SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Preliminary Draft Staff Report

Proposed Amendments to:

Rule 1403 – Asbestos Emissions from Demolition/Renovation Activities

October 31, 2018

Deputy Executive Officer
Planning, Rule Development and Area Sources
Philip Fine, Ph.D.

Assistant Deputy Executive Officer
Planning, Rule Development and Area Sources
Sarah Rees, Ph.D.

Manager of Area Sources
Planning, Rule Development and Area Sources
David De Boer

AUTHORS:	Bradley McClung – Air Quality Specialist
TECHNICAL ASSISTANCE:	Christopher Ravenstein – Staff Specialist Charlene Nguyen – Assistant Air Quality Specialist Ricky Lai – Air Quality Specialist Jason Aspell – Senior Enforcement Manager, Toxics John Anderson – Air Quality Analysis and Compliance Supervisor Garrett Kakishita – Supervising Air Quality Supervisor Amanda Sanders – Supervising Air Quality Supervisor Areio Soltani – Supervising Air Quality Supervisor Larry Israel – Air Quality Inspector III Michael Haynes – Air Quality Inspector III Cesar Garcia – Senior Air Quality Chemist Luke Eisenhardt – Air Quality Specialist, CEQA Analysis Ryan Finseth– Air Quality Specialist, Socioeconomic Analysis Brian Tomasovic – Senior Deputy District Counsel
REVIEWED BY:	Donald Hopps, Program Supervisor David De Boer, Manager of Area Sources
DISTRICT COUNSEL:	Brian Tomasovic – Senior Deputy District Counsel

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
GOVERNING BOARD

TABLE OF CONTENTS

EXECUTIVE SUMMARY

CHAPTER 1: BACKGROUND ON PROPOSED AMENDED RULE 1403

CHAPTER 2: SUMMARY OF PROPOSED AMENDED RULE 1403

CHAPTER 3: KEY ISSUES OF PROPOSED AMENDED RULE 1403

CHAPTER 4: IMPACT ASSESSMENT OF PROPOSED AMENDED RULE 1403

CHAPTER 5: PUBLIC COMMENTS

APPENDIX: REFERENCES AND ATTACHMENTS

RULE 1403 – ASBESTOS EMISSIONS FROM RENOVATION/DEMOLITION ACTIVITIES

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The proposed amendments to Rule (PAR) 1403 – Asbestos Emissions from Demolition/Renovation Activities, are meant to enhance the rule's objective, provide better understanding, improve the enforcement of rule requirements, and increase the overall rule effectiveness. The proposed changes will facilitate compliance for facility owners, general contractors, contractors, subcontractors, consultants and others who work with asbestos.

The proposed amendments will not change the economic impacts of the rule and no socioeconomic assessment was performed. In addition, the amendments are not expected to significantly affect either emission limitations or air quality. Staff has reviewed the proposed amendments and determined that the project is exempt from the requirements of the California Environmental Quality Act (CEQA).

RULE 1403 – ASBESTOS EMISSIONS FROM RENOVATION/DEMOLITION ACTIVITIES

CHAPTER 1: BACKGROUND ON PROPOSED AMENDED RULE 1403

- REGULATORY BACKGROUND
- PURPOSE AND APPLICABILITY
- AFFECTED FACILITIES
- LEGAL AUTHORITY

REGULATORY BACKGROUND

Rule 1403 – Asbestos Emissions from Demolition/Renovation Activities, was adopted by the South Coast Air Quality Management District (SCAQMD) Governing Board on October 6, 1989, to limit asbestos emissions from building demolition and renovation activities, including the removal and associated disturbance of asbestos-containing materials, as well as the storage and disposal of asbestos-containing waste material (ACWM) generated or handled by these activities. The Environmental Protection Agency (EPA) promulgated emission requirements for asbestos on April 5, 1984 (49 FR 13661) as part of the National Emission Standards for Hazardous Air Pollutants (NESHAP) program (40 Code of Federal Regulation (CFR), Part 61, Subpart M) under section 112 of the Clean Air Act (CAA). The SCAQMD has been delegated authority by the EPA to implement Part 61 which is accomplished through the adoption of and periodic amendments to Regulation X – NESHAP. Delegated authorities have the option of adopting and enforcing stricter regulations alongside their implementation and enforcement of the NESHAP.

EPA revised the NESHAP for asbestos on November 20, 1990 (55 FR 48406). Rule 1403 was amended April 8, 1994 to make it consistent with the revised NESHAP for asbestos, which was adopted by reference into Regulation X on October 4, 1991. Rule 1403 was also amended in November 2006 and October 2007 with administrative changes to add clarifying language and improve enforceability of the rule.

PURPOSE AND APPLICABILITY

The purpose of this rule amendment is to clarify language and assist with implementation of the rule. Rule 1403 specifies work practice requirements for building demolition and renovation activities in order to limit emissions of asbestos, a toxic air contaminant. The SCAQMD, a delegated authority, has a more stringent rule than either the NESHAP or the requirements of the Asbestos Hazard Emergency Response Act (AHERA) as implemented by the 40 CFR Part 763, Subpart E. This difference has caused misunderstanding within the regulated community. With this rule amendment, staff’s goal is to improve both comprehension and enforceability of Rule 1403.

