accepted for disposal, other enforcement actions (i.e., RCRA), and exception reports, etc. Such information may be obtained from a variety of sources:

- **Landfill lists.** Lists of landfills may be obtained from EPA Regional Offices, States and local agencies. Only some of these lists indicate whether ACWM is accepted by a particular landfill; however, individuals noted on the lists may be contacted to provide additional information.

- **Notifications.** Information pertaining to landfills not previously known to accept ACWM may be found in generator notifications. Additionally, any landfill noted which is scheduled to receive large quantities of ACWM should be targeted for inspection.

- **Previous inspection reports.** Waste disposal sites identified in inspection reports concerning demolitions or renovations performed out of compliance should be targeted for inspection.

PLANNING THE WASTE DISPOSAL SITE RECORDKEEPING INSPECTION

A NESHAP inspector who takes the time to properly plan a field inspection will find that the actual inspection will be accomplished more efficiently and will be more productive. In preparation for an asbestos landfill recordkeeping inspection an inspector should:

- Become familiar with the types of records a facility is required to maintain.

- Review agency files.

  - Determine whether the landfill whose records are to be inspected has been identified as the waste disposal site on demolition/renovation notifications received. Make copies of such notifications.

  - Determine if any reporting or recordkeeping problems have been reported for the site (e.g., an unexpectedly large number of exception reports). If the removal jobs and the disposal site are in the same regulatory jurisdiction this will be easy to do, since generators are required to inform the regulatory agency in charge if there are problems with the disposition of their ACWM. If the disposal site is located outside the regulatory jurisdiction, however, such information may not be available, for generators are not required to inform the agency responsible for the waste disposal site. Make copies of such information.

  - Examine landfill-generated reports (discrepancy, stationary source, improperly-contained ACWM, closure and excavation/disturbance reports).

  - Review any complaints submitted.

- Communicate with other agencies or departments. City building departments may issue demolition/renovation and construction permits. Health departments may issue landfill operating permits or have records of complaints. Review any pertinent inspection reports filed by these agencies.

- Acquire the following information:

  -Where records are maintained.
  -Directions to this location.
  -The business hours where the records are kept.
  -Who is in charge of maintaining these records.
  -The hours this person works.
  -Directions to the landfill.
  -Landfill operating hours.
  -How much ACWM is accepted by the landfill.
  -How often the landfill accepts ACWM.
  -How often records are sent to the central storage area from the landfill.

- Plan for the efficient use of time. Inspectors will probably have to inspect records kept both at the landfill and at an office or storage area elsewhere. Determine the traveling distance/time between the locations and plan accordingly. A full day may be necessary to properly inspect all records.

- Accumulate necessary inspection materials:

  -copies of applicable notifications, exception reports, etc.
  -employee identification
  -copy of regulation
  -bound notebook and writing implements
  -manila folders
  -large envelopes
  -landfill recordkeeping checklist
  -shipping supplies (if necessary)
  -business cards

- Try to plan the inspection for a day when asbestos is being accepted by the landfill so that landfill deposition and recordkeeping operations may be observed first-hand. Bring personal protective equipment, a camera, landfill inspection checklist and asbestos sampling materials as needed.

- If the landfill records are expected to be too numerous to review individually, devise a sampling strategy which will fulfill the objectives of the inspection. The six basic steps below are designed to help ensure that each sample selected is both appropriate and defensible:

  1) Determine the objective of the particular inspection step. What is the inspector trying to determine and what needs to be reviewed to make the determination? (e.g., compliance with the requirement to submit discrepancy reports - all WSRs)

  2) Identify the population under review. The population will vary depending on the intent of the inspection. (e.g., all WSRs; all WSRs that contain discrepancy information; WSRs for which exception reports have been filed, etc.)

  3) Determine whether a **judgmental** or **probabilistic** sampling method should be employed. A judgmental method is used when there is reason to suspect that a violation or violations have occurred. Probabilistic (statistical) methods, however, are more often used. (Keep in mind that the initial sampling strategy selected may have to be altered during the actual inspection.)

     Judgmental sampling is directed to the segments of the population where problems or deficiencies are likely to exist. For example, if the inspector is responding to exception reports from a generator, only that generators' WSRs may be examined.

     Probabilistic sampling (statistical sampling) is an organized, methodical process designed to select data which accurately represent the population of interest. Several varieties of such sampling are described below:

-***Random sampling:*** the objective is to select items purely by chance; pull items at random, without prejudice, or number the documents and use a random number table.

-***Block sampling:*** the objective is to draw conclusions about the population by examining certain segments or clusters of data that have been selected at random; often used when the population is so large that random sampling would produce too many subjects for review; can only be used when population is expected to be consistent throughout.

For example, if the inspector is trying to determine whether discrepancy reports are being filed appropriately, and information is available that no one was assigned to that task for the first six months following promulgation of the revisions to the Asbestos NESHAP, selecting a block of documents from that time period would not be appropriate. The information gathered would not be representative of the facility's compliance with these provisions.

-***Stratification Sampling:*** the objective is to arrange items by important categories or subsets; allows the inspector to categorize populations by groups.

For example, if the inspector is responding to numerous citizen complaints concerning dust generated by dumping activities on Saturdays, only these records may be selected for review.

-***Interval Sampling:*** also known as systematic sampling; objective is to select samples at various intervals (e.g., every tenth item); the first item must be picked at random.

4) Determine the sample size. Sample sizes can be determined either statistically or based on the inspector's judgment. In all cases, the sample must be representative of the total population selected. See Table 2-1.

TABLE 2-1. DETERMINATION OF MINIMUM SAMPLE SIZE

Population Size	Sample Size
2-8	3
9-15	5
16-25	8
26-50	13
51-90	20
91-150	32
151-280	50
281-500	80
501-1200	200
1201-3200	315
3201-10000	500

5) Conduct sampling.

6) Document the sampling strategy. In the field logbook describe the rationale for selecting the sample and how the sample was selected.

- Record known information. More efficient use of onsite inspection time is ensured if preliminary information is recorded on the landfill recordkeeping inspection checklist before arriving at the site.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 3

FIELD INSPECTION ACTIVITIES

Onsite activities include a pre-inspection interview, records inspection and wrap-up interview.

PRELIMINARY INTERVIEW

During the preliminary interview, it is critical that discussions be properly documented for they may later prove useful if violations are detected. The following steps should be followed once an inspector arrives on site:

- Show your identification and request to see the person in charge of maintaining the records pertaining to ACWM disposal.
- When this person arrives, introduce yourself and give him/her your business card.
- Document the name and title of the person interviewed. Get his/her business card if possible.
- Explain the authority (Section 114 (a)(2) of the Clean Air Act), purpose (asbestos NESHAP compliance), and components (records review) of the inspection.
- Inform the representative that the facility may be required to provide the inspector copies of records of interest.
- If records are being inspected at the landfill itself and offloading will be observed, discuss safety requirements and emergency procedures and indicate that photographs and/or samples may be taken.
- Determine whether the landfill has a State-required permit to operate. If it does, check the expiration date of the permit and record pertinent information on the inspection form.
- Ask the person to describe the recordkeeping procedures followed for WSRs and ACWM deposited at the site.
- Complete applicable sections of the Landfill Recordkeeping Inspection Checklist.
- If this is the facility's first Asbestos NESHAP compliance inspection, explain the waste disposal requirements to the interviewee and answer any questions to the best of your ability.

- Request the files you wish to review. If permission is denied, do not be forceful. Simply explain again the authority of your visit and ask the person to contact his/her supervisor regarding the situation. Either you or your agency's attorney may need to contact the facility's attorney directly to resolve the difficulties.

REVIEWING RECORDS

The records of most interest at a waste disposal site are 1) WSRs for each shipment of ACWM disposed of at the site, and 2) up-to-date records (on a map or diagram) that indicate the location, depth and area, and quantity of ACWM within the site.

Waste Shipment Records

For all ACWM received, the owner or operator of the active waste disposal site must comply with the following waste shipment recordkeeping provisions:

- Record and maintain the following information on forms similar to that noted in the regulation:

  -waste generator's name, address and telephone number;
  -transporter's name, address and telephone number;
  -quantity of ACWM received (cubic yards or meters);
  -presence of improperly-enclosed or uncovered waste, or any ACWM not sealed in leak-tight containers; and
  -date of receipt.

- Send a copy of the waste shipment record to the waste generator as soon as possible but no longer than 30 days after receipt of the waste.

- Attempt to reconcile differences in the amounts of ACWM received and that recorded on the waste manifest form brought by the transporter. If the discrepancy is not resolved within 15 days after receiving the waste, immediately submit a discrepancy report which details the discrepancy and attempts made to reconcile it to the governmental agency responsible for administering the asbestos NESHAP program for the *waste generator* (identified in the waste shipment record), *and, if different*, the governmental agency responsible for administering the asbestos NESHAP program for the disposal site.

- Retain a copy of all records and reports required by this paragraph for at least 2 years.

In inspecting the WSR file, note how the file is maintained and if the WSRs have been filled out completely, including all of the required signatures. All signatures should be **hand-written**.

Note any WSRs that have an entry pertaining to discrepancies or improperly-contained waste (Item 12 on the example WSR in the revised NESHAP) and ask how those discrepancies were resolved. Ask to see copies of any discrepancy reports or reports of improperly-contained waste submitted to the responsible agency for the WSRs in question.

Attempt to match information obtained during the pre-inspection agency file review (notifications, exception reports, etc.) with records maintained by the waste disposal site.

Pay attention to the dates of shipment of ACWM and acceptance by the landfill. ACWM is often stored by the transporter until a full load is accumulated.

Photocopy WSRs which lack the required information. If a photocopier is not available, either 1) record the necessary information in sufficient detail or 2) remove the records from the facility, photocopy them and return them later. (If records are to be removed from the facility, sign a receipt indicating that they will be returned as soon as possible).

ACWM Deposition Records

Ask the site operator for the most recent tally of the total quantity of ACWM deposited at the site. The operator should be able to provide you with a total that includes all but the most recent shipments. Examine the records showing the location, depth and area, and quantity of ACWM within the site to determine that they are up-to-date. Check to see that the proper information is being collected and the backlog of information to be added to the records is only for current waste shipments.

ADDITIONAL ACTIVITIES

If records are being reviewed at the landfill itself, you may be able to gain additional information regarding compliance with the provisions of the Asbestos NESHAP by doing the following:

- Observe ACWM being off-loaded into the landfill. Note how the load is verified, whether improperly-contained waste is present, and whether the vehicle is properly marked during offloading. Take samples as necessary to help assess compliance with the provisions of the waste disposal provisions of the asbestos NESHAP.

- If offloading cannot be observed, interview the person directly in charge of waste disposal site operations. Ask him/her to describe waste handling, load verification, and recordkeeping activities.

- Inspect the asbestos disposal site; compare your observations with information recorded on the required site map.

- Note the accessibility of the asbestos landfill area to the general public. If the landfill operator claims that a natural barrier or fence is being used to deter access, determine

if the Administrator has been informed and has agreed that access is sufficiently restricted.

QUALITY ASSURANCE CHECK

Once you have finished reviewing pertinent records, check to see that the objectives of the inspection have been met. Have appropriate types and quantities of records been reviewed? Have potential violations been thoroughly documented? Has the field inspection checklist been completed?

POST-INSPECTION INTERVIEW

Once you have reviewed your inspection activities, conduct a quick, concise wrap-up interview to obtain any additional information necessary and to convey to the owner/operator, in general terms, the findings of the inspection. It is extremely important that you do not make and convey a field decision concerning the facility's compliance for a number of reasons which include the following:

- You may later recall items you failed to mention and include them in your inspection report; if an enforcement action is contested, your credibility and integrity could be called into question.

- Individuals other than yourself may make the final determination pertaining to the facility's compliance status.

- You may not be aware of other enforcement actions being taken.

In situations where potential violations have been identified, be sure to note (on your checklist or in your field logbook) any observed or verbally-communicated responses of the owner/operator. This documentation may prove to be of great importance where enforcement actions are considered.

SECTION 4

POST-INSPECTION ACTIVITIES

No matter how blatant a violation appears, or how thoroughly an inspection was done, an enforcement case cannot be supported without proper records and documentation. It is imperative that each agency in charge of administering the asbestos NESHAP program set up and implement a system whereby supporting documentation is properly taken, controlled, and maintained. Generated reports and checklists must be clear and concise and accurately support the observations of the inspector. All records must be organized and properly maintained to be accessible for future use.

The purpose of this section is to outline inspection followup procedures and provide general guidance to aid in the process of report preparation, data management, document control, and record maintenance and storage.

INSPECTION FOLLOWUP

When potential violations have been documented, the inspector should complete his/her inspection report and brief his/her supervisor and/or attorney concerning the 1) need for reinspection; 2) need for information request under Section 114 of the CAA; 3) enforcement options available, etc.

REPORT PREPARATION

A comprehensive and properly completed checklist can serve as the inspection report. The following information should also be included:

- Inspector observations;
- Owner/operator admissions;
- Description of evidence collected; and
- Owner/operator response actions.

Since it may take several years before a lawsuit is filed, a detailed narrative of the inspection will prove beneficial in refreshing the inspector's memory and will provide strong evidence for the case.

DATA MANAGEMENT

Each violation of an asbestos landfill owner/operator should be entered into a computer tracking system to provide a record of violations for the landfill.

DOCUMENTATION

It is essential that all information gathered be properly documented, controlled and maintained. Since checklists and reports generated by an inspector may be the basis of affidavits for civil or criminal enforcement actions, they must be precise and legible. All documents generated during the course of an inspection are considered part of the permanent evidentiary file and should not be destroyed or thrown away, even if they become illegible or if inaccuracies are discovered. Errors in documents should be noted and corrected.

RECORDS MAINTENANCE

Records need to be properly filed and maintained to allow for easy access of all case documents. Records also need to be retained under storage conditions which minimize deterioration or loss of data files.

Regardless of whether computer-based data management systems or manual procedures are used, responsible individuals within a program office must be able to access and trace the destination of project files. The inspector must be familiar with and use all filing procedures appropriately.

SECTION 5

ASBESTOS NESHAP ENFORCEMENT

EPA may take administrative and/or judicial actions against violators of the asbestos NESHAP. Violations of asbestos landfill recordkeeping and reporting requirements include, but are not limited to the following.

LANDFILL RECORDKEEPING VIOLATIONS

Recordkeeping violations include failure to:

- Maintain records of waste shipments.
- Record information on location and amount of asbestos in disposal site.
- Return a signed copy of the WSR to the generator.
- Maintain records for sufficient time.

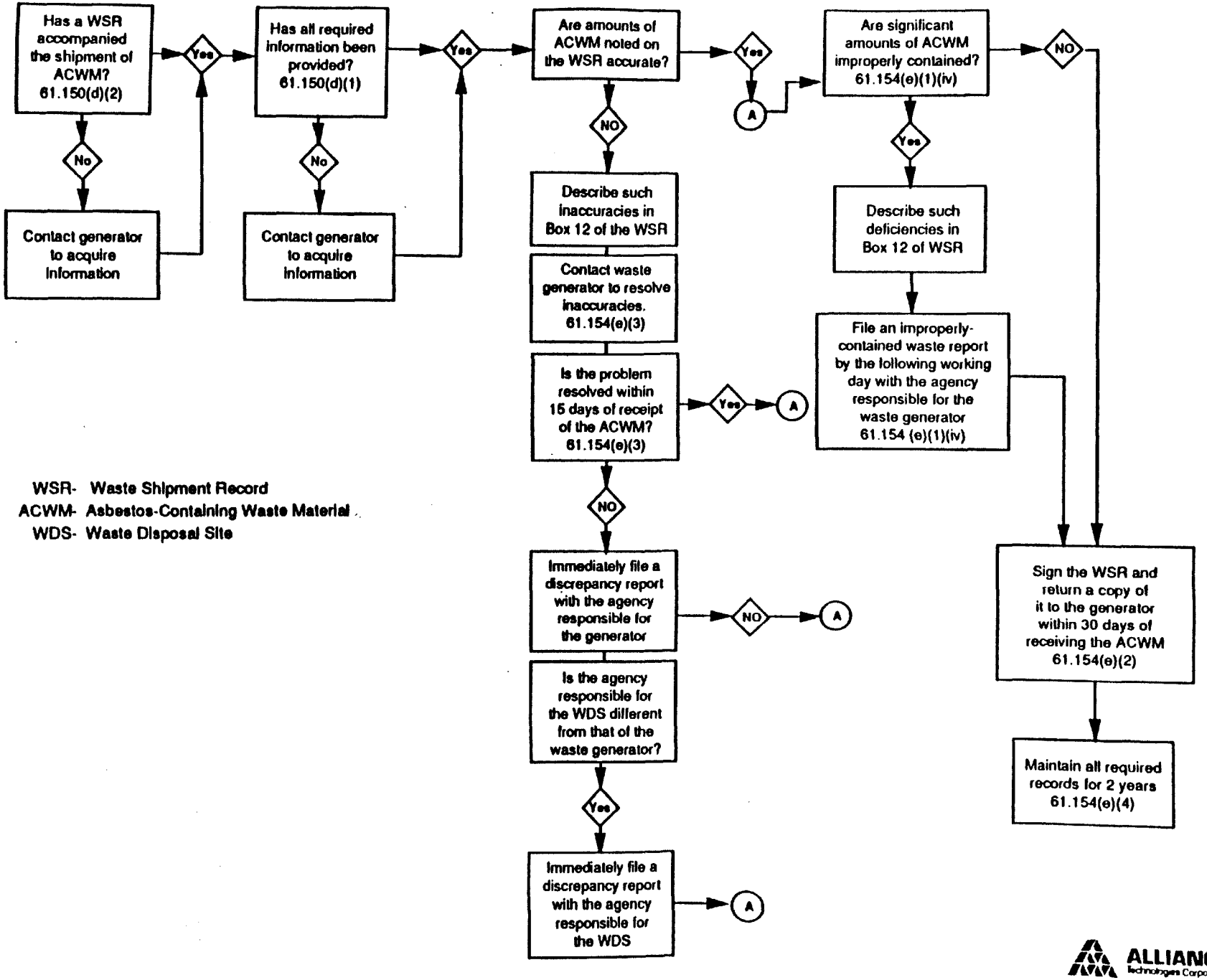
LANDFILL REPORTING VIOLATIONS

Reporting violations include failure to:

- File discrepancy reports.
- Report uncontained waste.
- File reports within required time.
- Report, upon closure, information to EPA (or its delegated authority) on location and amount of waste.
- Place, upon closure, a notification on deed to property concerning presence of asbestos waste.
- Notify EPA prior to excavating or disturbing buried asbestos-containing waste material.