AFFECTED INDUSTRY

The rule covers demolition or renovation activities and the associated disturbance of asbestos-containing material at buildings or facilities, asbestos storage facilities, and any active waste disposal sites. This rule, in whole or in part, is applicable to owners and operators; including, but not limited to, property owners, property lessors, asbestos abatement contractors, demolition contractors, general contractors, subcontractors, and asbestos consultants. The rule does not apply to a residential single-unit dwelling, as defined in the rule, when the owner-occupant personally and solely conducts the renovation activity at the dwelling.

Staff met with multiple contractors, consultants, facility operators, and laboratory personnel who are subject to Rule 1403, to gather information on the types of work they perform and how they comply with Rule 1403, as well as, the NESHAP, AHERA, and Cal-OSHA regulations. Table 1-1 shows the facilities that were visited by SCAQMD staff. Table 1-2 shows the meetings held at SCAQMD headquarters

TABLE 1-1: FACILITIES VISITED BY SCAQMD STAFF

FACILITY	CITY	COUNTY
Andeavor Refinery	Carson	Los Angeles
Exide Battery	Paramount	Los Angeles
NBC Universal	Universal City	Los Angeles
Los Angeles Unified School District (L.A.U.S.D.)	Los Angeles	Los Angeles
L.A.U.S.D. Laboratory (NVLAP certified lab)	Los Angeles	Los Angeles
Disneyland	Anaheim	Orange
Patriot Environmental Laboratory (NVLAP certified lab)	Fullerton	Orange
Envirocheck (NVLAP certified lab)	Orange	Orange

TABLE 1-2: MEETINGS WITH STAKEHOLDERS AT SCAQMD HEADQUARTERS

COMPANY
Southern California Gas Company
Southern California Edison
Los Angeles Department of Water & Power
Los Angeles Unified School District
California Council for Environmental & Economic Balance
Masek Consulting Services, Inc.

The most common areas of stakeholder misunderstanding related to facility surveys, asbestos sample collection, composite sample analysis, the SCAQMD Web Application (Web App) notification system, emergency notifications, issues related to underground transite pipe, approved-alternative clean-up procedures, and test methods. The goal of these amendments is to provide clarity in the rule language and address these issues directly where possible. Staff are also committing to improve and expand upon internal guidance documents to answer many of the questions concerning rule implementation.

Additionally, throughout the rule development process, staff accompanied SCAQMD Inspectors during field operations to see first-hand the problems encountered during routine inspections, and the inability to conduct those vital inspections to ensure compliance with all applicable regulations.

LEGAL AUTHORITY

The AQMD obtains authority to adopt, amend, or repeal rules and regulations from Health and Safety Code §§39002, 39650 et seq., 39666, 40000, 40001, 40440, 40725 through 40728, and 41508.

RULE 1403 – ASBESTOS EMISSIONS FROM RENOVATION/DEMOLITION ACTIVITIES

CHAPTER 2: SUMMARY OF PROPOSED AMENDED RULE 1403

- OVERVIEW: PROPOSED RULE AMENDMENTS
- PROPOSE AMENDMENTS

OVERVIEW: PROPOSED RULE AMENDMENTS

The proposed amendments to Rule 1403 clarify language to assist owners and operators in understanding and complying with the rule's requirements. Staff proposes revisions to the applicability subdivision, amending and adding new definitions to the definition subdivision, and adding language to the requirements subdivision to clear up any misconceptions about Surveys and Notifications. Staff has also proposed to add new language to the Sampling Protocol and Test Methods subdivision to be consistent with current EPA guidance. With the advent of the Rule 1403 Notification Web App, staff proposes to remove obsolete language within the Notification subparagraph. Other changes include clarifications and editorial corrections to subdivisions throughout the rule.

PROPOSED REVISIONS TO EXISTING RULE LANGUAGE

Subdivision (a) Purpose

Staff proposes to include the additional words "and facility" to the current rule language to clarify that the purpose of the rule is to limit asbestos emissions from facility demolition and renovation activities with buildings being the most common and notable example of a facility. The existing definition in Rule 1403 defines facility to also include underground pipelines, ships, and waste disposal sites. In addition, staff also proposes to capitalize the words "Asbestos-Containing Materials" and "Asbestos-Containing Waste Materials" to coincide with the acronyms ACM and ACWM. These revisions are shown in strikeout/underline rule language and the new rule language in subdivision (a) will read as follows:

> *(a) The purpose of this rule is to specify work practice requirements to limit asbestos emissions from building and facility demolition and renovation activities, including the removal and associated disturbance of ~~asbestos-containing materials~~ Asbestos-Containing Materials (ACM). The requirements for demolition and renovation activities include asbestos surveying, notification, ACM removal procedures and time schedules, ACM handling and clean-up procedures, and storage, disposal, and landfilling requirements for ~~asbestos containing waste materials~~ Asbestos-Containing Waste Materials (ACWM). All operators are required to maintain records, including waste shipment records, and are required to use appropriate warning labels, signs, and markings.*

Subdivision (b) Applicability

Staff proposes to include the additional words "property owners, property lessors, asbestos abatement contractors, demolition contractors, general contractors, subcontractors, and asbestos consultants" to the current rule language to clarify that the rule considers all of these persons or entities are subject to rule requirements and may be an owner or operator of a renovation or demolition project. These revisions are shown in strikeout/underline rule language and the new rule language in subdivision (b) will read as follows:

> *(b) This rule, in whole or in part, is applicable to owners and operators; including, but not limited to, property owners, property lessors, asbestos abatement contractors, demolition contractors, general contractors, subcontractors, and asbestos consultants, of any demolition or renovation activity, and the associated disturbance of asbestos-containing material, any asbestos storage facility, or any active waste disposal site.*

Subdivision (c) Definitions

Staff proposes to add nine (9) new definitions and revise twenty-eight (28) existing definitions in the proposed amended rule to provide enhanced clarity of existing definitions and further define terms used throughout the rule. These thirty-seven new and revised definitions are shown in strikeout/underline rule language.