THIS PAGE INTENTIONALLY LEFT BLANK

Asbestos Waste Disposal Site
WSR Recordkeeping Requirements



WSR- Waste Shipment Record
ACWM- Asbestos-Containing Waste Material
WDS- Waste Disposal Site

ALLIANCE Technologies Corporation

MS412/R

APPENDIX B

ASBESTOS WASTE DISPOSAL SITE RECORDS INSPECTION CHECKLIST

Site Name:_____

Site Address:_____

Agency Assigned Landfill Identification Number:_____

Inspector(s):_____

Date of Inspection:_____ Time of Inspection:_____

I. PRELIMINARY INTERVIEW

1. Owner Name:_____

2. Site Contact:_____

   a. Title:_____

   b. Affiliation:_____

   c. Mailing Address:_____

   d. Telephone Number:_____

		YES	NO	NA
3.	Is the landfill approved by the State?	—	—	—

If yes, Operating Permit No.:_____
Effective date:_____ through _____

4.	Are waste shipment records maintained? (61.154(e)(1))	—	—

Where are WSRs filed? _____

Do these records contain the following information?

a.	Waste generator's information (61.154(e)(1)(i)):		
	1) name	—	—
	2) address	—	—
	3) telephone number	—	—

		YES	NO	NA
b.	Transporter's information (61.154(e)(1)(ii)):			
	1) name	—	—	
	2) address	—	—	
	3) telephone number	—	—	
	4) signature	—	—	
c.	Quantity of ACWM (cubic yards or meters) (61.154(e)(1)(iii))	—	—	
d.	Presence of improperly enclosed or uncovered waste, or any ACWM not sealed in leak-tight containers (61.154(e)(1)(iv)):	—	—	—
	Has the landfill operator reported to the EPA, in writing, by the following day, the presence of a significant amount of improperly enclosed or uncovered waste? (Record or photocopy WSRs indicating improperly enclosed or uncovered waste.)			
e.	Date of receipt (61.154(e)(1)(v))	—	—	
f.	Comments:_____			

5. Have signed copies of waste shipment records been sent to the waste generator as soon as possible, but no longer than 30 days after receipt of the waste? (61.154(e)(2)) — —

Comments:_____

6. Has the landfill operator attempted to reconcile differences between the quantity of waste designated on the waste shipment record and the quantity actually received? (61.154(e)(3)) — — —

Explain: _____

_____

_____

_____

	YES	NO	NA
If the discrepancy is not resolved within 15 days after receiving the waste, has a report been filed immediately with the government agency responsible for administering the asbestos NESHAP program for the *waste generator*	—	—	
and			
if different, the government agency responsible for administering the asbestos NESHAP program for the *disposal site?*	—	—	

7. Are copies of all required records and reports retained for 2 years? (61.154(e)(4)) — —

8. Is a map or diagram of the disposal area being maintained? (61.154(f)) — —

Does the map or diagram contain the following ACWM information?

location	—	—
depth	—	—
area	—	—
quantity (cubic yards or meters)	—	—

9. Are records available for inspection? (61.154(i)) — —

10. Upon closure, has the disposal site operator informed EPA as to the location and amount of waste? (61.154(g)) — — —

11. Upon closure, has a notification concerning the presence of asbestos waste been placed on the deed to the property? ___ ___ ___

12. Has written approval from the Administrator been obtained prior to excavating or otherwise disturbing any ACWM already deposited and covered? (61.154(j)) ___ ___ ___

13. Has a stationary source report been filed with the Administrator or government agency responsible for administering the asbestos NESHAP program? (61.153.(a), 61.10) ___ ___ ___

14. When did construction of the disposal site commence? (61.07) _____

ITEM 8

A Guide To Normal Demolition Practices Under The Asbestos NESHAP

United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Washington, DC 20460

EPA - 340/1-92-013
September 1992

Stationary Source Compliance Series

EPA

A Guide to Normal Demolition Practices Under the Asbestos NESHAP

NESHAP

EPA - 340/1-92-013

A Guide to Normal Demolition Practices Under the Asbestos NESHAP

(TRC Ref. No. 1-456-019)

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planing and Standards
Stationary Source Compliance Division
Washington, DC 20460

September 1992

DISCLAIMER

This manual was prepared by TRC Environmental Corporation for the Stationary Source Compliance Division of the U.S. Environmental Protection Agency. It has been completed in accordance with EPA Contract No. 68D20059, Work Assignment No. IA2-19. This document is intended for information purposes ONLY, and may not in any way be interpreted to alter or replace the coverage or requirements of the asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR Part 61, Subpart M. Any mention of product names does not constitute endorsement by the U.S. Environmental Protection Agency.

TABLE OF CONTENTS

Section		Page
1	DEMOLITION PRACTICES AND NONFRIABLE MATERIALS	1-1
	Introduction	1-1
	Purpose	1-1
	Definitions	1-2
2	PRE-DEMOLITION BUILDING STATUS	2-1
	State and Local Regulations	2-1
	Unsafe Building Declarations	2-1
	Abatement Prior to Demolition	2-1
	Intentional Burning	2-2
3	DEMOLITION PRACTICES BY TYPE OF ACM	3-1
	Introduction	3-1
	Resilient Floor Covering (Tiles)	3-1
	Asphalt Roofing Products	3-3
	Asbestos-Cement Products	3-3
4	DEMOLITION PRACTICES BY METHOD	4-1
	Heavy Machinery Razing Operations	4-1
	Explosions/Implosions	4-3
	Hand Methods of Demolition	4-4
5	ONSITE WASTE HANDLING PROCEDURES	5-1
	Introduction	5-1
	Waste Consolidation	5-1
6	OFFSITE WASTE HANDLING PROCEDURES	6-1
Appendix I		I-1

SECTION 1

DEMOLITION PRACTICES AND NONFRIABLE MATERIALS

INTRODUCTION

EPA revised the asbestos NESHAP regulations on November 20, 1990 (see 40 CFR Part 61 Subpart M). Although the NESHAP has not been revised to alter its applicability to friable and nonfriable asbestos-containing materials (ACM), nonfriable asbestos materials are now classified as either Category I or Category II material.

Category I material is defined as asbestos-containing resilient floor covering, asphalt roofing products, packings and gaskets. Asbestos-containing mastic is also considered a Category I material (EPA determination - April 9, 1991). Category II material is defined as all remaining types of non-friable ACM not included in Category I that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure. Nonfriable asbestos-cement products such as transite are an example of Category II material.

The asbestos NESHAP specifies that Category I materials which are not in poor condition and not friable prior to demolition do not have to be removed, except where demolition will be by intentional burning. However, regulated asbestos-containing materials (RACM) and Category II materials that have a high probability of being crumbled, pulverized, or reduced to powder as part of demolition must be removed before demolition begins.

PURPOSE

EPA has identified a need to address how specific demolition practices affect Category I and II nonfriable ACM. The purpose of this manual is to provide asbestos NESHAP inspectors with such information.

This manual is intended to apply primarily to demolition and cleanup activities for buildings that contain Category I nonfriable ACM. Although references will be made to Category II nonfriable ACM, for the purposes of this document, it and all other RACM will be assumed to have been removed prior to the start of actual demolition activities. Work practices associated solely with building renovations will not be addressed.

This manual is designed to assist the asbestos NESHAP inspector in identifying practices that normally do or do not make Category I nonfriable ACM become regulated asbestos-containing material (RACM). Applicability determinations (both formal and informal) provided by the Regional NESHAP Coordinators have been incorporated into the appropriate sections of this document in an effort to promote nationwide consistency in applying the asbestos NESHAP to these demolition practices.

Activities associated with site cleanup such as segregation, reduction, and on and offsite disposal of ACM are discussed because they may take place during or after the major demolition activities at a site and consequently may influence a demolition contractor's choice of methods.

DEFINITIONS

The following definitions taken from the November 20, 1990 revision of the asbestos NESHAP regulation are provided for ease of reference.

Adequately wet means sufficiently mix or penetrate with liquid to prevent the release of particulates. If visible emissions are observed coming from asbestos-containing material, then that material has not been adequately wetted. However, the absence of visible emissions is not sufficient evidence of being adequately wet.

Asbestos-containing waste materials means mill tailings or any waste that contains commercial asbestos and is generated by a source subject to the provisions of this subpart. This term includes filters from control devices, friable asbestos waste material, and bags or other similar packaging contaminated with commercial asbestos. As applied to demolition and renovations operations, this term also includes regulated asbestos-containing material waste and materials contaminated with asbestos including disposable equipment and clothing.

Category I nonfriable asbestos-containing material (ACM) means asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than one percent asbestos as determined using the method specified in appendix A, subpart F, 40 CFR part 763, section 1, Polarized Light Microscopy.

Category II nonfriable ACM means any material, excluding Category I nonfriable ACM, containing more than one percent asbestos as determined using the methods specified in appendix A, subpart F, 40 CFR part 763, section 1, Polarized Light Microscopy that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

Cutting means to penetrate with a sharp-edged instrument and includes sawing, but does not include shearing, slicing, or punching.

Demolition means the wrecking or taking out of any load-supporting structural member of a facility together with any related handling operations or the intentional burning of any facility.

Facility means any institutional, commercial, public, industrial, or residential structure, installation, or building (including any structure, installation, or building containing condominiums or individual dwelling units operated as a residential cooperative, but excluding residential buildings having four or fewer dwelling units); any ship; and any active or inactive waste disposal site. For purposes of this definition, any building, structure, or installation that contains a loft used as a dwelling is not considered a residential structure, installation, or building. Any structure, installation or building that was previously subject to this subpart is not excluded, regardless of its current use or function.

Facility component means any part of a facility including equipment.

Friable asbestos material means any material containing more than one percent asbestos as determined using the method specified in appendix A, subpart F, 40 CFR part 763 section 1, Polarized Light Microscopy, that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure. If the asbestos content is less than 10 percent as determined by a method other than point counting by polarized light microscopy (PLM), verify the asbestos content by point counting using PLM.

Grinding means to reduce to powder or small fragments and includes mechanical chipping or drilling.

In poor condition means the binding of the material is losing its integrity as indicated by peeling, cracking, or crumbling of the material.

Inactive waste disposal site means any disposal site or portion of it where additional asbestos-containing waste material has not been deposited within the past year.

Installation means any building or structure or any group of buildings or structures at a single demolition or renovation site that are under the control of the same owner or operator (or owner or operator under common control).

Nonfriable asbestos-containing material means any material containing more than one percent asbestos as determined using the method specified in appendix A, subpart F, 40 CFR part 763, section 1, Polarized Light Microscopy, that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

Owner or operator of a demolition or renovation activity means any person who owns, leases, operates, controls, or supervises the facility being demolished or renovated or any person who owns, leases, operates, controls, or supervises the demolition or renovation operation, or both.

Planned renovation operations means a renovation operation, or a number of such operations, in which some RACM will be removed or stripped within a given period of time and that can be predicted. Individual nonscheduled operations are included if a number of such operations can be predicted to occur during a given period of time based on operating experience.

Regulated asbestos-containing material (RACM) means (a) Friable asbestos material, (b) Category I nonfriable ACM that has become friable, (c) Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading, or (d) Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations regulated by this subpart.

Remove means to take out RACM or facility components that contain or are covered with RACM from any facility.

Renovation means altering a facility or one or more facility components in any way, including the stripping or removal of RACM from a facility component. Operations in which load-supporting structural members are wrecked or taken out are demolitions.

Resilient floor covering means asbestos-containing floor tile, including asphalt and vinyl floor tile, and sheet vinyl floor covering containing more than one percent asbestos as determined using polarized light microscopy according to the method specified in appendix A, subpart F, 40 CFR part 763, Section 1, Polarized Light Microscopy.

Strip means to take off RACM from any part of a facility or facility components.

Visible emissions means any emissions, which are visually detectable without the aid of instruments, coming from RACM or asbestos-containing waste material, or from any asbestos milling, manufacturing, or fabricating operation. This does not include condensed, uncombined water vapor.

Waste generator means any owner or operator of a source covered by this subpart whose act or process produces asbestos-containing waste material.

Waste shipment record means the shipping document, required to be originated and signed by the waste generator, used to track and substantiate the disposition of asbestos-containing waste material.

SECTION 2

PRE-DEMOLITION BUILDING STATUS

This section discusses several factors that can affect the approach to demolition taken by a demolition contractor. It is being included because events that have taken place prior to the start of actual demolition work can influence the methodology(ies) chosen by demolition contractors. These events can be evaluated by an inspector, allowing for prediction of "hidden" potential problem areas. Reinforcement and clarification of applicable components of the asbestos NESHAP regulations are also included in this section.

STATE AND LOCAL REGULATIONS

State and local asbestos regulations are sometimes more stringent than the asbestos NESHAP regulations. This does not imply, however, that Category I nonfriable ACM is necessarily removed from a building prior to demolition. Contractors surveyed during research conducted in the preparation of this manual indicated that they typically treated Category I nonfriable ACM as RACM only when the owner or operator of the building being demolished was a state or local government agency or when project specifications explicitly specified that one or more of the Category I nonfriable ACM materials be removed prior to the start of demolition.

UNSAFE BUILDING DECLARATIONS

Several contractors surveyed utilized state or local mechanisms to have buildings declared unsafe as a means to avoid NESHAP requirements during and after demolition activities. However, a State or local agency should not issue a demolition order unless the facility is structurally unsound and in danger of imminent collapse. These conditions should be confirmed independently, and a demolition order should not be based solely on the representation of the contractor or the contractor's agent. Although issuance of a demolition order may have an effect on notification requirements under the asbestos NESHAP (see §61.145(a)(3)), it has no effect on requirements for disposal procedures for RACM after demolition activities. Also, waste segregation/reduction activities, addressed in Section 5 of this manual, are subject to the asbestos NESHAP provisions whether or not a building has been declared unsafe.

ABATEMENT PRIOR TO DEMOLITION

Demolition contractors typically require that a building owner/operator accept responsibility for the removal of all asbestos-containing materials found during the building inspection prior to the start of demolition activities. Several contractors indicated that if suspect ACM became exposed during demolition activities, and there was no prior knowledge of its existence at the start of demolition activities, that potential asbestos NESHAP requirements would be disregarded unless a change order was immediately processed by the owner/operator

requesting the time and materials necessary to achieve compliance with the asbestos NESHAP. Such practices are in direct violation of the asbestos NESHAP.

INTENTIONAL BURNING

As stated in the November 1990 asbestos NESHAP revision (see §61.145(c)(10)):

> *"If a facility is demolished by intentional burning, all RACM, including Category I and Category II nonfriable ACM, must be removed in accordance with the NESHAP before burning."*

Abandoned buildings utilized by fire departments for practice exercises involving partial burning are subject to this requirement.

For buildings which are still structurally sound but which have previously been subjected to partial or total, intentional or unintentional burning, an inspection for the condition of all ACM should be conducted. Category I ACM should be examined for friability and condition. Friable materials or Category I materials that are friable and in poor condition must be removed prior to any further demolition activity.

SECTION 3

DEMOLITION PRACTICES BY TYPE OF ACM

INTRODUCTION

For many years now the applicability of the asbestos NESHAP to demolitions involving Category I nonfriable ACMs (packings, gaskets, resilient floor coverings and mastic, and asphaltic roofing materials) has been the topic of much debate. Since significant amounts of airborne asbestos fibers are not believed to be produced from such materials during normal demolition activities, however, the asbestos NESHAP, in most cases, does not require their removal prior to demolition.

Category I materials are considered RACM only when they "will be or have been subjected to sanding, grinding, cutting, or abrading", they are in "poor condition" and "friable", or the structure in which they are located will be demolished by burning. (Definitions for these terms and additional information concerning Category I nonfriable ACM can be found in the preamble to the November 1990 revised asbestos NESHAP (SUPPLEMENTARY INFORMATION, Section IV - Significant Comments..., *Demolition and Renovation,* Nonfriable ACM and Broken ACM).

The following information details specific pre-demolition and demolition practices and their impact on Category I nonfriable ACM. The information has been compiled from telephone surveys of demolition contractors, the viewing of activities at a number of demolition sites, and formal and informal EPA applicability determinations. The effects of various demolition practices on asbestos-cement products are also discussed. Since the applicability of the asbestos NESHAP to Category II nonfriable materials is determined on a case-by-case basis, it is hoped that this additional information will help foster nationwide consistency in the application of the regulation to these materials.

As you will see, many of the various demolition techniques described do not, by themselves, cause Category I nonfriable ACM to become RACM. However, in many cases, post-demolition waste consolidation, cleanup, and recycling efforts can cause both Category I nonfriable ACM and Category II nonfriable ACM to become RACM. If that is likely to happen, such materials must be considered RACM and be treated as such. Post-demolition activities which can affect Category I and II materials will be detailed later in this manual.

RESILIENT FLOOR COVERING (TILES)

Depending on the types of activities occurring at a demolition site, floor tiles (and mastic) may or may not become subject to the provisions of the asbestos NESHAP.

Pre-demolition Floor Tile Removal

Although not usually required by the asbestos NESHAP, removal of asbestos-containing resilient floor tiles may occur prior to demolition. Such removal may be required when the substrate to which the floor covering is attached (particle board, wood, concrete) is to be recycled or salvaged.

Since the presence of mastic is not desirable on materials intended for resale or recycling, contractors use a variety of methods to remove this material as well.

A wide variety of floor tile removal methods exists, some of which cause the floor tiles and mastic to become RACM and subject to the provisions of the asbestos NESHAP. The following describes various removal methods and the applicability of the asbestos NESHAP to them.

Water/Amended Water/Solvents

Water, amended water, or solvents may be spread onto floor tiles in order to loosen them. After a period of soaking, the tiles may be removed using long-handled scrapers (ice chippers), or gas- or electrically-powered mechanical chisels. In cases where tile breakage is minimal, the floor tiles are not considered RACM. However, where breakage is extensive, the tiles are RACM and are subject to the provisions of the asbestos NESHAP.

Dry Ice

Although rarely used for this purpose nowadays, dry ice (frozen carbon dioxide) can be used to remove floor tiles. When dry ice is applied to the tiles, the intense cold causes the tiles to contract and detach from the substrate. As long as the tiles are not extensively damaged, they are not considered RACM.

Infrared Machines

Infrared machines may be used in the removal of floor tiles. These machines heat the flooring, thereby softening the tiles and adhesive, and allow for its easy removal. Since most tiles detach intact, they are not friable, and therefore are not considered RACM.

Shot-blasters

Shot-blasters are sometimes used in the removal of floor tiles. These machines direct a barrage of small pellets (shot) against the tiles and continually vacuum up and separate the mixture of pulverized tile and pellets. The pellets are reused immediately and the pulverized materials are segregated for disposal. EPA allows the use of shot-blasters only on wetted floor tiles. Floor tiles and mastic removed by shot-blasters are considered RACM and are therefore subject to the asbestos NESHAP.

Demolition with Floor Tiles in Place

Since ordinary demolition activities do not include the sanding, grinding, cutting and abrading of floor tiles, floor tiles and associated mastic that are not in poor condition and not friable are not considered RACM and are allowed to remain in place during demolition.

ASPHALT ROOFING PRODUCTS

The pre-demolition terms and conditions (governmental regulations, contract specifications) discussed in Section 2 also influence the handling of asbestos-containing roofing materials.

Pre-demolition Roof Removal

If preliminary assessment has determined that roofing materials contain asbestos, and regulations or contract specifications dictate removal of such material prior to demolition, licensed abatement contractors may be required to do the removal. Alternatively, the demolition contractor may undertake the operation.

Roofs may be removed in a variety of ways. Demolition personnel may use sledge hammers, pry bars, axes, adzes, shovels, ice chippers and roof-cutting saws to remove the roofing materials. They also may use tractor-mounted rotating blade cutters, power plows and power slicers. Use of roof-cutting saws, either hand- or power-driven, or tractor-mounted, are of great concern, since they can generate asbestos-containing dust from roofing materials. The sawing of Category I nonfriable ACM roofing material and the debris created by the sawing are regulated by the asbestos NESHAP. Since power plows and power slicers do not sand, grind, cut or abrade the roofing materials, their use and resultant debris are not subject to the asbestos NESHAP regulation. Category I nonfriable ACM roofing squares that have been decontaminated may be disposed of with other demolition debris or at an asbestos landfill.

Demolition with Roofing Materials in Place

Since demolition activities do not include sanding, grinding, cutting, or abrading, Category I asbestos-containing roofing materials not in poor condition and not friable are not considered RACM and are allowed to remain in place during demolition.

ASBESTOS-CEMENT PRODUCTS

Asbestos-cement products (such as transite) are commonly used for duct insulation, pipes, and siding. Being a Category II nonfriable ACM, asbestos-cement products need to be removed prior to demolition if they have a high probability of becoming crumbled, pulverized, or reduced to powder during demolition activities. EPA believes that most demolition activities will subject such Category II nonfriable ACM to the regulation.

Whether asbestos-cement products are subject to the asbestos NESHAP should be determined by the owner or operator on a case-by-case basis based on the demolition techniques to be used.

In general, if contractors carefully remove asbestos-cement materials using tools that do not cause significant damage, the materials are not considered RACM and can be disposed of with other construction debris.

However, if demolition is accomplished through the use of cranes (equipped with wrecking balls, clamshells or buckets), hydraulic excavators, or implosion/explosion techniques, asbestos-cement products will be crumbled, pulverized or reduced to powder, and are subject to the provisions of the asbestos NESHAP.

Some demolition contractors do not treat significantly damaged asbestos-cement products as RACM; they mix it with other demolition debris and dispose of it in direct violation of the waste-disposal provisions of the asbestos NESHAP.

SECTION 4

DEMOLITION PRACTICES BY METHOD

Methods of destruction employed at demolition sites include the use of heavy machines, explosions/implosions, and hand methods. All of these methods cause Category II nonfriable ACM to become RACM; however, Category I nonfriable ACM (packings, gaskets, resilient floor coverings, asphaltic roofing materials, mastic) that is not in poor condition and not friable prior to the demolition operation may be subjected to most of these techniques without becoming RACM. The following describes various demolition techniques and their effects on nonfriable materials. All Category I nonfriable ACM referenced is presumed not to be in poor condition and not friable prior to the demolition operation.

HEAVY MACHINERY RAZING OPERATIONS

For the purposes of this document heavy machinery (or equipment) includes large motorized vehicles such as bulldozers with rakes, top loaders, backhoes, skid loaders/bobcats, hydraulic excavators, and other similar machinery used for transporting, moving, or dislodging of materials at a demolition site. Cranes equipped with wrecking balls, clamshells, or buckets are also considered heavy machinery.

Heavy machinery is used at demolition sites for both razing operations and post-demolition activities. "Razing", the process which reduces a building's structural skeleton to rubble, typically occurs after the building's interior has been gutted by hand.

Use of heavy machinery during the razing process causes Category II nonfriable ACM, but not Category I nonfriable ACM to become RACM. Use of such equipment during subsequent operations, such as waste consolidation, however, is a major concern which will be addressed in Section 5 of this document.

Bulldozers and Similar Machinery

Included in this grouping of heavy machinery are all types of bulldozers, backhoes, top loaders and skid loaders/bobcats commonly used in conjunction with hand methods to raze buildings. Bulldozers move on tracks whereas backhoes, top loaders, and skid loaders operate on rubber tires.

Only if a great deal of working space exists at a site, and a precisely-controlled demolition is not necessary, can bulldozers such as 977 loaders and D-9s be used to demolish a building. These bulldozers are typically equipped with giant rakes designed to ram building walls and move debris.

977's or D-9s may be used to undermine a building, but hydraulic excavators (discussed later in this section) are usually used for this purpose.

Backhoes and top loaders are mainly used for moving debris and tearing off sections of walls and other building components.

Skid loaders, machines commonly used to load skids or pallets onto trucks, may be specially equipped with a type of ram for use during demolitions and are usually of the "bobcat" type.

The razing of a building using the heavy machinery described above causes Category II nonfriable ACM, but not Category I nonfriable ACM to become RACM.

Hydraulic Excavators

Hydraulic excavators, such as EL-300s, 225s or 215s, resemble a combination bulldozer/backhoe and operate on tracks. They are easier to use and provide greater control during demolition than the bulldozers described above. However, since they too raze buildings by ramming and tearing, like bulldozers, their use in congested areas is limited. Nearby buildings must be protected from the falling debris; plywood may be applied over the windows and rubber tires may be used to cushion and prevent damage to walls of adjacent structures.

On rare occasions, hydraulic excavators may be used to topple one- or two-story buildings by means of an undermining process. The strategy is to undermine the building while controlling the manner and direction in which it falls. The demolition project manager (who in many jurisdictions must be licensed by the city or state) must determine where undermining is necessary so that a building falls in the desired manner and direction. The walls are typically undermined at a building's base, but this is not always the case as building designs may dictate otherwise. Safety and cleanup considerations are also taken into account in determining the methods to be used.

Since the toppling of a building constitutes a safety hazard and generates enormous quantities of dust, many cities and towns will not approve of this method of demolition. Where the practice is allowed, the contractor may be required to keep the structure wet during demolition. Hydrant permits may be required and, because of the wetting restrictions, such demolitions may be impossible to accomplish during the winter.

Hydraulic excavators are also used to conduct cleanup activities such as excavation, fill burial, material reduction, and material load-out.

The use of hydraulic excavators during the razing process causes Category II nonfriable ACM, but not Category I nonfriable ACM to become RACM.

Cranes (Wrecking Ball, Clamshell, Bucket)

Although often employed in the past, particularly during demolitions of high-rise structures, cranes are now rarely used. They are expensive to operate and usually not necessary, since renovation has displaced demolition as the method of choice in dealing with many out-of-date

structures. Cranes are currently used only in situations where other equipment cannot be employed.

Cranes may be equipped with wrecking balls, clamshells or buckets, which are used in a variety of ways. All three may be dropped or swung against the structure to demolish it. When employed in this manner, clamshells provide the greatest force of the three and result in the fastest, most efficient demolition projects.

Buckets and clamshells allow a greater degree of control than wrecking balls. Buckets may be raised to the level where internal demolition of the building is taking place and be used merely to transport and segregate hand-loaded demolition materials collected from within. Clamshells can take big bites out of the structure and facilitate the segregation of demolition debris.

When demolition is accomplished by crane, the process can begin at the roof and progress continually downward, or alternate up and down. Materials are segregated to the greatest degree possible as the demolition progresses so that the need for post-demolition handling is minimized. In the case of high-rise structures, the interiors are usually gutted by hand prior to razing.

Effect on Category I Materials

The use of cranes during the razing process does not cause Category I nonfriable ACM to become RACM; therefore, Category I materials which are not in poor condition and not friable may remain in the building during such demolition.

Effect on Category II Materials

The use of wrecking balls on asbestos-cement (A/C) siding (a Category II nonfriable ACM) on buildings is specifically addressed in the November 1990 asbestos NESHAP revision (see SUPPLEMENTARY INFORMATION, Section IV - Significant Comments..., *Demolition and Renovation*, Nonfriable ACM):

> *"...the A/C siding on a building that is to be demolished using a wrecking ball is very likely to be crumbled, or pulverized with increased potential for the release of significant levels of asbestos fibers. Such material in this instance should be removed prior to demolition."*

Therefore, A/C siding, although a nonfriable material, is considered RACM when a wrecking ball is being used to demolish the structure. Whenever buckets and clamshells are to be swung like wrecking balls, A/C materials should also be considered RACM.

EXPLOSIONS/IMPLOSIONS

Building implosions utilizing explosive devices constitute a rarely-used demolition technique. In simplest form, this method is accomplished through the use of explosive charges placed

strategically throughout a building so that the building collapses in on itself and debris does not radiate outward to any appreciable distance. Relatively large quantities of dust are created, however, and the direction and magnitude of transport are matters of concern.

Effect on Category I Materials

The asbestos NESHAP does not require the removal of Category I nonfriable ACM that is not in poor condition and not friable prior to building implosions. Normal implosion techniques do not cause nonfriable materials to become RACM. The destruction of buildings during military target practice is considered to be another form of explosive demolition. Category I materials may remain in place during target practice. However, if it can be expected that the building and ACM will burn as a result of explosive demolition, the ACM must be removed prior to demolition.

Recent examination of asbestos-containing floor tiles and roofing materials contained in a large building demolished by implosion revealed that the floor tile was in fair to good condition and had not become friable. Tiles had been broken up into small quantities of large pieces as the individual floors collapsed upon each other. The roofing materials were similarly affected; they too remained nonfriable following demolition by implosion.

EPA does not consider Category I material to be RACM as a result of building implosions. If, however, Category I materials are to be subjected to sanding, grinding, cutting, or abrading after demolition, they must be treated as RACM and be removed from the building before demolition.

Effect on Category II Materials

Category II materials, such as transite, found in or on buildings scheduled for implosion/explosion destruction must be removed before such demolition. Such materials are considered RACM because they have "a high probability of becoming crumbled, pulverized or reduced to powder" during such activities.

HAND METHODS OF DEMOLITION

This section of the manual addresses hand methods employed during demolition and includes segregation activities which take place during demolition (as opposed to cleanup) and their effects on Category I materials. "Hand methods", for the purposes of this manual, refer to the use of motorized and non-motorized tools that can be operated by hand and are not used for transportation. The methods discussed include not only those used in the gutting of building interiors prior to razing, but also those used during razing itself. Unless otherwise noted, "hand methods" refers to those methods that do not significantly damage the ACM and therefore do not cause Category I nonfriable ACM to become RACM.

Most buildings of ten floors or less are currently razed at least partially, if not fully, by hand. Hand methods allow much greater control over a building's collapse than other methods and permit easier segregation of demolition materials for resale or recycling than other demolition methods. In addition, hand methods may be required because of workspace limitations.

Depending on the size of the job and demolition schedule, the size of a demolition crew may vary from as few as five individuals to 30 or more. As a general rule, workers use relatively inexpensive tools such as pry bars, hand-held saws, power saws, sledge hammers, axes, bolt cutters, and acetylene torches during gutting and razing operations.

As the gutting/salvage activities progress, demolition debris is typically deposited into a trailer or dumpster strategically placed outside a window of the building being demolished. The window frame is removed and materials are loaded into the storage containers by hand, or, where possible, by bobcats operating within the building. Many jobs require the use of dust-tight chutes for the transport of such debris.

On the rare occasion where onsite burial of demolition debris is allowed, the first activity to take place in the building is the removal of the first story's flooring. This is done so that as waste materials accumulate on upper floors, they can be sent down into the basement through the center of the building, typically through elevator shafts, for disposal. Chutes may be used if elevator shafts are not available. Such onsite disposal typically is allowed only for noncombustible materials such as cement and brick. Waste consolidation activities which occur in the basement area are of great concern to EPA and are discussed in Section 5 of this manual.

Excess demolition wastes are loaded out for transport to a landfill that accepts construction debris. If no basement area exists, or if materials cannot be sent into dumpsters or trailers immediately as previously described, debris may be stored in piles scattered around the site. These materials may subsequently be moved by hand or through the use of light or heavy machinery. Section 5 of this manual details such operations.

Floor Removal and Disposition

The techniques used in removing flooring depend upon its ultimate fate. Where it is in poor condition and incapable of being reused or recycled, the flooring is typically ripped out using pry bars and sledge hammers and sent offsite for disposal. Sometimes wood flooring and other debris is burned to reduce the volume of waste. In this case, the asbestos must be removed prior to burning the wood debris. Since demolition debris disposal costs are so high ($100 - $500 per 60-100 cubic yard load) as much salvage/recycling of materials is done as possible.

Wood or particle board flooring is sometimes segregated and sold to recycling centers where it is chipped up and sold as filler or mulch (composting, gardening, etc.). If resilient asbestos-containing floor covering is attached to such flooring it is considered RACM and must be removed prior to recycling. Tiles are often chipped or scraped off the substrate using the methods described in Section 3.

Large planks and joists, and beams (both wooden and steel) may also be saved if they are in good condition. Wooden planks are usually lifted with pry bars, whereas the larger joists and beams are segregated for reuse following the razing of the structure.

Where demolition debris will be recycled, any asbestos remaining on the debris must be removed prior to any recycling that will sand, grind, cut, or abrade the asbestos or otherwise cause it to become RACM.

Roof Removal and Disposition

On occasion one may find that the roof of a building being demolished is removed before the building is razed. Such removal may be required when buildings are very close to one another, or when the roofing contains asbestos-containing materials.

There are two major types of roofing: "built-up roofing" and "sheet goods". Built-up roofing contains multiple layers of felt and asphalt. Sheet goods typically consist of a single layer of material.

Roofs are often taken out by hand, typically by using pry bars, sledge hammers, axes, adzes, bolt cutters, ice chippers, shovels and roof-cutting saws. If the roof contains asbestos materials (felt, cork, etc.), an asbestos removal contractor may be employed to remove it. Some abatement contractors wet the roof with plain or amended water and then use shrouded power saws whose exhaust is HEPA-filtered to cut the roofing into manageable (often 2' x 3') pieces. After the pieces are lifted, the edges may be encapsulated. Other abatement contractors may build a full containment and establish a reduced pressure environment prior to removing the roofing materials.

Depending upon the contractors involved and the condition of the asbestos-containing roof debris, the debris may or may not be segregated from other demolition debris. Abatement contractors may store roof debris in lined dumpsters onsite and dispose of it at an asbestos landfill; if the asbestos-containing roofing material is not in poor condition and is not friable however, it may be disposed of in a landfill which accepts ordinary demolition waste.

Asbestos-containing roofing material may not be ground up for recycling into other products.

Work Progression

Demolition crews typically work downward, floor by floor. Materials such as doors, windows, electrical and other fixtures which can be salvaged are removed first. Interior partitions are then ripped, cut, or knocked out using various hand-held tools including sledge hammers, axes, adzes and pry bars. Brick is generally segregated immediately after being knocked out of walls so it can be examined at the site by potential buyers. Ceilings are also ripped out using pry bars, axes and sledge hammers. Steel and other metal materials are typically placed in separate debris piles from other materials. Work proceeds in a similar floor/wall, floor/wall pattern until the first floor is once again reached.

Sawing/Cutting Operations

In order to raze a building by hand, load-bearing members must be cut. Based upon the composition, thickness, and condition of the structural member being cut, saws selected range

from hand saws to Sawz-alls™ and gas-driven carbide blade hand saws. Large bolt cutters are also used to cut steel members. Category I materials subjected to sawing or cutting are subject to the provisions of the asbestos NESHAP; however, typical demolition sawing/cutting operations rarely involve such materials.

Grinding Operations

Grinding operations are not common occurrences at most demolition sites. On occasion, however, asbestos-containing mastic and remaining pieces of floor tile may be ground off concrete destined for recycling. Category I material so treated is RACM and is subject to the provisions of the asbestos NESHAP.

Pulverizing Operations

On occasion, asbestos-containing floor tiles are removed from their substrate by hand, using either hand-held ice choppers or electrically- or gas-powered mechanical chippers. If use of such methods pulverizes, crumbles or reduces the floor tiles to powder, the tiles must be considered RACM and must be handled in accordance with the requirements of the asbestos NESHAP.

Summary

On rare occasions Category I nonfriable ACM may be subjected to hand methods involving the uncontrolled drilling, cutting, sawing, grinding or abrading of such materials; under these circumstances Category I materials are considered RACM.

SECTION 5

ONSITE WASTE HANDLING PROCEDURES

INTRODUCTION

At the present time it is not demolition operations and ordinary cleanup activities but the post-demolition activities involving waste consolidation and recycling of Category I and II materials which are of greater concern. If such activities subject either Category I or II nonfriable ACM to sanding, grinding, cutting or abrading, the materials become RACM and are then subject to the provisions of the asbestos NESHAP.

In general, since cleanup activities such as loading waste debris onto trucks for disposal do not subject nonfriable materials to sanding, grinding, cutting or abrading, such materials are not considered asbestos-containing waste materials and are not regulated by the asbestos NESHAP.

However, waste consolidation efforts which involve the use of jack hammers or other mechanical devices such as grinders to break up asbestos-containing concrete or other materials covered or coated with Category I nonfriable ACM, are subject to the regulation.

In addition, operations such as waste recycling which sand, grind, cut, or abrade Category I or II nonfriable ACM are subject to the asbestos NESHAP. When these types of activities are performed, Category I and II nonfriable ACM become RACM.

The following details the post-demolition activities of waste consolidation (segregation and reduction), waste load-out and onsite waste disposal and their effects on nonfriable ACM.