New definitions in Proposed Amended Rule 1403:

Paragraph (c)(5) – Proposed New Language

Staff proposes to add a definition for ASBESTOS CONSULTANT since they are the person conducting asbestos surveys as described in subparagraph (d)(1)(A). It is also a requirement that building or facility surveys shall be performed by a licensed Asbestos Consultant as described in clause (d)(1)(A)(iv) and (v), as newly proposed. The proposed new rule language in subdivision (b) includes Asbestos Consultant and staff believes that further warrants the proposed language as follows:

> *(5) ASBESTOS CONSULTANT is any person conducting asbestos surveys in accordance with subparagraph (d)(1)(A) and required to have the qualifications as specified in clause (d)(1)(A)(iv) or (v).*

Paragraph (c)(18) – Proposed New Language

Staff proposes to add two definitions for END DATE FOR RENOVATION ACTIVITIES and END DATE FOR DEMOLITION ACTIVITIES. The Notification requirement in subclause (d)(1)(B)(ii)(VI) stipulates a project start date and an end date, but there was some confusion with stakeholders as to what was meant by each date. Staff proposes new rule language to clarify these end dates; the proposed language is as follows:

> *(18) END DATE FOR RENOVATION ACTIVITIES is the last day when teardown is complete or, if later, the last day when all accumulated ACWM is removed from the project site. END DATE FOR DEMOLITION ACTIVITIES is the last day when the last load of building waste has left the project site.*

Paragraph (c)(25) – Proposed New Language

Staff proposes to add a new definition for HOMOGENEOUS MATERIAL since the term homogeneous material, is referenced in subclause (d)(1)(A)(iii)(V) and subparagraphs (h)(1)(A) through (E). Staff believes this new rule language provides additional clarification on what is homogeneous material. The proposed language for is as follows:

> *(25) HOMOGENEOUS MATERIAL is material that is similar in color, texture, and apparent or known date of installation.*

Paragraph (c)(33) – Proposed New Language

Staff proposes to add a new definition for OWNER-OCCUPANT to specifically define an owner-occupant, as separate from those who buy residential homes and perform renovation or demolition activities, for the purpose of profiting off their quick sale (e.g., “house flippers”). This new proposed definition seeks to prevent this practice by clarifying who is an Owner-Occupant for the purposes of this rule. The proposed rule language is as follows:

> *(33) OWNER-OCCUPANT is a homeowner who occupies a residential single-unit dwelling as a principal place of residence as demonstrated by an approved claim for the homeowners’ property tax exemption or the disabled veterans’ property tax exemption.*

Paragraph (c)(37) – Proposed New Language

Staff proposes to add a new definition for RECEPTOR to compliment proposed language in subclause (d)(1)(B)(i)(II); which refers to a specific renovation activity within one-quarter (1/4) mile of a “receptor.” This reference warrants a definition for what is meant by a receptor. The proposed rule language is as follows:

> *(37) RECEPTOR is any offsite residences, institutions (e.g., schools, hospitals), industrial, commercial, and office buildings, parks, recreational areas inhabited or occupied by the public at any time, or such other locations as the district may determine.*

Paragraph (c)(42) – Proposed New Language

Staff proposes to add a new definition for START DATE address the confusion within the regulated community on when the start day begins. Staff believes a new proposed definition will clarify the start date for renovation and demolition activities. The proposed rule language is as follows:

> *(42) START DATE is the first date the renovation or demolition activities disturb building materials including, but not limited to, the setting up of containment. This activity does not include staging of equipment.*

Paragraph (c)(45) – Proposed New Language

Staff proposes to add a new definition for SUPERVISOR to clarify what is meant by the term Supervisor; which is referenced in subclause (d)(1)(B)(ii)(II), subparagraph (d)(1)(G), clauses (d)(1)(H)(v) and (vii), and subparagraph (g)(1)(E). The proposed rule language is as follows:

> *(45) SUPERVISOR is any employee of the owner or operator conducting the demolition or renovation activity who has the required training as described in subdivision (i).*

Paragraph (c)(46) – Proposed New Language

Staff proposes to add a new definition for SURFACING MATERIALS to clarify what is meant by this term; which is referenced in subparagraph (h)(1)(A). Sampling protocols vary depending on surfacing materials or other types of materials. This warrants a definition to clarify what is meant by surfacing materials. The new proposed rule language is as follows:

> *(46) SURFACING MATERIAL is material that is sprayed-on, troweled-on, or otherwise applied to surfaces, including, but not limited to acoustical plaster, fireproofing materials, texturizing materials, or other materials on surfaces for acoustical, fireproofing, or other purposes.*

Paragraph (c)(45) – Proposed New Language

Staff proposes to add a new definition for VISIBLE EMISSIONS, emissions or evidence of emissions coming from asbestos related activities found outside the contained work area or asbestos containers. Staff believes this new proposed rule language is appropriate for asbestos renovation and demolition activities. The new proposed rule language is as follows:

> *(45) VISIBLE EMISSIONS are any emissions or evidence of emissions coming from asbestos related activities found outside the isolated work area or on-site storage including but not limited to dust, debris, particles, or fibers, which are visually detectable without the aid of instruments.*

Revisions to existing definitions in Proposed Amended Rule 1403:

Staff proposes to revise twenty-eight (28) existing definitions in Subdivision (c) to enhance clarity of the rule. These twenty-eight (28) existing definitions have minor revisions to enhance the proposed rule language and to clarify the given definition. These minor revisions are shown in strikeout/underline rule language.