WASTE CONSOLIDATION

Waste consolidation operations involve segregation and reduction activities that have as their ultimate goal the resale, recycling, and disposal of demolition debris.

Segregation of Demolition Debris

Demolition contractors segregate demolition debris primarily to maximize their profits. As much material as possible is collected for resale and recycling (e.g., wood, brick, steel and concrete); the remaining debris is most often transported offsite for disposal.

Segregation may involve cutting and grinding operations, the breaking and tearing apart of materials to separate them by material type, and the transport of materials within the demolition site boundaries.

Since segregation activities may be accomplished using hand methods and heavy equipment, nonfriable ACM may or may not become friable in the process. The following text details various segregation activities and describes their effects on nonfriable materials.

Segregation by Hand

Materials such as wood, brick and steel are generally separated from other demolition debris using equipment such as sledgehammers, prybars, adzes and axes. If any hand equipment is used to cut, sand, grind, or abrade Category I or II materials, RACM is thus created and the provisions of the asbestos NESHAP apply.

Material Transport

Since heavy equipment is often used to move and segregate demolition debris, questions have been raised concerning the effect of such transport particularly on Category I nonfriable ACM.

If Category I nonfriable ACM is transported across a demolition site in the bucket of a top loader, backhoe, hydraulic excavator or other similar vehicle, it is not considered RACM since it is not subjected to sanding, grinding, cutting or abrading during this activity.

Use of bulldozers, on the other hand, is expected to have a greater impact on Category I materials. However, EPA has stated that "...if the bulldozer is moving the debris or picking it up to be put in a vehicle and inadvertently runs over Category I material, then it is not subject to the NESHAP standard" (see Appendix I). Consequently, the moving of debris by bulldozers, whether by carrying it in a bucket or pushing it along the ground does not in itself cause Category I nonfriable ACM to become RACM.

Category II nonfriable ACM subjected to sanding, grinding, cutting or abrading during collection and transport is considered RACM and thus subject to the asbestos NESHAP.

Vehicular Traffic Impact

Rubber-tired Vehicles

If nonfriable ACM is intentionally run over by rubber-tired vehicles as a means of segregation, it does not automatically become RACM but must be examined for damage. If it has become extensively damaged, i.e., it was sanded, ground, cut or abraded during segregation, it becomes RACM and is subject to the NESHAP regulation.

Tracked Vehicles

Although tractor treads present greater risks of causing extensive damage to nonfriable ACM, limiting their use at demolition sites is not considered practical. Intentionally running over nonfriable ACM with tractor treads as a means of segregation is considered grinding; material thus treated becomes RACM.

Intentional segregation in this manner is addressed in the preamble to the revised asbestos NESHAP (SUPPLEMENTARY INFORMATION, Section IV, Significant Comments and Changes to the Proposed Revisions, Demolition and Renovation, Nonfriable ACM):

> *"Examples of practices...included the breaking of nonfriable insulation from steel beams by repeatedly running over the beams with a crawler tractor...these and other similar practices involving nonfriable asbestos material were considered to render nonfriable ACM into dust capable of becoming airborne."*

Reduction of Demolition Debris

Reduction activities are of the greatest concern to EPA, since they are most likely to cause both Category I and Category II nonfriable ACM to become RACM.

Category I Reduction

The use of bulldozers to reduce the volume of Category I materials causes them to become RACM as discussed elsewhere in this manual and in the following EPA correspondence:

> *"If, after a demolition, material left in the facility... is intentionally ground up (such as repeatedly running over the debris with a bulldozer to compact the material), then 61.150(a)(3) applies. The material must be adequately wetted and kept adequately wet during collection and transport to a site or facility operated in accordance with 61.154 or 61.155."* (See Appendix I).

Reduction by the use of sledgehammers does not normally cause Category I nonfriable ACM to become RACM. The use of pneumatic hammers, however, whether hand-operated or attached to heavy machinery, does cause these materials to become RACM. The use of cranes with clamshells or other heavy machinery with rakes or buckets to partially reduce Category I nonfriable ACM is permissible if the material is left recognizable in its original form. Extensively damaged Category I ACM (that which has been sanded, ground, cut, or abraded) becomes RACM. Consolidating waste materials containing Category I nonfriable ACM in the hole (basement) of a building and subsequently grinding or crushing it via bulldozer subjects the operation to the asbestos NESHAP.

For wood/tile debris, demolition crews sometimes use tree chippers to grind the material up. Any Category I nonfriable ACM subjected to this treatment becomes RACM.

Category II Reduction

Reduction of Category II materials such as asbestos-cement pipe and concrete following demolition is also a matter of concern.

Asbestos-Cement Pipe

EPA considers asbestos-cement pipe to be a "facility component" (as defined in 40 CFR §61.141) of the facility which owns or utilizes the pipe. In addition, EPA considers asbestos-cement pipe to be Category II nonfriable asbestos containing material. This material becomes "regulated asbestos containing material" (RACM), as defined in 40 CFR §61.141, when it becomes "friable asbestos material" or when it "has a high probability of becoming or has become crumbled, pulverized or reduced to powder by the forces expected to act on the material during the course of demolition or renovation operations regulated by [40 CFR Part 61 Subpart M]." Consequently, the crushing of asbestos-cement pipe with mechanical equipment will cause this material to become RACM. The demolition and renovation provisions in 40 CFR §61.145 and the waste disposal provisions in 40 CFR §61.150 apply to asbestos-cement pipe where the pipe is considered RACM, and the amount of pipe being removed and crushed is at least 260 linear feet for a single renovation project or during a calendar year for individual nonscheduled operations.

Concrete

At certain demolition sites demolition contractors may rent and operate large concrete-pulverizing machines called PC-400s. Since the asbestos content of concrete is rarely known, use of such machines is a matter of concern to EPA. Under no circumstances should asbestos-containing concrete, or concrete to which asbestos-containing resilient flooring is attached, be subjected to such treatment.

Onsite Waste Disposal

As mentioned in other sections of this manual, using heavy machinery to crush demolition debris containing Category I or II nonfriable ACM in place prior to or during burial, can cause the ACM to become RACM subject to the provisions of sections §61.150 (waste disposal) and §61.151 (inactive waste disposal sites) or §61.154 (active waste disposal sites). If Category I or II materials are not rendered friable, they are not subject to the asbestos NESHAP.

EPA has recently responded to a question regarding the onsite disposal of crushed asbestos-cement pipe, a Category II material. The response is applicable as well to the burying of Category I material which has been sanded, ground, cut or abraded. In its correspondence EPA stated that the practice of backfilling and burying crushed asbestos-cement pipe in place causes these locations to become active waste disposal sites subject to the requirements of §61.154. Furthermore, if no additional asbestos-containing waste material is buried at that location for a year, the site becomes an inactive waste disposal site subject to the requirements of §61.151(e) and §61.154(h).

Consequently, the owner of the land would be required to comply with the requirements for active and inactive waste disposal sites.

In order to avoid the creation of a waste disposal site which is subject to the Asbestos NESHAP, it was suggested that the owners or operators of the pipe consider other options for dealing with it. If the pipe is left in place or removed in such a way that it is not crumbled, pulverized or reduced to power, it would not be subject to the NESHAP. If the pipe must be crushed, the creation of an active waste disposal site can be avoided by removing the pipe from the site and transporting it to a landfill which accepts asbestos waste material.

An alternative method suggested involved the pumping of grout into the buried lines which are no longer in service.

Waste Load Out

As mentioned previously, waste load out activities generally do not cause Category I nonfriable ACM to become RACM. Top loaders are typically used to deposit demolition debris containing Category I nonfriable ACM into trucks for hauling to landfills that accept construction debris.

Recent EPA correspondence discusses the hauling and ultimate disposal of both Category I and Category II ACM as follows:

> *It is required under §61.150(a)(3) that asbestos-containing waste material be kept adequately wet. Asbestos-containing waste material as applied to demolitions and renovations includes RACM waste and materials contaminated with asbestos including disposable equipment and clothing. Category I or Category II nonfriable ACM that has been contaminated by RACM, and cannot be decontaminated (e.g., building debris in a pile contaminated with RACM) must be treated as asbestos-containing waste material. Category I or Category II ACM that does not meet the definition of RACM after a demolition or renovation, and is not contaminated with RACM, is not asbestos-containing waste material and is not subject to the wetting requirement of §61.150(a)(3).*
>
> *Category I or II nonfriable ACM that is not subject to §61.150(a)(3) would still have to be disposed of in a landfill that accepts building debris, in a landfill that operates in accordance with §61.154, or at a facility that operates in accordance with §61.155. This waste material would not be allowed to go to any facility that would sand, grind, cut or abrade the non-RACM waste or otherwise turn it into RACM waste (such as a cement recycling facility). In addition, if Category I or II nonfriable ACM is sanded, ground, cut or abraded during disposal at a landfill, before it is buried, it is subject to the NESHAP.* (See Appendix I).

SECTION 6

OFFSITE WASTE HANDLING PROCEDURES

The issues discussed in this section include landfills, recycling centers, conversion facilities, and renovation activities. Since EPA has taken a "cradle to grave" approach regarding the disposition of ACM, responsibility for the ultimate fate of Category I ACM rests with all individuals involved in handling the material.

Landfills

Category I and II ACM that has become RACM must be disposed of in a landfill that operates in accordance with §§61.150 and 61.154, or in an EPA-approved conversion facility described in §61.155 of the asbestos NESHAP.

Category I and II nonfriable ACM which has not become RACM during demolition may be disposed of in a landfill that normally accepts construction debris. However, if Category I or II nonfriable ACM is sanded, ground, cut or abraded before it is buried at the landfill, it is subject to the asbestos NESHAP.

Recycling Centers

At the present time, EPA does not allow either Category I or II nonfriable demolition debris to go to any facility (e.g., a cement recycling facility) that will sand, grind, cut or abrade it or otherwise turn it into RACM waste. Recycling facilities which cause non-RACM waste to become RACM waste are subject to the provisions of the asbestos NESHAP (See Appendix I).

Conversion Facilities

Conversion facilities are addressed in Section 61.155 of the November 1990 revised asbestos NESHAP. Owners/operators of such facilities must handle ACWM according to the provisions of the asbestos NESHAP.

ITEM 9

Guidelines For Catastrophic Emergency Situations Involving Asbestos

United States
Environmental Protection
Agency

Air And Radiation
(EN-341W)

EPA 340/I-92-010
February 1992

EPA

Guidelines For Catastrophic Emergency Situations Involving Asbestos

Guidelines for Catastrophic Emergency Situations Involving Asbestos

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Stationary Source Compliance Division
Washington, DC 20460

September 1991

TABLE OF CONTENTS

I. INTRODUCTION 1
A. Background 1
B. Purpose 1

II. RECENT EMERGENCIES 3
A. Gramercy Park 3
B. Hurricane Hugo 3
C. San Francisco Earthquake 4

III. OTHER APPLICABLE STATUTES 6
A. AHERA 6
B. EPCRA 6
C. CERCLA 7
D. OSHA 7

IV. ASBESTOS NESHAP APPLICABILITY 8
A. Definitions (61.141) 8
B. Demolition and Renovation Provisions (61.145) 9
1. Emergency Renovation Operations 9
2. Government-Ordered Demolitions 10
C. Waste Disposal (61.150) 11
D. Active Waste Disposal Sites (61.154) 12

V. PRE-EMERGENCY PLANNING 13
A. Emergency Response Organization 13
B. Coordination With Local Emergency and Related Organizations 13
1. The Problem 18
2. Strategy 18
C. Mapping Asbestos Locations 20
1. Asbestos Milling, Manufacturing, and Fabricating 20
2. Asbestos in Facilities 21
a. Surveys of Buildings for Asbestos 21
b. Schools 23
c. Local Building Permit Agencies 23
d. Notifications 25
D. Cleanup and Disposal 25
1. Water Supply 26
2. Chemical Contamination 26
3. Waste Disposal 27
4. Backup Personnel 27
5. Laboratory Capabilities 27
6. Emergency Exemptions 28

VI. EMERGENCY PERIOD 29

VII. CONCLUSIONS 30

REFERENCES 32

APPENDIXES

A Asbestos NESHAP Checklist for Catastrophic Emergency Situations 33

B FEMA Regional Directors 35

C State Official Responsible for Disaster Operations 39

D Regional Asbestos Coordinators 54

GUIDELINES FOR CATASTROPHIC EMERGENCY SITUATIONS INVOLVING ASBESTOS

I. INTRODUCTION

A. Background

In 1989, the California earthquake and Hurricane Hugo resulted in the destruction of or damage to numerous buildings, many of which contained asbestos. Badly damaged or destroyed structures had to be demolished quickly to reduce the threat of injuries from the damaged structures and to aid in restoring the affected areas. In the same year, a steam pipe explosion in Gramercy Park, NY spread asbestos over a wide area with the potential to expose a large number of people to asbestos.

These recent natural and man-made disasters and others that have damaged or destroyed structures containing asbestos have served to focus attention on the need to consider asbestos along with other emergency response activities. Understandably, the emphasis in an emergency or disaster situation is on efforts to mitigate the immediate threats to public health and safety and to return the stricken area to its former condition as quickly as possible. Also, the organizations that typically respond to emergency or disaster situations, such as fire departments and emergency management agencies, do not deal with asbestos as part of their normal duties. As a result, there may be a tendency to overlook potential public health threats like asbestos, which do not pose an immediate, life-threatening hazard.

B. Purpose

These guidelines are intended to assist Regional, state, and local agencies in managing potential asbestos hazards resulting from a catastrophic accident or disaster. The guidelines may be used as a reference for advanced planning or, once the emergency presents

itself, to help ensure that, to the extent feasible and compatible with other emergency measures, all appropriate steps are taken to safely handle and dispose of all asbestos, while avoiding unnecessary exposures to asbestos. The guidelines provide information that may be helpful to EPA Regional offices and delegated NESHAP agencies that must respond to emergencies involving asbestos.

The guidelines review the experiences of EPA Regional and state enforcement agencies in dealing with asbestos during recent emergencies. Information is included on statutes and regulations that may be applicable in emergency situations, including the emergency provisions of the asbestos NESHAP. Lines of communication within EPA and between EPA and emergency management agencies are discussed. A list of contacts responsible at the state level for emergency and disaster activities is provided, as is a protocol for coordinating asbestos NESHAP activities with local fire and building departments. Information is provided to help identify potential sources of asbestos releases, and factors are identified that should be considered in planning for the cleanup and disposal of asbestos.

II. RECENT EMERGENCIES

Three emergencies occurred in 1989 that focused EPA's attention on the handling of asbestos. One was a technological failure--a Consolidated Edison steam pipe explosion at Gramercy Park in N.Y. City; the other two were natural phenomena--Hurricane Hugo and the San Francisco earthquake. These emergencies are reviewed here for lessons that may help plan for and deal with similar problems in the future.

A. Gramercy Park

On August 19, 1989, an underground Consolidated Edison steam pipe exploded in Gramercy Park in New York City, discharging 400°F steam, asbestos and mud into the air and onto and into nearby buildings. The explosion killed three people, injured 24, and forced the evacuation of 200 residents. Two-hundred pounds of asbestos from pipe insulation were released with the explosion. The cleanup and decontamination of the contaminated structures required several months. The asbestos-contaminated waste was collected and transported to the Meadowfill Landfill, Clarksburg, West Virginia for disposal. The cleanup was supervised by the New York City Department of Environmental Protection, with oversight by EPA. This cleanup effort was not regulated under the asbestos NESHAP, because it was neither a demolition nor a renovation.

B. Hurricane Hugo

In September 1989, Hurricane Hugo made a landfall on the South Carolina coast at Charleston destroying many buildings, damaging many others, and creating vast amounts of debris, some of it contaminated by asbestos. The City of Charleston was declared a disaster area and the South Carolina Department of Health and Environmental Control (SCDHEC) was asked to assist with the cleanup of debris. To deal with a problem of such great magnitude, SCDHEC adopted the following procedures:

- Buildings destroyed by Hugo were considered to be demolished by natural causes and notification requirements were waived. Removal contractors were not required for the cleanup; however, wetting and proper disposal of asbestos-containing material were required.

- Remaining, uncontaminated building debris was disposed of in accordance with solid waste regulations.

- Open burning was permitted in the disaster area to clear it of trees and wood products without using landfills.

- Partially destroyed buildings could be demolished without notifications after asbestos materials were removed by abatement contractors.

A problem that emerged in South Carolina was that of unscrupulous contractors preying on unsuspecting home owners by telling them that they were subject to $25,000 a day in fines unless their roofs were repaired by licensed asbestos contractors, when, in fact, SCDHEC regulations did not apply to private residences unless the homeowner selected a licensed asbestos contractor. A one-page Guidelines for Homeowners with Damaged Asbestos Roofing was issued by SCDHEC to outline requirements for homeowners.

Emergency preparedness representatives, presumably unaware of the presence of asbestos, complicated asbestos NESHAP enforcement by instructing people to go ahead and knock down damaged buildings.

C. San Francisco Earthquake

On October 17, 1989, an earthquake registering 7.1 on the Richter scale shook San Francisco. According to the Region 9 asbestos NESHAP coordinator, many demolition contractors thought the NESHAP regulations did not apply following the earthquake and many buildings were demolished without regard to asbestos. At a minimum, the NESHAP coordinator feels that wetting should be employed and the debris disposed of properly. Based on the Region 9 experience, the NESHAP coordinator suggested the following to prepare for emergencies:

- Create an emergency phone list
- Coordinate with nearby Regions
- Tie into existing emergency communication plans
- Set up an emergency protocol for buildings and fire departments
- Set up emergency protocols with delegated agencies
- Prepare and pre-position press releases regarding NESHAP and asbestos risks
- Contact the Federal Emergency Management Agency (FEMA) regarding asbestos risks and NESHAP
- Contact state emergency planners
- Set up an informal network of volunteer inspectors.

The NESHAP coordinator also noted that there was a shortage of inspectors available to determine whether asbestos was present in the damaged buildings and that obtaining additional help was a problem.

III. OTHER APPLICABLE STATUTES

In addition to the asbestos NESHAP, there are other Federal statutes that provide planning information and/or cleanup authority applicable to catastrophic emergencies involving asbestos. They include the Asbestos Hazard Emergency Response Act (AHERA); the Emergency Planning and Community Right-to-Know Act (EPCRA); the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA); and the Occupational Safety and Health Act (OSHA).