Paragraph (c)(2) – Proposed Revised Language

Staff proposes additional rule language to clarify the low-pressure spray or mist. The proposed rule language is as follows:

> *(2) ADEQUATELY WET is the condition of being sufficiently mixed or penetrated with amended water to prevent the release of particulates or visible emissions. The process by which an adequately wet condition is achieved is by using a dispenser or water hose with a nozzle that permits the use of a fine, low-pressure spray or mist that uses a setting that will not break up the ACM during the wetting operation.*

Paragraph (c)(4) – Proposed Revised Language

Staff proposes a minor revision to clarify "actinolite and tremolite" rather than "actinolite or tremolite." The proposed rule language is as follows:

> *(4) ASBESTOS is the asbestiform varieties of serpentine (chrysotile), riebeckite (crocidolite), cummingtonite-grunerite (amosite), anthophyllite, actinolite, ~~or~~ and tremolite.*

Paragraph (c)(5) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(6) as deemed appropriate, and add additional language to promote clarity to this definition. The proposed rule language is as follows:

> *(~~5~~6) ASBESTOS-CONTAINING MATERIAL (ACM) is ~~both friable asbestos-containing material or~~ any material that contains more than one percent (1.0%) asbestos including friable ACM, Class I nonfriable ~~asbestos-containing material~~ ACM and Class II nonfriable ACM as determined by the provisions in paragraph (h)(2) in this rule. This includes any material that is presumed or assumed to contain more than one percent (1.0%) asbestos.*

Paragraph (c)(6) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(7) as deemed appropriate, add scrapping and drilling as additional mechanical asbestos removal methods and include the filters from control devices that have been contaminated with asbestos. The proposed rule language is as follows:

> *(~~6~~7) ASBESTOS-CONTAINING WASTE MATERIAL (ACWM) is any waste that contains commercial asbestos and that is generated by a source subject to the provisions of this rule. ACWM includes, but is not limited to, ACM which is friable, has become friable, or has a high probability of becoming friable, or has been subjected to scraping, sanding, grinding, cutting, drilling or abrading, and the waste generated from its disturbance, such as asbestos waste from control devices, filters from control devices, particulate asbestos material, asbestos slurries, bags or containers that previously contained asbestos, used asbestos-contaminated plastic sheeting and clothing, and clean-up equipment waste, such as cloth rags or mop heads.*

Paragraph (c)(7) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(8) as deemed appropriate, and add additional text "Part" to the existing rule language. The proposed rule language is as follows:

> *(~~7~~8) ASBESTOS HAZARD EMERGENCY RESPONSE ACT (AHERA) is the act which legislates asbestos-related requirements for schools (40 CFR Part 763, Subpart E).*

Paragraph (c)(8) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(9) as deemed appropriate, and remove Class II nonfriable ACM text from the existing rule language. The proposed rule language is as follows:

> *(~~8~~9) ASSOCIATED DISTURBANCE of ACM ~~or Class II nonfriable ACM~~ is any crumbling or pulverizing of ACM ~~or Class II nonfriable ACM~~, or generation of uncontrolled visible debris from ACM ~~or Class II nonfriable ACM~~.*

Paragraph (c)(9) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(10) as deemed appropriate, and add additional language to promote clarity to this definition. The proposed rule language is as follows:

> *(~~9~~10) CLASS I NONFRIABLE ASBESTOS-CONTAINING MATERIAL is ~~material~~ ACM, containing more than one percent ~~(1%)~~(1.0%) asbestos as determined by paragraph (h)(2), and that, when dry, can be broken, crumbled, pulverized, or reduced to powder in the course of demolition or renovation activities. Actions which may cause material to be broken, crumbled, pulverized, or reduced to powder include physical wear and disturbance by mechanical*

> *force~~, such as~~ including, but not limited to, scraping, sanding, sandblasting, cutting, drilling or abrading, improper handling or removal or leaching of matrix binders. Class I nonfriable ~~asbestos-containing material~~ACM includes, but is not limited to, packings, gaskets, resilient floor covering, fractured or crushed asbestos cement products, cement water pipes, transite materials, mastic, asphalt roofing products, roofing felts, and roofing tiles.~~, cement water pipes and resilient floor covering~~.*

Paragraph (c)(10) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(11) as deemed appropriate, and revise the weighted percent from "1%" to "1.0%." The original intent of Rule 1403 was to regulate more than one-percent asbestos, meaning that 1.15% asbestos was not to be rounded down to 1% asbestos. The proposed rule language is as follows:

> *(~~10~~11) CLASS II NONFRIABLE ASBESTOS-CONTAINING MATERIAL is ~~all other material~~ACM containing more than one percent ~~(1%)~~(1.0%) asbestos as determined by paragraph (h)(2), that is neither friable nor Class I nonfriable.*