A. AHERA

Regulations promulgated under the authority of AHERA require the preparation of management plans for asbestos in school buildings (40 CFR 763.93). Plans must be prepared by an accredited management planner and include:

- The name and address of each school building and whether it contains friable asbestos.
- A blueprint, diagram or written description that identifies the location and approximate square or linear feet of asbestos.

Thus, a data base on asbestos in school buildings already exists in the administrative offices of school systems in many communities. This data base is potentially useful either for emergency response planning or for identifying asbestos-containing structures following the occurrence of a catastrophic emergency.

B. EPCRA

Since asbestos is not listed as an extremely hazardous substance, emergency plans developed under EPCRA do not address asbestos. However, the Act also requires routine toxic chemical release reporting and friable asbestos is a reportable emission (40 CFR 372.65). Information collected in this way is entered into a computer file known as the Toxic Release Inventory System (TRIS) which can be accessed to identify asbestos sources in SIC

codes 20 through 39. TRIS would seem to be a useful database for either emergency response planning or identifying facilities where friable asbestos might be expected following an emergency.

C. CERCLA

Hazardous air pollutants regulated under the Clean Air Act (CAA) are also regulated as hazardous substances under CERCLA. CERCLA provides the authority and funds for emergency government response to hazardous substance releases into the environment, including the ambient air and allows the federal government to recover the costs of responding to and cleaning up hazardous substance releases.

Emissions of reportable quantities (RQs) of listed substances must be reported to the National Response Center in Washington. The RQ for asbestos is 1 lb. (0.454 kg) of pure asbestos (40 CFR 302.4).

As noted earlier, the Gramercy Park response was conducted under New York City law and was not regulated under the asbestos NESHAP. A federal response could have been carried out under CERCLA, however, if that had been needed.

D. OSHA

The OSHA rules on asbestos (29 CFR 1910.1001 and 29 CFR 1926) are applicable in catastrophic emergencies. OSHA rules specify a permissible exposure limit for asbestos, respiratory protection, work practices, and engineering controls for worker protection. There are no exemptions for emergencies in the Act.

IV. ASBESTOS NESHAP APPLICABILITY

The applicability of the asbestos NESHAP (40 CFR Part 61, Subpart M) in emergency situations is discussed here. Whenever asbestos will be damaged or disturbed as part of a demolition or renovation and a threshold amount (160 square feet, or 260 linear feet, or 35 cubic feet) is exceeded, or whenever a building is demolished, the asbestos NESHAP applies. There are no provisions that stay the applicability of the NESHAP as a result of disaster, although there are emergency-related provisions. The relevant sections of the NESHAP include Definitions (61.141), Standard for Demolition and Renovation (61.145), Standard for Waste Disposal for Manufacturing, Fabricating, Demolition, Renovations, and Spraying Operations (61.150), and Active Disposal Sites (61.154).

A. Definitions (61.141)

The only definition that is specifically applicable to emergencies is "emergency renovation operation." The NESHAP defines the term as follows:

> "Emergency renovation operation" means a renovation operation that was not planned but results from a sudden, unexpected event that, if not immediately attended to, presents a safety or public health hazard, is necessary to protect equipment from damage, or is necessary to avoid imposing an unreasonable financial burden. This term includes operations necessitated by nonroutine failures of equipment.

The repair or replacement of an apartment building's asbestos-insulated boiler that fails during the winter may be considered an emergency renovation, since to delay repair or replacement could expose residents of the apartment building to dangerously cold temperatures. Or, the repair of asbestos-insulated equipment that suddenly fails at a power plant could result in prolonged power outages and affect many essential services if not attended to immediately. These are examples of asbestos removal operations that might be considered emergency renovations. It is usually the responsibility of the building owner or

operator to demonstrate that the renovation was an emergency. The implications for an emergency renovation in the context of the NESHAP requirements are discussed below.

B. Demolition and Renovation Provisions (61.145)

The demolition and renovation provisions of the NESHAP contain specific requirements that may apply in certain emergency situations and include the provisions for emergency renovation operations and government-ordered demolitions.

1. Emergency Renovation Operations

In order for a renovation to be considered an emergency renovation operation and be subject to the NESHAP, it must satisfy the definitional requirements of an emergency renovation operation and it must also meet the applicability requirements of Section 61.145 (a)(4)(iv). Section 61.145 (a)(4)(iv) specifies that for an emergency renovation to be subject to the notification and control provisions of the NESHAP, the combined amount of regulated asbestos-containing material (RACM) that is to be stripped or removed as a result of the emergency, must equal or exceed 260 linear feet of asbestos on pipes or 160 square feet on other facility components, or 35 cubic feet if the asbestos material is already off the facility component and the length or area could not be determined previously.

Notifications for emergency renovation operations that are subject to the NESHAP must be given as early as possible before the renovation begins, but no later than the next working day following the day the emergency renovation begins (61.145 (b)(3)(iii)). As for all notices, they must be in writing and may be delivered by U.S. Postal Service, commercial delivery service, or hand delivery. The NESHAP does not permit notification by telephone or telephone facsimile (fax) machines. The information contained in the notice for an emergency renovation is the same as that required for all notices, except that the following additional information is also required:

- The date and the hour that the emergency occurred,
- A description of the sudden, unexpected event, and
- An explanation of how the event caused an unsafe condition, or would cause equipment damage or an unreasonable financial burden (61.145 (b)(4)(xv)).

Emergency renovation operations are subject to the emission control procedures of section 61.145 (c). These procedures include removal of asbestos from the facility before any activity that would disturb or break up the asbestos, wetting the asbestos during stripping, keeping the asbestos that has been removed or stripped wet until collected or contained for disposal, and having an individual on-site who is trained in the provisions of the NESHAP. There are no exemptions from emission control procedures for emergency renovation operations.

2. Government-Ordered Demolitions

The NESHAP exempts certain types of demolitions from some of the notification and emission control requirements. The applicability provisions in section 61.145 (a)(3) state that a facility that is being demolished as a result of a government order that is issued because the facility is structurally unsound and in danger of imminent collapse, is exempt from the following:

- Notification requirement to provide 10 working days advance notice. Notice for such demolitions must be provided as early as possible before demolition and not later than the following working day.
- Notification requirement to include the scheduled starting and completion dates of asbestos removal.

All other notification requirements apply. In addition, the notice for government-ordered demolitions must include the name, title, and authority of the State or local government

representative who ordered the demolition, the date the order was issued, and the date on which the demolition is ordered to begin.

As specified in the applicability provisions of 61.145 (a)(3), government-ordered demolitions are exempt from all but the following emission control procedures:

- The requirement to strip or place in leak-tight wrapping all asbestos covered or coated facility components that were removed in sections or units (61.145 (c)(4)).
- The requirements for large facility components to be removed where the asbestos will not be disturbed (61.145 (c)(5)).
- The requirements for RACM that has been stripped or removed (61.145 (c)(6)).
- The requirements during periods of freezing temperatures (61.145 (c)(7)).
- The requirement for a person trained in the provisions of the NESHAP to be on site (61.145 (c)(8)).
- The requirement that all government-ordered demolitions adequately wet the portion of the facility that contains RACM during the wrecking operation (61.145 (c)(9)).

C. Waste Disposal (61.150)

For facilities that have been demolished in response to government orders, Section 61.150 (a)(3) requires that the resulting asbestos-containing waste be adequately wetted at all times after demolition and kept wet during the handling and loading for transport to a disposal site. Such waste may be transported and disposed of in bulk. All the rest of the waste disposal provisions in section 61.150 apply, including the requirements to dispose of the waste as soon as practical at an appropriate site, to properly mark vehicles used to transport the waste, to maintain waste shipment records, to provide a copy of the waste shipment record to the disposal site, and to report any waste for which a copy of the waste shipment record signed by the disposal site owner or operator is not received from the disposal site within the prescribed amount of time.

D. Active Waste Disposal Sites (61.154)

There are no special provisions or exemptions from the NESHAP for any asbestos-containing waste material that is subject to the asbestos NESHAP. Asbestos-containing waste from emergency renovations, government-ordered demolitions, or from any source covered by the NESHAP must be disposed of in compliance with all the provisions of 61.154.

V. PRE-EMERGENCY PLANNING

In advance of a catastrophic emergency, Regional, state and local NESHAP coordinators should take certain steps to ensure that potential asbestos hazards can be adequately managed and asbestos exposures minimized. The following sections identify activities that, if performed prior to an emergency, should help to ensure an adequate response in the event of a catastrophic emergency.

A. Emergency Response Organization

Each Regional office should prepare a flow chart for their Region (similar to Figure 1) with the names and telephone numbers of contact persons and backups. Copies of the completed flow chart should be provided to neighboring Regions.

An organizational flow chart showing in parallel the levels of government engaged in enforcing the asbestos NESHAP and responding to catastrophic emergencies is given in Figure 1. Normal channels for the flow of information, requests for assistance, etc. are shown as solid lines connecting the government agencies, while channels that need to be established in order to plan for and respond to asbestos encountered in forced demolitions resulting from emergencies are shown as dashed lines. Example emergency telephone lists for Regional, state, and local asbestos NESHAP coordinators are presented in Figures 2, 3, and 4. The lists are presented for illustrative purposes only; they are not intended to be comprehensive. The telephone lists needed by a NESHAP coordinator will depend on several factors including, for example, the extent to which NESHAP authority has been delegated.

B. Coordination With Local Emergency and Related Organizations

The responsible NESHAP coordinators should establish contact with responsible emergency agencies and inform them of the NESHAP requirements.

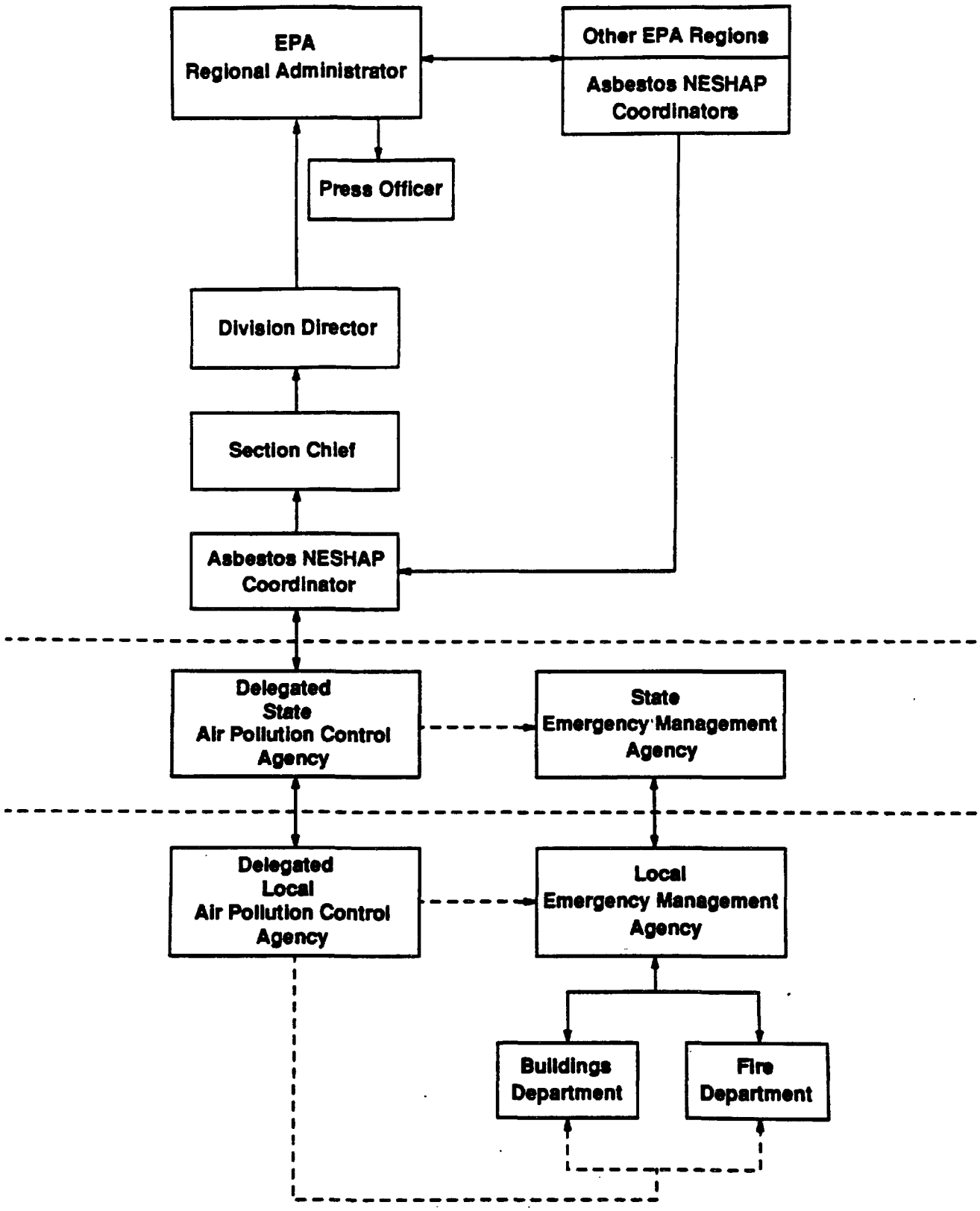


Figure 1. Emergency response structure.

Contact	Telephone number
Other EPA Regional asbestos NESHAP coordinators	_____
	_____
State asbestos NESHAP coordinators	_____
	_____
	_____

Figure 2. Example emergency telephone list for Regional asbestos NESHAP coordinator.

Contact	Telephone number
Regional asbestos NESHAP coordinator	_____
Asbestos NESHAP coordinators of adjacent states	_____ _____ _____
Local asbestos NESHAP coordinators	_____ _____ _____
Local air pollution control agencies	_____ _____ _____
State emergency management agency	_____
Landfill operators	_____ _____ _____
Laboratories	_____ _____ _____
Emergency response organizations	_____ _____ _____

Figure 3. Example emergency telephone list for state asbestos NESHAP coordinator.

Contact	Telephone number
State asbestos NESHAP coordinator	_____
Other local asbestos NESHAP coordinators	_____ _____ _____
Local emergency management agency	_____
Building department	_____
Fire department	_____
Landfill operators	_____ _____
Laboratories	_____ _____
Emergency response organization	_____

Figure 4. Example emergency telephone list for local asbestos NESHAP coordinator.

1. The Problem

In the aftermath of catastrophic events that result in significant structural damage to buildings, fire and buildings departments personnel typically are called upon to identify those structures that are in imminent danger of collapse. Recent experience with Hurricane Hugo and the San Francisco earthquake indicates that these personnel are often not conscious of the presence of asbestos and the hazard it represents. Nor are they aware that the NESHAP prescribes minimum work practices that must be followed even in an ordered demolition resulting from a catastrophic emergency. The first part of the problem then is one of a lack of awareness of the applicable asbestos regulations on the parts of some local government personnel. It can be remedied by a conscious effort to inform them of the NESHAP. The second part of the problem is that local emergency personnel, even if they are aware of asbestos and the NESHAP, may not be qualified to determine whether asbestos is present in a structure. Accordingly, an asbestos NESHAP inspector needs to be on the scene.

2. Strategy

As a courtesy, Regional asbestos NESHAP coordinators should contact the FEMA Regional Directors to explain EPA's interest in asbestos, the NESHAP requirements applicable to catastrophes, and EPA's plan to inform state and local emergency preparedness agencies of the NESHAP requirements. Copies of the regulation and A Guide to the Asbestos NESHAP, As Revised November 1990 with the relevant portions highlighted should be made available to FEMA. Names, addresses, and telephone numbers of FEMA Regional Directors are given in Appendix B.

Then the Regional asbestos NESHAP coordinators should recommend that the state air pollution control agencies in their regions contact their counterpart state emergency preparedness agencies to inform them of the NESHAP requirements. Again, copies of the

regulation and Guide should be provided. The state emergency preparedness agency should be asked to inform local emergency preparedness agencies that they will be contacted by their local air pollution control agency, as appropriate. The state air pollution control agency should then contact local air pollution control agencies and recommend that they contact the appropriate local emergency preparedness agencies. Names, addresses, and telephone numbers of state officials responsible for disaster operations are given in Appendix C.

By working through the local emergency preparedness agency, the local air pollution control agency can reach fire and building department personnel and share the message with them. The asbestos NESHAP coordinator should discuss with heads of fire and building departments their procedures for identifying buildings that need to be demolished and develop procedures whereby the NESHAP agency can be kept apprised of the location of buildings that are ordered demolished during emergency situations.

Many state and local emergency preparedness agencies utilize emergency operations centers to coordinate emergency response and relief activities in times of disaster. These operations centers frequently have communications systems designed to remain intact during disasters when normal systems, such as telephone lines, may be inoperative. In their contacts with state and local emergency preparedness agencies, NESHAP coordinators should discuss the possibility of having access to these systems if their normal communication links are disrupted in an emergency.

At the local level, plans can be prepared that provide for making asbestos NESHAP inspectors available to assist in evaluating asbestos problems in buildings following disasters. State and Regional NESHAP enforcement agencies should plan to respond by providing additional inspectors if requested and public information services. A checklist is provided in Appendix A summarizing suggested lines of communications along with other planning aids.

C. Mapping Asbestos Locations

State and local NESHAP coordinators should, to the extent feasible, determine the presence and location of asbestos-containing facilities before a catastrophic emergency occurs.

During an emergency, knowing which structures in the community contain asbestos and which do not could save time, reduce the risk associated with entering unsafe structures, and avoid the unnecessary cost of treating the building as though it contained asbestos when in fact it did not. Even at the facility level, knowing what equipment, for example, is insulated with asbestos could be useful in responding to an accident involving that equipment. Sources of location information are discussed below and are separated into those for asbestos milling, manufacturing, and fabricating; and demolition and renovation.

1. Asbestos Milling, Manufacturing, and Fabricating

The most obvious source of information on the location of asbestos mills, manufacturers, and fabricators is EPA's own compliance inspection records for these sources. Where enforcement of the NESHAP has been delegated, the responsible state or local government should have in its files the names and locations of these sources.

Additional information on asbestos sources may be available from agencies responsible for enforcement of occupational safety and health regulations. OSHA enforcement agencies will have information on many of the same sources covered by asbestos air pollution regulations. Typically, however, OSHA rules cover a much wider range of sources than those covered by the asbestos NESHAP. Many of these additional sources may not be of as great a concern because they frequently include sources that handle small amounts of asbestos or asbestos-containing products, such as automobile brake servicing shops and the field fabrication of asbestos products for construction.