Paragraph (c)(12) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(13) as deemed appropriate and include additional language to clarify the definition and that it applies to cutting with the intent to remove asbestos. The proposed rule language is as follows:

> *(~~12~~13) CUTTING is ~~penetrating~~the partial or complete penetration into a material with the intent of removing ACM ~~with~~using a sharp-edged instrument. ~~and~~Cutting includes sawing, but does not include shearing, slicing, or punching.*

Paragraph (c)(13) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(14) as deemed appropriate, and include additional language to clarify a load-supporting structural member. The proposed rule language is as follows:

> *(~~13~~14) DEMOLITION is the wrecking or taking out of any load-supporting structural member; including, but not limited to, the foundation, roof support structures, or any exterior wall of a facility and related handling operations or the intentional burning of any facility.*

Paragraph (c)(14) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(15) as deemed appropriate, and correct grammatical errors. The proposed rule language is as follows:

> *(~~14~~15) EMERGENCY DEMOLITION is a demolition ordered by a governmental agency for the purpose of eliminating peril to the safety of persons, property or the environment resulting from hazards such as collapse, fire, crime, disease, ~~or~~ toxic contamination, or other hazard ~~as~~ determined by the Executive Officer.*

Paragraph (c)(15) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(16) as deemed appropriate, and add additional language to provide clarification to this definition. Staff proposes adding to the definition "an imminent threat to public health and safety" and "encountering previously unknown ACM during demolition or excavation" to facilitate obtaining an emergency waiver from the requirement to submit the notification 10 working days prior to beginning any demolition or renovation activities. The proposed rule language is as follows:

> *(~~15~~16) EMERGENCY RENOVATION is any renovation that was not planned and results from an imminent threat to public health and safety, a sudden unexpected event that results in unsafe conditions, or encountering previously unknown ACM during demolition or excavation. Such events include, but are not limited to, renovations necessitated by non-routine failures of equipment, earthquake, flood or fire damage. An ~~economic~~ unreasonable financial burden alone~~, without a sudden, unexpected event,~~ does not give rise to conditions that meet this definition.*

Paragraph (c)(17) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(19) as deemed appropriate, and clarify that it must be locked when storing ACM. The proposed rule language is as follows:

> *(~~17~~19) ENCLOSED STORAGE AREA means a storage room, drum, roll-off container, other hard-sided container, or fenced area that is designed to be securely closed with a lock when storing ACM.*

Paragraph (c)(18) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(20) as deemed appropriate, and add additional language to clarify this definition. Debate has prevailed within the industry as to when a building or facility does not require an asbestos survey because it was built after a certain date. While asbestos-containing materials are typically more prevalent in pre-1980 construction, there is no guarantee that asbestos-containing materials would not be present in newer construction. Staff, therefore, proposes to add language which states that a facility is subject to Rule 1403 in spite of its "age or date of construction." The proposed rule language is as follows:

> *(~~18~~20) FACILITY is any institutional, commercial, public, industrial or residential structure, installation, building, any ship~~ or~~, vessel, ~~and any~~ active, or inactive waste disposal site. A facility is subject to this rule regardless of its current use, ~~or~~ function, age, or date of construction. For example, a facility destroyed by fire, explosion, or natural disaster, including any debris, shall remain~~s~~ subject to this rule's provisions.*

Paragraph (c)(19) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(21) as deemed appropriate, and spell out Heating, Ventilation, and Air Conditioning systems; which is identified by the acronym HVAC. The proposed rule language is as follows:

> *(~~19~~21) FACILITY COMPONENT is any part of a facility including foundations and or utility/commodity pipelines; and equipment such as but not limited to heaters, boilers, Heating, Ventilation, and Air Conditioning systems (HVAC), and motors.*

Paragraph (c)(20) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(22) as deemed appropriate, and revise the weighted percent from "1%" to "1.0%." The original intent was more than one-percent asbestos, meaning that 1.15% asbestos was not to be rounded down to 1% asbestos. In addition, Staff also proposed to add additional rule language to provide examples of friable asbestos-containing material. The proposed rule language is as follows:

> *(~~20~~22) FRIABLE ASBESTOS-CONTAINING MATERIAL is any material containing more than one percent ~~(1%)~~(1.0%) asbestos as determined by paragraph (h)(2), that, when dry, can be crumbled, pulverized, or reduced to powder by using hand pressure or lacks fiber cohesion, identified by flaking, blistering, water damage, scrapes, gouges, or other physical damage. Friable ACM may include, but is not limited to, sprayed-on or troweled-on fireproofing, acoustic ceiling material and ceiling tiles, resilient floor covering backing, thermal systems insulation, nonasphalt-saturated roofing felts, asbestos-containing paper and joint compound.*

Paragraph (c)(21) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(23) as deemed appropriate, and add additional text "typically" and "Part" to the existing rule language and remove an obsolete reference to “Appendix G” from the existing rule language. The proposed rule language is as follows:

> *(~~21~~23) GLOVE BAG is a sealed compartment with attached inner gloves used for handling ACM. When properly installed and used, glove bags provide a small work area enclosure typically used for small-scale asbestos stripping operations. Information on glove bag installation, equipment, and supplies, and work practices is contained in the Occupational Safety and Health Administration's final rule on occupational exposure to asbestos (~~Appendix G~~ to 29 CFR 1926.1101(g)).*