Another source of information on asbestos milling, manufacturing, and fabricating facilities is the Toxic Chemical Release Inventory System (TRIS), a computer system designed by EPA to track the annual emission of toxic chemicals into the environment. TRIS compiles toxic emissions information submitted by facilities, including asbestos processing facilities, regulated under the Superfund Amendments and Reauthorization Act (SARA). TRIS can be accessed by the name of the pollutant and provide a list of the names and locations of sources in the data base. Facilities are required to report under TRIS if they release above a certain amount of the toxic pollutant. If the estimated emissions fall below a certain level, a facility is not required to submit information and will not be picked up by TRIS. TRIS can be accessed by EPA employees and other Federal, state, and local government officials on EPA's National Computer Center (NCC) in Research Triangle Park, North Carolina. The user must have an NCC user ID and authorization to access the system. To obtain a user ID, contact TRIS User Support at (202) 475-9419.

2. Asbestos in Facilities

Facility refers to any institutional, commercial, public, industrial, or residential structure, installation, or building (excluding residential buildings having four or fewer dwelling units). There are several potential sources of information that may be used to help locate asbestos-containing structures within a community.

a. Surveys of Buildings for Asbestos

The results of an EPA survey of buildings for the presence of asbestos may be helpful in identifying asbestos-containing facilities.[1,2] In addition to estimating the number of buildings that contained asbestos, the survey also looked at the presence of asbestos in relation to various building characteristics, including height and age of the building. The findings of the EPA survey represent the situation on a national basis. The presence of

asbestos in buildings may vary from these national averages from one part of the country to another for various reasons, such as climate and age of cities.

Overall, the survey found that 20 percent of all buildings contained asbestos-containing friable material, either in the form of sprayed- or trowelled-on asbestos, asbestos ceiling tile, asbestos pipe and boiler insulation, or a combination of two or all three types. Pipe and boiler insulation was more common (found in 16 percent of the buildings) than sprayed- or trowelled-on asbestos (found in 5 percent of the buildings). Asbestos ceiling tile was rarely found. Pipe and boiler insulation was generally limited to machine rooms, while sprayed- or trowelled-on material was usually found exposed to areas of public use rather than behind drop ceilings or otherwise concealed.

Relative to the age of buildings, the study found that in buildings built prior to 1960, most of the asbestos was found as boiler and pipe insulation; after 1960, most of the friable asbestos was sprayed or trowelled onto ceilings and steel beams, a practice which continued until 1973 when most sprayed-on uses of asbestos were banned by EPA. Decorative sprayed-on asbestos was banned in 1978.

The study also found that taller buildings are more likely to have asbestos-containing friable material. Of the 19 high-rise buildings (8 or more floors) surveyed, all contained asbestos pipe and boiler wrap and 41 percent contained sprayed- or trowelled-on asbestos material.

As stated above, the EPA survey results represent national averages of asbestos-containing buildings. The results may be significantly different in different parts of the country. For example, in a survey of buildings in New York City for the presence of asbestos, the results varied significantly from the national averages presented in the EPA study.[3] Overall, 68 percent of buildings in New York City have some form of asbestos. The

New York City survey showed that tall office buildings most frequently contained asbestos and also contained the greatest amount of asbestos. Table 1 presents a summary of the survey results regarding the percent of buildings with asbestos and the amount of asbestos per building.

b. Schools

Information on asbestos in schools is available at the local level as well as at the state level. Under AHERA, schools are required to inspect their facilities for the presence of asbestos, document the location of the asbestos and keep this information on site as well as forward a copy to the responsible state agency. In some states, the state department of education will retain copies of this information, while in other states, the state agency responsible for asbestos programs is the designated state agency responsible under AHERA. Each school must also keep a copy of the inspection results in its files. The Regional Asbestos Coordinators for each region can provide information on state contacts for information on asbestos in schools. A list of the addresses and telephone numbers for the Regional Asbestos Coordinators is given in Appendix D.

c. Local Building Permit Agencies

In most communities, a building permit is required prior to any new construction. As part of the application for a building permit, the building plans are reviewed by the permitting agency to determine that the structure is designed and will be constructed in accordance with applicable building codes. Building plans usually specify that a particular code or standard will be met which, for example, relates to a certain fire rating. The specifications which accompany the building plans state what materials are to be used to meet the code specified in the plans. If asbestos was recommended for a certain application in order to meet the relevant codes, the specifications would contain that information. A copy

Table 1. New York City Survey Results -- Percentage of Buildings Containing Asbestos and Average Amount of Asbestos Per Building

Building Category	Percent of Buildings with Asbestos	Average Amount of Asbestos per Building with Asbestos (sq. ft.)
Tall office buildings	84	64,341
Educational structures	83	3,233
Hotels	78	3,802
Walk-up apartments	74	457
Hospitals	72	6,929
Elevator apartments	72	4,832
Churches	71	919
One and two family	68	167
Outdoor recreation	64	969
Short office buildings	64	2,109
Stores	62	363
Factories	61	1,759
Theaters	57	4,438
Govt./transportation	43	8,282
Warehouses/lofts	40	2,393
Garages/gas stations	17	419

Source: City of New York Department of Environmental Protection. Final Report. Assessment of the Public's Risk of Exposure to In-Place Asbestos. New York, New York. December 1, 1988.

of approved building plans is usually kept by building permit agencies. Where a copy of the specifications is also kept by the permitting agency, it could be used to help identify buildings that contain asbestos.

d. Notifications

A number of large industrial facilities, such as petroleum refineries and chemical plants, contain large amounts of asbestos in the form of thermal insulation. Many of these facilities remove asbestos as part of nonscheduled renovation operations in addition to scheduled renovations and demolitions. Nonscheduled renovations are typically maintenance-related or repair-related renovations for which the exact date of occurrence cannot be predicted, but based on previous experience, are likely to occur. Because the dates of these renovations cannot be predicted, facilities where these operations occur often submit annual, semiannual, or quarterly notices to EPA or its delegated authority describing how these nonscheduled renovations will be handled to control asbestos emissions. Notices of nonscheduled renovations and scheduled renovations and demolitions received from large industrial facilities identify where asbestos is to be found and in what amounts.

D. Cleanup and Disposal

The responsible NESHAP coordinator should identify critical activities and resources and develop contingency plans for augmenting or replacing them in an emergency.

Operations to clean up and dispose of asbestos during emergencies may be hampered by unusual conditions resulting from the disaster. Often during disaster-related emergencies, the normal provider/supplier relationships are disrupted so that business as usual is difficult, if not impossible. Identified below are some circumstances that could complicate cleanup and disposal operations and some suggested approaches to planning for such contingencies. The

list of considerations is not intended to be complete since any number of complications could arise.

1. Water Supply

Water supplies may be disrupted during disasters making it difficult to wet asbestos during the demolition or abatement of asbestos-containing structures. This is likely to be more of a problem where relatively large quantities of water are needed, for example, when a building is being demolished upon a government order and the asbestos cannot be removed prior to demolition. Large quantities of water will be needed to keep the debris wet during demolition and during the loading for transport to a disposal site. However, during an emergency, adequate water may not be readily available. If possible, such demolitions should be delayed until the water supply can be restored or until an alternate supply can be obtained.

2. Chemical Contamination

Where accidents or emergencies involve industrial facilities, there is the possibility that any asbestos that is involved may be contaminated with process chemicals. In some instances, the chemicals may be hazardous. Where asbestos is contaminated with toxic chemicals, other regulations may also apply to their handling and disposal. For hazardous chemicals regulated under RCRA, for example, the disposal site requirements are more stringent than those for asbestos. In some instances, it may not be advisable to apply water to the contaminated asbestos waste. Usually the emergency response teams that deal with accidents involving hazardous chemicals will know the best procedures for handling those chemicals. Coordination with emergency response teams in these situations should help ensure that the hazards associated with asbestos are adequately addressed.

3. Waste Disposal

Where a large number of asbestos-contaminated facilities are damaged and need to be demolished without prior removal of the asbestos, a large amount of asbestos-contaminated waste will be generated. The existing capacity of the landfills that are available to accept asbestos waste may be inadequate. Another problem may arise if the landfill is not accessible as a result of the disaster. Under these conditions, alternative disposal sites would be needed. In some cases, it may be possible to arrange with another local landfill to accept the waste, or it may be necessary to transport the waste to more distant sites. Alternative sites should be identified in advance, if possible. To the extent possible, uncontaminated demolition waste should be segregated from the asbestos-contaminated debris to reduce the volume that has to be disposed of in accordance with the NESHAP. NESHAP coordinators should establish emergency contacts for landfills and agree on emergency procedures in advance for accepting and handling asbestos-containing waste.

4. Backup Personnel

It may be necessary to have additional enforcement personnel available to oversee asbestos cleanup and disposal operations, since decisions may have to be made at the same time at numerous locations regarding appropriate actions to take. Cleanup operations that go on around the clock may require inspections after normal working hours to make sure work is being done properly. Additional NESHAP inspectors may be available from other NESHAP delegated local agencies, the state, the Region, or from other states.

5. Laboratory Capabilities

Large numbers of bulk samples may require quick analysis before NESHAP enforcement personnel can make decisions on appropriate actions to take. Arrangements should be made for additional laboratory support to handle a potentially large number of

samples. In addition, consideration should be given to arranging for overnight analysis of bulk samples. This would allow for the results from the analysis of samples collected one day to be available to enforcement personnel at the beginning of the next day.

6. Emergency Exemptions

Although the NESHAP contains provisions for emergency renovations and ordered demolitions, the nature of the emergency may require some flexibility in enforcing the NESHAP. For example, the NESHAP requires a written notice beforehand, but in no case later than the following working day, for ordered demolitions. It is conceivable that, under catastrophic emergency conditions, normal mail delivery services and transportation systems would be so disrupted as to make it impossible to deliver a written notice in the time period specified by the NESHAP. The responsible NESHAP coordinator should be aware that situations may arise that make strict application of the NESHAP difficult, if not impossible. While it is not possible to know in advance all the scenarios that may require flexibility in applying the NESHAP, it would be advisable to discuss predictable problems with agency management as well as with other NESHAP enforcement agencies at the appropriate Regional, state, or local level.

VI. EMERGENCY PERIOD

When a catastrophic emergency occurs, the responsible NESHAP coordinator should implement those plans developed prior to the emergency. Listed below are some of the more significant actions to be taken. Specific actions to be taken will, of course, depend on the nature of the emergency.

- Contact those agencies listed in the emergency response structure (see Figure 1).
- Assess the need to issue press release(s).
- Through contact with building and fire departments, determine magnitude of the problem, i.e., number of damaged structures.
- Activate previously established procedures with fire and building departments to be kept informed of buildings that are ordered to be demolished.
- Assess need for additional resources, e.g., inspectors, laboratory capabilities, etc. and take steps, as necessary, to augment existing resources.
- Provide guidance to delegated agencies, as appropriate.
- Assess need to allow selected exemptions to the NESHAP requirements.
- Make periodic contacts with agencies listed in the emergency response structure, as needed.

VII. CONCLUSIONS

Efforts to restore the damaged areas to their predisaster condition often involve removing or repairing damaged structures. There may be a natural tendency at this stage to overlook certain hazards, such as asbestos, that are not immediately life threatening. However, such hazards are serious and may manifest themselves many years from the time of exposure and should be taken into consideration. Given the health hazards associated with asbestos exposure, it is reasonable that adequate measures be taken during emergency situations to minimize exposure to asbestos from the demolition or renovation of buildings. The applicability of the asbestos NESHAP is not altered as the result of a disaster. With a few exceptions for emergency renovations and government-ordered demolitions, all of the NESHAP requirements are applicable in emergency situations.

One of the key factors in effectively dealing with asbestos in emergency situations is communications. Communications are needed between the asbestos NESHAP coordinator and the other emergency response agencies and related agencies. The first step is for the Regional asbestos NESHAP coordinator to discuss this matter with Regional FEMA personnel and assure them of EPA's desire to cooperate with FEMA and other emergency response agencies. The next step is for the Regional EPA offices to inform their respective state NESHAP enforcement agencies of the need to coordinate efforts. The delegated state NESHAP agency should then contact the state emergency preparedness office to discuss the need to consider asbestos in emergency situations. Finally, the same communications should occur at the local level.

This guidance document is intended to assist asbestos NESHAP coordinators in dealing with asbestos during catastrophic emergency situations. It provides suggestions for coordinating with other local and state emergency-related agencies, information on applicable

statutes and regulations, possible sources of information to help locate asbestos in a community, and special considerations relevant to clean up and disposal. This document will be most useful for advanced planning for emergency situations, although it will still find use when a disaster strikes.

REFERENCES

1. U.S. Environmental Protection Agency. Asbestos in Buildings: A National Survey of Asbestos-Containing Friable Materials. EPA 560/5-84-006. Washington, DC. June 1984. 260 p.

2. U.S. Environmental Protection Agency. Additional Analysis of EPA's 1984 Asbestos Survey Data. EPA 560/5-88-010. Washington, DC. September 1988. 87 p.

3. New York City Department of Environmental Protection. Assessment of the Public's Risk of Exposure to In-place Asbestos. New York, NY. December 1, 1988.

APPENDIX A

ASBESTOS NESHAP CHECKLIST FOR CATASTROPHIC EMERGENCY SITUATIONS

Appendix A

ASBESTOS NESHAP CHECKLIST FOR CATASTROPHIC EMERGENCY SITUATIONS

1. Regional Coordination Activities

   Regional FEMA
   Other regional NESHAP coordinators
   Delegated state NESHAP agencies

2. State Coordination Activities

   State emergency preparedness agencies
   Delegated local NESHAP agencies

3. Local Coordination Activities

   Local emergency preparedness agencies
   Local building departments
   Local fire departments

4. Link with Emergency Communication System

5. Emergency Telephone List

6. Alternate Water Supplies

7. Coordination with Emergency Response Agency for Hazardous Chemical Contamination

8. Alternate Waste Disposal Sites

9. Additional Asbestos Inspectors

10. Laboratory Support

11. Press Releases

APPENDIX B

FEMA REGIONAL DIRECTORS

Appendix B
FEMA REGIONAL DIRECTORS

Region I

Mr. Richard H. Strome
Regional Director
Federal Emergency Management Agency
J.W. McCormack, Post Office and
Court House, Room 442
Boston, Massachusetts 02109

FTS: 223-9540; Commercial: (617) 223-9540; FAX: 223-9519

Region II

Mr. Phillip McIntire
Regional Director (Acting)
Federal Emergency Management Agency
26 Federal Plaza, Room 1338
New York, New York 10278

FTS: 649-8208; Commercial: (212) 238-8202; FAX: 238-8245

Region III

Mr. Paul Giordano
Regional Director
Federal Emergency Management Agency
Liberty Square Building (Second Floor)
105 S. Seventh Street
Philadelphia, Pennsylvania 19106

FTS: 489-5608; Commercial: (215) 931-5608; FAX: 489-5513

Region IV

Mr. Major P. May
Regional Director
Federal Emergency Management Agency
1371 Peachtree Street, N.E., Suite 700
Atlanta, Georgia 30309

FTS: 230-4200; Commercial: (404) 853-4200; FAX: 230-4230

Region V

Mr. Arlyn F. Brower
Regional Director
Federal Emergency Management Agency
175 W. Jackson Boulevard (Fourth Floor)
Chicago, Illinois 60604

FTS: 363-5501; Commercial: (312) 408-5501; FAX: 363-5521

Region VI

Mr. Bradley M. Harris
Regional Director
Federal Emergency Management Agency
Federal Regional Center
800 N. Loop 288, Room 206
Denton, Texas 76201-3698

FTS: 749-9104; Commercial: (817) 898-9104; FAX: 749-9290

Region VII

Mr. S. Richard Mellinger
Regional Director
Federal Emergency Management Agency
Old Federal Office Building
911 Walnut Street, Rom 200
Kansas City, Missouri 64106

FTS: 759-7061; Commercial: (816) 283-7061; FAX: 759-7504

Region VIII

Dr. Marian L. Olson
Regional Director
Federal Emergency Management Agency
Denver Federal Center, Building 710
Box 25267
Denver, Colorado 80225-0267

FTS: 322-4812; Commercial: (303) 235-4815; FAX: 322-4976

Region IX

Mr. William M. Medigovich
Regional Director
Federal Emergency Management Agency
Building 105
Presidio of San Francisco
San Francisco, California 94129

FTS: 469-7100; Commercial: (415) 923-7100; FAX: 469-7157

Region X

Mr. Raymond C. Williams
Regional Director (Acting)
Federal Emergency Management Agency
Federal Regional Center
130 228th Street, S.W.
Bothell, Washington 98021-9796

FTS: 390-4604; Commercial: (206) 487-4604: FAX: 390-4707

Source: Directory of Governors, State Officials and Adjutants General Responsible for Disaster Operations and Emergency Planning, FEMA-9. Washington, D.C.: Federal Emergency Management Agency, July 1990.

APPENDIX C

STATE OFFICIAL RESPONSIBLE FOR

DISASTER OPERATIONS

Appendix C

STATE OFFICIAL RESPONSIBLE FOR DISASTER OPERATIONS

STATE	STATE EMERGENCY DIRECTOR	RESPONSIBLE SENIOR OFFICIAL
ALABAMA	Mr. William O. Brock Director, Alabama Emergency Management Agency 520 South Court Street Montgomery, Alabama 36130 (205) 834-1375	same
ALASKA	Mr. Ervin P. Martin Director, Division of Emergency Services, Dept. of Military and Veterans Affairs 3501 E. Bogard Road Wasilla, Alaska 99687-2689 (907) 376-2337	Maj. Gen. John W.Schaeffer The Adjutant General Dept. of Military Veterans Affairs 1800 E. Dimond Boulevard Suite 3-450 Anchorage, Alaska 99515-2097 (907) 249-1565
AMERICAN SAMOA	Mr. Maiava (Oliver) F. Hunkin Disaster Program Coordinator Department of Public Safety American Samoa Government P.O. Box 1086 Fagatogo, American Samoa 96799 011-684-633-2331	Mr. Tuilefano M. Vaela's Acting Commissioner of Public Safety, Department of Public Safety American Samoa Government P.O. Box 1086 Fagatogo, American Samoa 96799 011-684-633-1111
ARIZONA	Mr. William D. Lockwood Director, Arizona Division of Emergency Services National Guard Building 5636 East McDowell Road Phoenix, Arizona 85008 (602) 244-0504	Maj. Gen. Donald L. Owens The Adjutant General National Guard Building 5636 East McDowell Road Phoenix, Arizona 85008 (602) 273-9710

ARKANSAS	Mr. James Lee Witt Director, Office of Emergency Services P.O. Box 758 Conway, Arkansas 72032 (501) 329-5601, Ext. 201 (501) 374-1201 (Little Rock)	Same
CALIFORNIA	Mr. Donald R. Irwin Director, Office of Emergency Services, State of California 2800 Meadowview Road Sacramento, California 95832-1499 (916) 427-4201	Same
COLORADO	Mr. Richard E. Hatten Director, Disaster Emergency Services EOC, Camp George West Golden, Colorado 80401 (303) 273-1624	Mr. David J. Thomas Executive Director Colorado Department of Public Safety 700 Kipling Street Suite 3000 Lakewood, Colorado 80215-5865 (303) 239-4398
CONNECTICUT	Mr. Frank Mancusco State Director, Office of Emergency Management 360 Broad Street Hartford, Connecticut 06105 (203) 566-3180/4338 FAX (203) 247-0664	Same
DELAWARE	Mr. James W. Hoffman Director, Division of Emergency Planning and Operations P.O. Box 527 Delaware City, Delaware 19706 (302) 834-4531	Mr. Patrick W. Murray Secretary of Public Safety Department of Public Safety Highway Administration Building Dover, Delaware 19901 (302) 736-4321

DISTRICT OF COLUMBIA	Mr. Joseph P. Yeldell Director, Office of Emergency Preparedness 2000 14th Street, NW, Eighth FL. Washington, DC 20009 (202) 727-6161	Same
FLORIDA	Mr. Gordon L. Guthrie Director, Division of Emergency Management 2740 Centerview Drive Tallahassee, Florida 32399 (904) 487-4918	Mr. Tom Pelham Secretary, Department of Community Affairs 2740 Crestview Drive Tallahassee, Florida 32399 (904) 488-8466
GEORGIA	Mr. Billy J. Clack Executive Director, Georgia Emergency Management Agency P.O. Box 18055 Atlanta, Georgia 30316-0055 (404) 624-7000	*Maj. Gen. Joseph W. Griffin The Adjutant General and Director, Georgia Emergency Management Agency P.O. Box 18055 Atlanta, Georgia 30316-0055 (404) 624-6000
GUAM	Mr. Jose T. Terlaje Director, Civil Defense/Guam Emergency Services Office Territory of Guam P.O. Box 2877 Agana, Guam 96910 011-671-477-9841	Same
HAWAII	Mr. Roy C. Price, Sr. Vice Director of Civil Defense Department of Defense 3949 Diamond Head Road Honolulu, Hawaii 96816 (808) 734-2161	*Maj. Gen. Alexis T. Lum The Adjutant General of the National Guard and Director of Civil Defense Department of Defense 3949 Diamond Head Road Honolulu, Hawaii 96816 (808) 734-2195

IDAHO	Mr. Darrell G. Waller Coordinator, Bureau of Disaster Services Military Division 650 West State Street Boise, Idaho 83720 (208) 334-3460	Maj. Gen. Darrell V. Manning The Adjutant General Military Division P.O. Box 45 Boise, Idaho 83707 (208) 385-5242
ILLINOIS	Mr. John Plunk, Acting Director Illinois Emergency Services and Disaster Agency 110 East Adams Street Springfield, Illinois 62706 (217) 782-6818 - FTS 372-7851	Same
INDIANA	Mr. Jerome Hauer, Director Indiana State Emergency Management Agency State Office Building, Room 315 100 North Senate Avenue Indianapolis, Indiana 46204 (317) 232-3830 - FTS 372-7852	Same
IOWA	Ms. Ellen Gordon Administrator, Disaster Services Division Hoover State Office Bldg. Level A, Room 29 Des Moines, Iowa 50319 (515) 272-5211	Maj. Gen. Warren G. Lawson The Adjutant General and Executive Director Department of Public Defense Camp Dodge 7700 N.W. Beaver Drive Johnston, Iowa 50131-1902 (515) 278-9211
KANSAS	Vacant Deputy Director, Division of Emergency Preparedness P.O. Box C-300 Topeka, Kansas 66601 (913) 233-9253 X 301	Maj. Gen. Phillip B. Finley The Adjutant General and Director, Division of Emergency Services P.O. Box C-300 Topeka, Kansas 66601 (913) 233-7560 X 101

KENTUCKY	Mr. James H. "Mike" Molloy Executive Director, Kentucky Disaster and Emergency Services Boone Center, Parkside Drive Frankfort, Kentucky 40601 (502) 564-8680	Brig. Gen. Michael W. Davidson The Adjutant General and State Director of Disaster and Emergency Services Boone National Guard Center Frankfort, Kentucky 40601 Attn: James H. Molloy (502) 564-8558
LOUISIANA	Mr. Robert Warren, Director Office of Emergency Preparedness Department of Public Safety P.O. Box 66536, Audubon Station Baton Rouge, Louisiana 70896 (504) 342-5470	Col. (Ret.) Marlin A. Flores Deputy Secretary Department of Public Safety P.O. Box 66614 Baton Rouge, Louisiana 70896 (504) 925-6117
MAINE	Mr. David D. Brown Director, Maine Emergency Management Agency State Office Bldg., Station 72 Augusta, Maine 04333 (207) 289-4080 FTS: 289-4080	Gen. Ernest Park The Adjutant General and Commissioner, Department of Defense and Veterans Services Maine National Guard Camp Keyes Augusta, Maine 04333 (207) 626-4225
MARSHALL ISLAND	Mr. Phil Kabua Disaster Control Officer, Republic of the Marshall Islands Majuro, Marshall Islands 96960 93-011-692-9-3234	Mr. Phil Kabua Republic of the Marshall Islands Majuro, Marshall Islands 96960

MARYLAND	Mr. David A. McMillion Director, Maryland Emergency Management Agency Two Sudbrook Lane, East Pikesville, Maryland 21208 (301) 486-4422 FTS 486-4422	Brig. Gen. John Barshay Maryland Military Department National Guard 5th Regiment Armory 29th Division Street Baltimore, Maryland 21201 (301) 764-4004
MASSACHUSETTS	Mr. Robert J. Boulay Director, Massachusetts Civil Defense Agency and Office of Emergency Preparedness 400 Worcester Road Framingham, Massachusetts 01701 (508) 820-2000	Mr. Charles V. Barry Secretary, Department of Public Safety One Ashburton Place, Room 2133 Boston, Massachusetts 02108 (617) 727-7775
MICHIGAN	Dave Charney State Director Emergency Management Division Michigan State Police 300 S. Washington Square, Suite 300 Lansing, Michigan 48913 (517) 373-6271 - FTS 372-7853	Col. R. T. Davis Acting Director, Department of State Police and State Division of Emergency Services 714 S. Harrison Road East Lansing, Michigan 48823 (517) 337-6157
MICRONESIA	Mr. Ehson D. Johnson Director, Disaster Control Officer The Federated States of Micronesia 96941 (011) 691-9228	Same

MINNESOTA	Mr. Thomas Motherway Director, Division of Emergency Services Department of Public Safety State Capitol, B-5 St. Paul, Minnesota 55155 (612) 296-2233 - FTS 372-7854	Mr. Paul Tschida Commissioner, Department of Public Safety 211 Transportation Bldg. St. Paul, Minnesota 55155 (612) 296-6642
MISSISSIPPI	Mr. James E. Maher Director, Emergency Management Agency P.O. Box 4501, Fondren Station Jackson, Mississippi 39216 (601) 352-9100	Same
MISSOURI	Mr. Richard D. Ross Director, State Emergency Management Agency P.O. Box 116 Jefferson City, Missouri 65102 (314) 751-9571	Maj. Gen. Charles Kiefner The Adjutant General 1717 Industrial Drive Jefferson City, Missouri 65101 (314) 751-9710
MONTANA	Mr. F. Guy Youngblood Administrator, Disaster and Emergency Services Division Department of Military Affairs P.O. Box 4789 Helena, Montana 59604-4789 (406) 444-6911	Maj. Gen. James W. Duffy The Adjutant General Department of Military Affairs P.O. Box 4789 Helena, Montana 59604 (406) 444-6910
NEBRASKA	Mr. Richard L. Semm Assistant Director, Nebraska Civil Defense Agency National Guard Center 1300 Military Road Lincoln, Nebraska 68508 (402) 473-1410	Maj. Gen. Stanley M. Heng The Adjutant General and Director, Nebraska Civil Defense Agency National Guard Center 1300 Military Road Lincoln, Nebraska 68508 (402) 473-1100

NEVADA	Mr. Robert R. King Director, Nevada Division of Emergency Services Military Department 2525 S. Carson Street, Capitol Complex Carson City, Nevada 89710 (702) 885-4240	Maj. Gen. Robert Dwyer The Adjutant General Military Department 2525 S. Carson Street, Capitol Complex Carson City, Nevada 89710 (702) 887-7302
NEW HAMPSHIRE	Colonel George Iverson Director, Governor's Office of Emergency Management State Office Park South 107 Pleasant Street Concord, New Hampshire 03301 (603) 271-2231 FAX (603) 225-7341	Same
NEW JERSEY	Maj. Joseph J. Craparotta Deputy State Director Office of Emergency Management New Jersey State Police P.O. Box 7068 West Trenton, New Jersey 08628 (609) 882-2000	Justin J. Dintino Superintendent of State Police P.O. Box 7068 West Trenton, New Jersey 08628 (609) 882-2000
NEW MEXICO	Mr. Thomas H. Johnson Director, Technical and Emergency Support Division Department of Public Safety 4491 Cerrillos Road P.O. Box 1628 Santa Fe, New Mexico 87504 (505) 827-3375	Col. Robert Kemble Secretary, Office of the Secretary Department of Public Safety 4491 Cerrillos Road P.O. Box 1628 Santa Fe, New Mexico 87504 (505) 827-3370

NEW YORK	Mr. Donald A. DeVito Director, State Emergency Management Office Division of Military and Naval Affairs Public Security Bldg. State Campus Albany, New York 12226-5000 (518) 457-2222	Maj. Gen. Lawrence P. Flynn Adjutant General, NYS Division of Military and Naval Affairs 330 Old Niskayuna Road Latham, New York 12110-2224 (518) 786-4502
NORTH CAROLINA	Mr. Joseph F. Myers Director, North Carolina Division of Emergency Management Administration Building 116 West Jones Street Raleigh, North Carolina 27611 (919) 733-3867	Mr. Joseph W. Dean Secretary, Department of Crime Control and Public Safety P.O. Box 27687 Raleigh, North Carolina 27611 (919) 733-2126
NORTH DAKOTA	Mr. Ronald D. Affeldt Director, North Dakota Division of Emergency Management P.O. Box 5511 Bismarck, North Dakota 58502-5511 (701) 224-2111	Maj. Gen. Alexander MacDonald The Adjutant General P.O. Box 5511 Bismarck, North Dakota 58502-5511 (701) 224-5102
NORTHERN MARIANA ISLANDS	Mr. Felix A. Sasamoto Disaster Control Officer Office of the Governor Commonwealth of the Northern Mariana Islands Saipan, Mariana Islands 96950 011-670-322-9529/9572	Same

OHIO	Mr. Dale W. Shipley Deputy Director, Ohio Emergency Management Agency 2825 West Granville Road Columbus, Ohio 43235-2712 (614) 889-7155 FTS 372-7855	Adjutant General's Department Ohio Emergency Management Agency 2825 West Granville Road Columbus, Ohio 43235-2712 Attn: Dale W. Shipley (614) 889-7150
OKLAHOMA	Mr. Woodrow Goins Director, Oklahoma Civil Defense Agency P.O. Box 53365 Oklahoma City, Oklahoma 73152 (405) 521-2481	Same
OREGON	Ms. Myra T. Lee Administrator, Emergency Management Division Executive Department 603 Chemeketa Street, NE Salem, Oregon 97310 (503) 378-4124	Mr. Fred Miller, Director Executive Department 15 Cottage Street, NE Salem, Oregon 97310 (503) 378-3104
PENNSYLVANIA	Mr. Joseph LaFleur Director, Pennsylvania Emergency Management Agency Transportation and Safety Building, B-151 Harrisburg, Pennsylvania 17120 (717) 783-8150	Lt. Gov. Mark S. Singel Chairman, Pennsylvania Emergency Management Council State Capitol Harrisburg, Pennsylvania 17120 (717) 787-3300
PUERTO RICO	Mr. Heriberto Acevedo Director, State Civil Defense Agency P.O. Box 5127 San Juan, Puerto Rico 00906 (809) 724-0124	Same

RHODE ISLAND	Mr. Edward A. Cotugno Executive Director, Rhode Island Emergency Management Agency State House Providence, Rhode Island 02903 (401) 421-7333 FAX (401) 751-0827	Maj. Gen. Andre Trudeau The Adjutant General and Director, Rhode Island Emergency Management Agency Armory of Mounted Commands 1051 North Main Street Providence, Rhode Island 02904 (401) 277-2100
SOUTH CAROLINA	Mr. Paul Lunsford Director, Emergency Preparedness Division 1429 Senate Street Columbia, South Carolina 29201 (803) 734-8020	Maj. Gen. T. Eston Marchant The Adjutant General Rembert C. Dennis Building 1000 Assembly Street Columbia, South Carolina 29201 (803) 748-4200
SOUTH DAKOTA	Mr. Gray N. Whitney Director, Division of Emergency and Disaster Services Department of Military Affairs EOC-State Capitol Pierre, South Dakota 57501-5060 (605) 773-3231	Maj. Gen. Harold J. Sykora The Adjutant General State Director of Civil Defense State Capitol Pierre, South Dakota 57501-5060 (605) 773-5340
TENNESSEE	Mr. Lacy E. Suiter Director, Tennessee Emergency Management Agency 3041 Sidco Drive Nashville, Tennessee 37204 (615) 252-3300	Maj. Gen. Carl Wallace The Adjutant General 3041 Sidco Drive Nashville, Tennessee 37204 (615) 252-3001

TEXAS	Mr. Robert A. Lansford State Coordinator, Division of Emergency Management Texas Department of Public Safety Box 4087, N. Austin Station Austin, Texas 78773 (512) 465-2000 x 2138	Mr. Joe E. Milner Director, Texas Department of Public Safety and Division of Emergency Management Box 4087, N. Austin Station Austin, Texas 78773 (512) 465-2000 x 370
TRUST TERRITORY OF THE PACIFIC	Mr. Charles Jordan Chief, Office of Planning and Statistics Office of the High Commissioner Trust Territory Headquarters Saipan, Mariana Islands 96950 011-670-322-9333	Same
UTAH	Mrs. Lorayne Frank Director, Division of Comprehensive Emergency Management Department of Public Safety 1543 Sunnyside Avenue Salt Lake City, Utah 84105-0136 (801) 533-5271	Mr. D. Douglas Bodiero Commissioner, Department of Public Safety 4501 South 2700 West Salt Lake City, Utah 84119 (801) 965-4463
VERMONT	Mr. George Lowe Director, State of Vermont Department of Public Safety Division of Emergency Management Waterbury State Complex 103 S. Main Street Waterbury, Vermont 05676 (802) 244-8721 FAX (802) 244-8655	Mr. Charles E. Bristow Commissioner, Department of Public Safety 103 S. Main Street Waterbury, Vermont 05676 (802) 244-8718

VIRGINIA	Mr. Addison E. Slayton, Jr. State Coordinator Office of Emergency Services 310 Turner Road Richmond, Virginia 23225 (804) 674-2497	Col. Robert Suthard Secretary, Department of Public Safety Ninth Street Office Bldg. Sixth Floor Richmond, Virginia 23225-6491 (804) 786-5351
VIRGIN ISLANDS	Mr. William S. Harvey Director, Virgin Island Territorial VITEMA #3-4 King Street Christiansted, US VI 00820 (809) 774-2244	Maj. Gen. Charles Hood The Adjutant General Virgin Islands Territorial Emergency Management Agency Foreign Arrivals Bldg. Alexander Hamilton Airport St. Croix, US 00850 (809) 772-7443
WASHINGTON	Ms. Kate Heimbach Assistant Director, Division of Emergency Management Dept. of Community Development 4220 East Martin Way, PT-11 Olympia, Washington 98504-8611 (206) 753-5255	Mr. Chuck Clarke Director, Department of Community Development State of Washington Ninth & Columbia Building, MS/GH-51 Olympia, Washington 98504-4151 (206) 753-5625
WEST VIRGINIA	Mr. Bill R. Joplin Acting Director, West Virginia Office of Emergency Services State Capitol Complex, EB 80 Charleston, West Virginia 25305 (304) 348-5380	Same
WISCONSIN	BG Richard I. Braund, USNG (Ret.) Administrator, Division of Emergency Government Department of Administration 4802 Sheboygan Avenue, Rm. 99A Madison, Wisconsin 53707 (606) 266-3232 - FTS 372-7856	BG Jerald D. Slack The Adjutant General Wisconsin National Guard 3020 Wright Street Madison, Wisconsin 53708 (608) 241-6312

WYOMING	Mr. Edwin S. Usui Coordinator, Wyoming Disaster and Civil Defense Division P.O. Box 1709 Cheyenne, Wyoming 82003 (307) 777-7566	Maj. Gen. Charles Wing The Adjutant General P.O. Box 1709 Cheyenne, Wyoming 82003 (307) 772-6233

Source: Directory of Governors, State Officials and Adjutants General Responsible for Disaster Operations and Emergency Planning, FEMA-9. Washington, DC: Federal Emergency Management Agency, July 1990.