Paragraph (c)(23) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(26) as deemed appropriate, and correct grammatical errors. The proposed rule language is as follows:

> *(~~23~~26) INSTALLATION is 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 central control).*

Paragraph (c)(24) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(27) as deemed appropriate, and remove the existing “enclosed container” rule language. The proposed rule language is as follows:

> *(~~24~~27) ISOLATED WORK AREA is the immediate ~~enclosed containment~~ area in which the asbestos abatement activity takes place.*

Paragraph (c)(26) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(29) as deemed appropriate, and add the word “an” to clarify the existing rule language. The proposed rule language is as follows:

> *(~~26~~29) LOCKED means rendered securely closed and able to be opened only with a key or an access code.*

Paragraph (c)(28) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(31) as deemed appropriate, and correct grammatical errors. The proposed rule language is as follows:

> (~~28~~31) OUTSIDE AIR is the air outside of ~~the~~a facility or outside of the isolated work area.

Paragraph (c)(29) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(32) as deemed appropriate, and add the demolition and renovation operation proposed language. The proposed rule language is as follows:

> *(~~29~~32) OWNER or OPERATOR OF A DEMOLITION OR RENOVATION ACTIVITY is any person who owns, leases, operates, controls or supervises activities at the facility being demolished or renovated; the demolition or renovation operation; or both.*

Paragraph (c)(31) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(35) as deemed appropriate, capitalize where necessary, and add "renovation operation" to promote clarity to this definition. The proposed rule language is as follows:

> *(~~31~~35) PLANNED RENOVATION is a renovation operation, or a number of such operations, in which the amount of ACM that will be removed or stripped within a given period of time can be predicted. Individual ~~n~~Nonscheduled ~~r~~Renovation ~~o~~Operations are included if a number of such operations can be predicted to occur during a given period of time based on ~~operating~~renovation operation experience.*

Paragraph (c)(33) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(38) as deemed appropriate, and add additional language to clarify what staff considers the removal of ACM or facility components. The proposed rule language is as follows:

> *(~~33~~38) REMOVAL is the taking out of ACM or facility components including, but not limited to, cutting, drilling, scraping, abrading, grinding, or similarly disturbing ACM or facility components that contain or are covered with ACM from any facility.*

Paragraph (c)(34) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(39) as deemed appropriate, refer to the acronym HVAC solely since Heating, Ventilation, and Air Conditioning Systems was used previously in the rule language, and include the term "one or more" for clarity. The proposed rule language is as follows:

> *(~~34~~39) RENOVATION is the altering of a facility or the removing or stripping of one or more facility components in any way, including, but not limited to, the stripping or removal of ACM from facility components, retrofitting for fire protection, and the installation or removal of ~~heating, ventilation, air~~*

> *~~conditioning (~~HVAC~~)~~ systems. Activit~~y~~ies involving the wrecking or taking out of one or more load-supporting structural members are defined as demolitions.*

Paragraph (c)(35) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(40) as deemed appropriate, and include the term "Duplexes" for clarity. The proposed rule language is as follows:

> *(~~35~~40) RESIDENTIAL SINGLE UNIT DWELLING is a structure that contains only one residential unit. Duplexes, ~~A~~apartment buildings, townhouses, and condominiums are not residential single unit dwellings.*

Paragraph (c)(36) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(41) as deemed appropriate, and revise the weighted percent from "1%" to "1.0%." The original intent was more than one-percent asbestos, meaning that 1.15% asbestos was not to be rounded down to 1% asbestos. The proposed rule language is as follows:

> *(~~36~~41) RESILIENT FLOOR COVERING is asbestos-containing floor tile, including asphalt and vinyl floor tile, and sheet vinyl floor covering containing more than one percent ~~(1%)~~(1.0%) asbestos as determined by paragraph (h)(2).*

Paragraph (c)(39) – Proposed Revised Language

Staff proposes to change the paragraph number to (c)(48) as deemed appropriate, and change the term from "source" to "facility" for clarity, as follows:

> *(~~39~~48) WASTE GENERATOR is any person who owns or operates a ~~source~~ facility subject to the provisions of this rule according to subdivision (b), and whose act or process produces ACWM.*

Subdivision (d) Requirements

Staff proposes to provide clarity to existing requirements and add rule language which will assist the regulated community in understanding the requirements of Rule 1403 that were not denoted in existing rule language. This additional language is consistent with the National Emission Standards for Hazardous Air Pollutants (NESHAP) set by the United States Environmental Protection Agency (EPA) and other local Air Pollution Control Districts within the United States and the state of California. These proposed changes are promulgated by a misunderstanding of the original intent of Rule 1403 as understood by a review of previous staff reports. These changes are shown in strikeout/underline format.