APPENDIX D

REGIONAL ASBESTOS COORDINATORS

Appendix D

REGIONAL ASBESTOS COORDINATORS

Regional Asbestos Coordinator
US EPA, Region I
JFK Federal Building
Boston, MA 02203
(617) 565-3835

Regional Asbestos Coordinator
US EPA, Region 2
Woodbridge Avenue
Edison, NJ 08837
(201) 321-6671

Regional Asbestos Coordinator
US EPA, Region 3
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-3160

Regional Asbestos Coordinator
US EPA, Region 4
345 Courtland Street
Atlanta, GA 30365
(404) 347-5014

Regional Asbestos Coordinator
US EPA, Region 5
230 South Dearborn Street
Chicago, IL 60604
(312) 353-6003

Regional Asbestos Coordinator
US EPA, Region 6
Allied Bank Tower
1445 Ross Avenue
Suite 1200
Dallas, TX 75720
(214) 655-7244

Regional Asbestos Coordinator
US EPA, Region 7
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7381

Regional Asbestos Coordinator
US EPA, Region 8
One Denver Place
999 18th Street
Suite 500
Denver, CO 80202-2405
(303) 293-1442

Regional Asbestos Coordinator
US EPA, Region 9
75 Hawthorne Street
San Francisco, CA 94105
(415) 556-5406

Regional Asbestos Coordinator
US EPA, Region 10
1200 6th Avenue
Seattle, WA 98101
(206) 442-4762

☆U.S. Government Printing Office : 1992 - 312-014/40056

ITEM 10
Asbestos Sampling Bulletin

ASBESTOS SAMPLING BULLETIN
September 30, 1994

Supplementary Guidance on Bulk Sample Collection and Analysis
U.S. EPA, OPPT/CMD (7404)

I. Introduction

Recent Notices in the Federal Register (59 FR 542, Jan. 5, 1994; and (59 FR 38970, Aug. 1, 1994), announced clarifications regarding the analysis of bulk samples obtained from multi-layered systems to determine the presence of asbestos. As part of a public outreach effort, the Environmental Protection Agency (EPA) developed this supplemental guidance bulletin. The public should take note that the contents are presented as **guidance.** This guidance does not change current regulatory requirements of the 1987 Asbestos in Schools Rule (AHERA). Local education agencies (LEAs) may choose to adopt the recommended guidance as a matter of policy offering added precaution and protection for workers and building occupants, and also to avoid the possibility of non-compliance with EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations.

This bulletin was developed by EPA primarily for two reasons:

1) to provide guidance regarding the adoption and use of an improved method for the analysis of asbestos in bulk samples ("Test Method – Method for the Determination of Asbestos in Bulk Building Materials," EPA/600/R-93/116, July 1993). The improved method is especially useful for detecting the presence of asbestos in asbestos-containing floor tiles, but it also provides better analytical results in building materials that may contain asbestos at low concentrations.

2) to clarify EPA's guidance and requirements for the collection and analysis of bulk samples of multi-layered materials, particularly in schools. EPA recommends that multi-layered samples that have been found to be non-asbestos-containing for the EPA "Asbestos in Schools Rule" (AHERA) be resampled before disturbing them, unless lab reports are available documenting that all layers were previously sampled and analyzed. Resampling (if elected) should be done according to the guidelines set forth previously in a January 5, 1994 NESHAP Federal Register Notice, an Aug. 1, 1994 AHERA Federal Register Notice, and in the improved analytical method to avoid potential violation of the asbestos NESHAP regulations.

Note that under the AHERA and NESHAP regulations, LEAs can assume that certain materials are asbestos-containing and manage them as such. This continues to be an acceptable alternative to sampling or resampling.

Both EPA's AHERA program for schools and the EPA asbestos NESHAP program recommend the adoption of the improved bulk sample analysis method published by EPA's Office of Research and Development in July 1993 (EPA/600/R-93/116). EPA developed the improved analytical method to address certain materials:

- that are known to contain asbestos fibers, but in which the asbestos percentage is "low" (< 10%);

- where the presence of asbestos is obscured by a matrix binder of some kind (e.g., vinyl or asphalt floor tiles);

- in which small, thin fibers are present, but are frequently not detected at the magnification and resolution limits of polarizing light microscopes.

The improved method builds on the previous (1982) "Interim" polarizing light microscope (PLM) method. As before, it begins with a careful examination of the sample using a stereo-microscope, then proceeds

(as before) to the examination of sample specimens under a polarizing light microscope. In most cases, these steps will be sufficient to characterize a sample as asbestos-containing (asbestos present > 1 %) or non-asbestos-containing (no asbestos detected, or 1 % or less in the sample).

The improved method includes additional procedures required for the reliable analysis of certain bulk building materials, such as steps for the elimination of the obscuring matrix materials (quantitative analysis of the sample is improved by the use of comparative standard samples having known quantities of asbestos matrix materials), as well as specifying use of transmission electron microscopy (TEM). These additional steps comprise the chief improvements in the new method. The Agency believes that adoption of the improved method should remedy the analytical problems frequently encountered when testing materials such as resilient floor tile (vinyl or asphalt), mastic, and "layered" building materials using the 1982 "Interim" PLM method.

Finally, the results obtained from following recent guidance on "layered samples" and use of the improved sampling procedures for certain problem materials should, where it is possible to do so, facilitate following EPA's "manage in place" guidance for asbestos operations and maintenance (O&M) programs, (EPA "Green Book," July 1990).

II. Issues of Concern

There are two principal issues addressed in this guidance.

Issue 1. The possible misidentification of certain "problem" materials as non-asbestos-containing, with subsequent failure to include them under a surveillance and O&M program. These "problem materials" include asbestos-containing floor tiles, and certain multi-layered building materials.

The 1982 EPA "Interim Method for the Determination of Asbestos in Bulk Insulation Samples" (40 CFR 763, Appendix A to Subpart F) was limited in that it did not provide guidance for analyzing materials that contain thin (i.e., <0.25 micrometer) asbestos fibers. As a consequence, floor tiles analyzed according to the 1982 method and for which negative results were reported may actually contain undetected asbestos in the form of thin fibers below the limits of resolution of the polarized light microscope.

The improved method provides acceptable procedures for reducing matrix materials so that fibers may be made available for microscopic analysis. It also addresses the thin fiber limitation of the 1982 method by providing directions for the use of transmission electron microscopy (TEM) as needed.

The improved method also directs laboratories to analyze the individual layers or strata of a multi-layered sample and to report a single result for each layer. The 1982 "Interim Method," in contrast, provided that the analytical result for a multi-layered sample with discrete layers be reported as one result across all layers. (Although the analyst was directed to identify the presence of discrete layers as seen under stereo-microscopic examination of the bulk sample, and to identify and quantify asbestos fiber content in each layer.) Because the 1982 method allowed the result to be reported as one number, multi-layered samples which may have contained asbestos in a single layer may have been reported by laboratories as non-asbestos-containing.

Thus, under the recommended improved test method, more than one result will be reported for multi-layered samples, and a multi-layered sample which previously was determined to be non-asbestos-containing may actually have layers which will be classified as asbestos-containing based on the presence of asbestos in greater than one percent. The January 5, 1994 NESHAP notice in the Federal Register directs the attention of the regulated community to their requirement to analyze multi-layered samples in this manner for compliance with NESHAP.

The recognition, sampling, and analysis of "layered" building materials may be of particular importance when known or assumed asbestos-containing building materials (ACBM) are left in place. AHERA requires the management of known or assumed ACBM under a school's asbestos operations and maintenance program. EPA issued guidance in July, 1990 ("Managing Asbestos in Place," the "green book") that recommends similar programs in any building or facility where asbestos-containing materials (ACM) are present.

For example, if a planned renovation or remodelling is scheduled, and if the outer surface (i.e., the surface exposed to the room's interior) of a wall or ceiling system is an asbestos-containing layer, that fact should be known prior to some disturbance such as sanding in preparation for painting. Similarly, if an underlying layer of a wall or ceiling system is going to be disturbed (e.g., making a penetration to install light fixtures or heating/cooling ducts), that fact should be known before a service or maintenance worker cuts or drills into the wall or ceiling, and should affect how that work is performed. (See the 1992 guidance manual, "Asbestos Operations & Maintenance Work Practices," published by the National Institute of Building Sciences.)

Issue 2. Possible (unknowing) violations of the asbestos NESHAP by LEAs.

EPA's asbestos NESHAP program has also made "applicability determinations" regarding plaster/stucco or skim coat layers applied over wallboard systems. As stated above, the EPA Asbestos NESHAP position was summarized in a notice of clarification recently published in the Federal Register (January 5, 1994). That notice in the Federal Register directs the attention of the regulated community to the NESHAP requirement to analyze multi-layered samples and report results for discrete layers.

Schools operating under the requirements of AHERA have been, and continue to be, subject to EPA's asbestos NESHAP compliance requirements, when involved in renovation or demolition activities where RACM (regulated ACM) will be disturbed. EPA believes that the August 1994 Federal Register notice clarifies LEA responsibilities under the asbestos NESHAP, and that this guidance regarding the use of the improved sampling and analysis method will further clarify the situation and reduce the potential for possible violations of the asbestos NESHAP.

III. Examples of Materials of Concern

Building materials typically containing thin asbestos fibers (e.g., floor tiles) or asbestos in low concentration ($< 10\%$) are the subject of this guidance.

Also, plaster wall or ceiling systems, resilient flooring systems (flooring, mastic, underlayment), and wallboard systems are examples of layered building materials subject to this guidance.

EPA does not regard a sheet of "plasterboard" by itself ("sheetrock," "wallboard," "gypsum board") as a multi-layered material. EPA is not adding a requirement to sample a section of plasterboard as such (see definition in APPENDIX) as a "layered" material under either AHERA or NESHAP regulations.

Lack of knowledge about the possible asbestos content of different strata in layered materials can lead to increased exposure risk under certain circumstances. In this guidance bulletin, EPA is attempting to address the concern for sampling layered materials in a manner so as to reduce risk, as well as the need to comply with recent NESHAP interpretations. The Jan. 5, 1994 Federal Register asbestos NESHAP clarification should be consulted with regard to materials such as joint compound, texturing materials, etc. added to the surface of wallboard, and when those materials would be subject to EPA's NESHAP regulation.

NOTE: Section V of this guidance bulletin offers a suggested strategy for distinguishing between joint compound found at joints in wallboard systems or when the material was applied as a skim coat; i.e., for

determining whether "joint compound" has been applied as a "skim coat" over a wall surface (as referred to in the NESHAP Jan. 5, 1994 FR notice.)

IV. Helpful Sampling Techniques

LEA "designated persons," accredited asbestos Building Inspectors, consultants, and others should follow previous EPA published requirements and guidance with regard to techniques for obtaining bulk samples of building materials in order to analyze them for the presence of asbestos. This information was presented both in guidance documents (such as the 1985 Pink Book and the Purple Book), and in the 1987 AHERA "Asbestos in Schools" Rule Sec. 763.86, 763.87 (see "References.") The techniques are also discussed in approved training courses for accrediting Building Inspectors.

To clarify EPA's guidance, it is important for the sampling device (core borer, knife, etc.) to penetrate all layers of the sample to the substrate. As discussed in Section II, it may be important to know whether discrete layers of a multi-layered sample contain asbestos. Service and maintenance workers may need to perform their work on exposed surface layers that contain asbestos. Or, their task may require them to penetrate non-asbestos layers into or through underlying asbestos-containing layers. Knowledge of where asbestos occurs in a multi-layered sample is important as a means of reducing the potential for asbestos exposure, and in selecting proper work practices to do so. It is also important to know the asbestos content of individual layers, of course, for NESHAP compliance purposes.

Thus, the person who obtains the sample for analysis may need to use professional judgement based on an on-site situation. If a bulk sample remains intact through all layers, and the inspector judges that the sample will remain intact until it reaches the analytical laboratory, the sample may not need to be separated into its respective layers until the laboratory analyst does so. However, if a bulk sample crumbles or breaks down at the time of sample collection, the sample collector may be required to take separate samples from discrete layers at the site, and carefully identify them and their position in the multi-layered system for proper and useful reporting by the laboratory.

EPA guidance regarding the need to keep layers separate as a particular sample is collected, therefore, depends on several factors. They include the professional judgement of the accredited individual who takes the sample, the physical condition and integrity of the material making up discrete layers of a multi-layered sample, the possible importance of reporting asbestos content of an exposed surface layer vs. inner layers of a system (depends on planned activity, such as in O&M tasks), and being in compliance with regulatory requirements.

The 1993 bulk sample guidance bulletin stresses the need for taking sufficient sample volumes of the material to be analyzed. Sufficient sample volumes differ for different material types. Since the quantity of the sample can affect the analytical sensitivity, EPA's recommendations in the July 1993 method should be noted.

V. Suggested Sampling Strategy for Dealing with Joint Compound vs. a Skim Coat/Add-on Application

(NESHAP Compliance Issue: Sampling needs to be conducted to determine if materials are joint compound or a skim coat application of the compound over a wall surface.) Be aware that materials applied to ceilings might differ from materials used on walls, and that original construction and later renovations can result in the application of different materials at different times. Joint compound applied to drywall installations prior to 1980 is more likely to contain asbestos than with installations after that date.

A. SAMPLING STRATEGY --

1. JOINT COMPOUND: Sample where joints are expected (take a minimum of 3 samples). For example,

a. Inside or outside corners

b. Wallboard joint intervals; i.e., 4 feet from corners on wall stud. Use stud locator or knock on wall to locate stud (listen for "solid" sound). Look at walls above suspended ceiling panels; unpainted joints covered by joint compound are often discernable there.

c. Note that joint compound is often applied to fill depressions around nailheads; consider the "spottiness" of that type of application.

2. ADD-ON MATERIALS: Sample where joints are NOT expected (take a minimum of 3 samples). For example,

a. Between corners and wallboard joint intervals. Locate by knock on wall, listen for "hollow" sound.

3. KEEP GOOD RECORDS of sample locations for later evaluation of results. Note: A laboratory cannot distinguish joint compound at joints from the same material used as a skim coat. Therefore, it is very important that individuals collecting samples clearly describe the sample composition so that the analytical laboratory knows whether to report the results as individual layers or as a "composite" result for non-layered material. (See B-1, B-2 below.)

B. ANALYSIS OF SAMPLES IN LABORATORY, and DATA ANALYSIS BY THE SAMPLER/ASSESSOR

All samples with outer layer having >1% asbestos on wallboard will be noted. When this situation applies, then the following must be considered:

1. If only joint sampling areas show layers with >1% asbestos, then material is joint compound.

a. Combine (weighted) analytical results into composite result for each sample.

1) If result is ≤1%, no management is necessary.
2) If result is >1%, the material is RACM (NESHAP) and management is necessary.

2. If samples from both joint sampling area and non-joint areas show layers with >1% asbestos, then the material should be considered "skim coat" or add-on material.

a. Do not composite (average) the results; report the results for each layer. Provide a description of each layer in the report, to include their location in relation to each other.

b. Material so located should be treated as separate RACM layers according to the asbestos NESHAP, and management is necessary.

VI. References

1. Advisory Regarding Availability of an Improved Bulk Sample Analysis Test Method; Supplementary Information on Bulk Sample Collection and Analysis; 59 FR 38970, Federal Register, Aug. 1, 1994.

2. Asbestos-Containing Materials in Buildings: Simplified Sampling Scheme for Friable Surfacing Materials (pink book), U.S. EPA 560/5-85-030a, October 1985.

3. Asbestos-Containing Materials in Schools; Final Rule and Notice (AHERA Rule), 40 CFR Part 763, October 1987.

4. Asbestos NESHAP Clarification Regarding Analysis of Multi-layered Systems, 59 FR 542, Federal Register Jan. 5, 1994.

5. Guidance for Controlling Asbestos-Containing Materials in Buildings (purple book), U.S. EPA 560/5-85-024, 1985.

6. Guidance Manual: Asbestos Operations and Maintenance Work Practices, National Institute of Building Sciences (NIBS), Washington, D.C., September 1992.

7. Managing Asbestos in Place: A Building Owner's Guide to Operations and Maintenance Programs for Asbestos-Containing Materials (green book), U.S. EPA 20T-2003, July 1990.

8. National Emission Standards for Hazardous Air Pollutants for Asbestos (Asbestos NESHAP Rule), 40 CFR 61, subpart M, November 1990.

9. Test Method: Method for the Determination of Asbestos in Bulk Building Materials, U.S. EPA 600/R-93/116, July 1993.

APPENDIX: Definitions

Binder: With reference to a bulk sample, a component added for cohesiveness, such as plaster, cement, glue, vinyl, asphalt, etc.

Bulk sample: For the purposes of this guidance, representative portion of building material taken at one distinct location for qualitative and quantitative identification of asbestos. In a multilayered system, one needs a representative portion of each layer.

Discrete: Individually distinct, visually recognizable.

Layer: Stratum; one thickness of some material laid or lying over or under another thickness of the same or different material.

Material: The substances or constituents of which something is composed or can be made. Various materials are used in building construction, such as sand, wood, metal, plaster, cement, asbestos, etc.

Matrix: Material in which asbestos fibers are enclosed or embedded.

NESHAP: "National Emission Standards for Hazardous Air Pollutants;" EPA's asbestos NESHAP regulation, at 40 CFR 61 Subpart M (especially for demolition and renovation activities).

Plaster: A pasty composition comprised largely of water, lime, and sand, that hardens on drying and is used for coating building components such as walls, ceilings, and partitions. Asbestos fibers or other fibrous materials sometimes have been mixed into the plaster to give particular properties.

* "acoustical" plaster – plaster specially formulated and applied (sprayed or trowelled on) so as to deaden or absorb sound.

* "browncoat" plaster -- also called "scratch coat;" a base coating of plaster, usually applied over perforated plaster board, wooden lath or wire mesh.

* "topcoat" plaster -- a surface finish layer of plaster, usually white and smooth; may contain sand to produce a grainy surface.

Plasterboard: A board used in large sheets as a backing or as a substitute for plaster in walls and consisting of several plies of paper, fiberboard, or felt, usually bonded to a hardened gypsum plaster core. ("gyp[sum] board," "drywall," "wallboard," "sheetrock")

PLM: Polarized light microscopy; a technique for analyzing bulk building material samples for presence of asbestos. The sample is illuminated by polarized light and viewed under an optical microscope.

Sample: To take a sample of or from some material, especially to judge the quality or composition of that material.

Separable: Capable of being separated.

Skim coat: A thin layer or coating of one material (e.g., plaster, stucco, joint compound) applied over another.

Stratum: Layer; one of a series of layers, levels, or gradations in an ordered system; a bed or layer.

Stucco: A fine plaster used in the decoration and ornamentation of interior walls. (Also, a material usually made of Portland cement, sand, and a small amount of lime, applied to form a hard covering for exterior walls.)

Substrate: The underlying support, foundation, or base (wood lath, wire screen, concrete, etc.) to which something else (e.g., plaster) is applied.

System: An integrated group of building components which form an organized functional unit, such as a wall system, or ceiling system, or floor system.

TEM: Transmission Electron Microscopy and related techniques; will enable specific identification of thin asbestos fibers.