Clause (d)(1)(A)(i) – Proposed Revised Language

Staff proposes to enhance the clarity of the current rule language by stating that an asbestos consultant is the only person who shall conduct a facility survey provided that the person is certified by Cal/OHSA Section 9021.5 of the labor code or possesses a current and valid certificate from a Cal/OSHA approved AHERA building inspector training course in accordance with clause (d)(1)(A)(iv) or (v). Staff proposes to clarify that a survey may be limited to the part of the facility where the demolition or renovation will occur, shall include an "onsite" inspection, the sampling of materials in accordance with subdivision (h), and that there are not any exceptions to a survey based on the age of the facility. The proposed new language is as follows:

> *(i) The affected facility, part of the facility where the demolition or renovation operation will occur, or facility components shall be thoroughly surveyed by an asbestos consultant, meeting the requirements of clause (d)(1)(A)(iv) or (v), for the presence of asbestos prior to any demolition or renovation activity. The survey shall include the onsite inspection, identification, and quantification of all friable, and Class I and Class II non-friable ~~asbestos-containing material~~ACM, and any physical sampling of materials in accordance with subdivision (h). There are no exceptions to this survey requirement based on the date of construction or the age of a facility.*

Clause (d)(1)(A)(ii) – Proposed Revised Language

Staff is proposing a minor grammatical correction in clause (d)(1)(A)(ii) in efforts to clarify rule language. The proposed new language is as follows:

> *(ii) A thorough survey shall include, at a minimum, identification of all affected materials at the facility, including but not limited to all layers of flooring materials to the joist level, and all materials in the wall or ceiling cavities as necessary to identify and sample them.*

Clause (d)(1)(A)(iii) – Proposed Revised Language

Staff is proposing additional language to subclauses (d)(1)(A)(iii)(II) and (d)(1)(A)(iii)(III), in efforts to clarify the rule language. In subclause (d)(1)(A)(iii)(IV), staff proposes to refine the requirements for a listing of all samples collected and to require a unique code or number delineating each sample on the sketch of the facility. In subclause (d)(1)(A)(iii)(V), staff proposes new rule language requiring a table in the survey report containing all suspected materials tested, the area of homogeneous material, asbestos content, and the percent damage. In subclause (d)(1)(A)(iii)(VII), staff proposes new rule language detailing the requirements for a Chain of Custody document. The proposed rule language for the subclauses under clause (d)(1)(A)(iii) are shown as follows:

(II) A written statement of the qualifications of the ~~person~~ asbestos consultant who conducted the survey, demonstrating compliance with clause (d)(1)(A)(iv) or (v);

(III) The dates the facility was visited and the survey was conducted;

(IV) A listing of all suspected materials containing any asbestos, a listing of all samples collected, ~~and~~ a sketch ~~of~~ detailed sufficiently to determine where the samples were taken, and a unique code or number delineating each sample on the sketch;

(V) A table of all suspected materials tested, the approximate area of each homogeneous material, the asbestos content of each material tested, and the percent of the area that is damaged;

(VII) A detailed Chain of Custody (COC) document identifying all samples obtained that shall, at minimum, satisfy the following:

  (1) Record of the name of the individual collecting the samples;

  (2) Record of the location, type of material, date, time, and unique identification number or code for each sample that was obtained; and,

  (3) Whenever the possession of samples is transferred, both the individual relinquishing the samples and the individual receiving the sample shall sign, print their name legibly, and record the date and time on the COC document.

Clause (d)(1)(A)(iv) – Proposed Revised Language

Staff proposes revisions to clause (d)(1)(A)(iv) to clarify training and certification requirements for persons performing asbestos surveys and to distinguish asbestos consultants who are contracted outside of the facility to perform asbestos surveys from employees who conduct asbestos surveys exclusively for the facility where they are employed, which are addressed in the subsequent proposed clause. The proposed rule language is as follows:

(iv) Persons ~~conducting~~ contracted to perform asbestos surveys, in accordance with subparagraph (d)(1)(A), shall be certified by Cal/OSHA pursuant to regulations required by subdivision (b)of Section 9021.5 of the Labor Code, and shall have taken and passed an EPA-approved Building Inspector Course and conform to the most recent updated procedures outlined in the Course.

Clause (d)(1)(A)(v) – Proposed Revised Language

Staff proposes the addition of a new clause following clause (d)(1)(A)(iv) to specify the training and certification requirements for persons performing asbestos surveys exclusively at the facility where they are employed. Cal/OSHA has confirmed that persons conducting asbestos surveys for the employers need not be certified asbestos consultants, but must possess a current and valid certificate from a Cal/OSHA approved AHERA building inspector training course. Staff believes adding this new rule language will clarify that asbestos surveys conducted by the facility employee(s) are allowed provided that they have current and valid Cal/OSHA certification. This additional rule language is to accommodate stakeholders who have staff certified to perform surveys and inspections at their facilities, but are not licensed and certified asbestos consultants. The proposed clause is as follows:

> *(v) Persons conducting asbestos surveys at the facility where they are employed exclusively, in accordance with subparagraph (d)(1)(A), shall possess a current and valid certificate from a Cal/OSHA approved AHERA building inspector training course.*

Subparagraph (d)(1)(B) – Proposed Revised Language

Staff proposes revisions to the current rule language to clarify who shall submit notifications and to update the format by which the notifications shall be submitted. Staff proposes language clarifying that only the person performing the renovation or demolition shall submit complete and correct notifications in a District-approved electronic format. In November 2016, the district put into operation the Rule 1403 Notification Web Application as the District-approved electronic format for notification of any renovation or demolition activity subject to Rule 1403. Staff proposes removing from rule language any text that references notifications in other formats. Staff also proposes additional rule language that directs how notifications for emergency renovations or emergency demolitions shall be made during non-District staffing hours or periods when the Web Application is unavailable. The proposed rule language for the subparagraph is as follows:

> *(B) The District shall be notified of the intent to conduct any demolition or renovation activity. Complete and correct Notifications shall be submitted by the person performing the renovation or demolition in a District-approved electronic format. ~~format which may include but not be limited to U.S. mail, telephone, facsimile, digital, internet, and e-mail. Telephone, facsimile, digital, and e-mail notifications shall be confirmed with follow-up written notifications to the District postmarked or delivered to the District within 48 hours from submitting the telephone, facsimile, digital, or e-mail notification.~~ No notification shall be considered ~~received~~ submitted unless it is accompanied by the required fee ~~pursuant to~~ in accordance with District Rule 301,~~ as part of the required written notification~~ and has a status of "submitted" in the District Rule 1403 Notification Web Application. Notifications for emergency renovations or emergency demolitions during non-District staffing hours or periods when the Web Application is unavailable shall be made by calling (800) CUT-SMOG. Notifications shall be provided in accordance with the following requirements:*

Clause (d)(1)(B)(i) – Proposed Revised Language

Staff is proposing minor grammatical corrections to subclauses (d)(1)(B)(i)(I) and (d)(1)(B)(i)(III). Staff proposes the addition of subclause (d)(1)(B)(i)(II) to address specific projects whereby underground pipe renovation activities can be submitted two (2) working days before any activities begin instead of the usual ten (10) working days as required in subclause (d)(1)(B)(i)(I). This notification is limited to underground pipe located more than one-quarter (1/4) mile from the nearest receptor; which is now a defined term. This additional rule language is to accommodate renovations performed by stakeholders who routinely handle this type of project; whereby the release of asbestos fibers and the risk of public exposure are minimal. However, projects that are subject to the NESHAP and to its requirement for a 10 working day notification would not be able to depend on this proposed rule accommodation. As a result of the addition of subclause (d)(1)(B)(i)(II), staff proposes the changes to the numbers of the subsequent subclauses as deemed necessary. In subclause (d)(1)(B)(i)(IV), staff proposes additional language pointing to clauses (d)(1)(B)(iii) and (d)(1)(B)(iv) in order to clarify that complete and correct notifications for emergency demolition or renovation have the required additional information as stated in those clauses. The proposed rule language for the subclauses under clause (d)(1)(B)(i) are shown as follows:

(I) Demolition or Renovation Activities
The notification shall be submitted to the District no later than 10 working days before any demolition or renovation activities other than emergency demolition, emergency renovation, and planned renovations involving individual ~~n~~Nonscheduled ~~r~~Renovation ~~o~~Operations begin.

(II) Renovation Activities exclusively involving Underground Pipe Situated in Remote Locations
The notification shall be submitted to the District no later than two (2) working days before any activities begin if the location is more than one-quarter (1/4) mile from nearest receptor. The distance to the nearest receptor, the method used to determine the distance, and the person determining the distance shall be included with the survey.

(~~II~~III)Planned Renovation - Annual Notification
The District shall be notified by December 17 of the year preceding the calendar year for which notice is being given for ~~p~~Planned ~~r~~Renovation activities which involve individual ~~n~~Nonscheduled ~~r~~Renovation ~~o~~Operations.

(~~III~~IV)Emergency Demolition or Renovation
The District shall be notified as soon as possible, but prior to any emergency demolition or renovation activity in accordance with clauses (d)(1)(B)(iii) and (d)(1)(B)(iv).

Clause (d)(1)(B)(ii) – Proposed Revised Language

Staff is proposing additional language and revisions to clause (d)(1)(B)(ii) in efforts to clarify the rule language addressing the information that shall be included in all notifications and to enhance consistency.

In subclause (d)(1)(B)(ii)(II), staff proposes to include "site" before "owner" to distinguish the owner of the site, which is the area occupied by one facility or multiple facilities, from the operator of the facility and to replace "supervising person" with "at least one supervisor" to update the terminology and acknowledge that the owner or operator conducting the demolition or renovation activity may provide information for more than one supervisor.

In subclause (d)(1)(B)(ii)(IV), to adhere to one unit of measurement to describe the size of Asbestos-Containing Material (ACM) or facility or part/components of a facility affected by demolition or renovation, staff proposes to remove "square meters" so that (square) feet remains.

In subclause (d)(1)(B)(ii)(VI), staff proposes minor revisions to streamline and harmonize the rule language which include updating "starting" with "start" and "completion" with "end" before dates, removing redundant language requiring starting and completion dates for demolition or renovation on notifications, adding capitalization where necessary, and replacing "as described in" with "in accordance with" to maintain the notion of conformity.

Staff also proposes to add two new items to subclause (d)(1)(B)(ii)(VI) to address additional notification procedures for 1) projects that do not conform to the traditional Monday through Friday work schedule, and 2) for projects that suffer a delay due to events outside their control after the Start Date (e.g., flood, fire, earthquake). Due to the alteration in the schedule of work inherent to these two project scenarios, staff proposes new rule language specifying what to submit (as part of or as an update to a notification) and when to inform the District of the altered work schedule for each project scenario. The proposed time frame by which the required submission of updated items shall be provided to the District (i.e., as soon as the change of schedule or delay is known but no later than the start of the work shift associated with the change or delay) allows reasonable and sufficient time for owners and operators of demolition or renovation activities to conduct operations as necessary following the change of schedule or delay and for SCAQMD compliance staff to adjust accordingly for the inspections of these projects.

In subclause (d)(1)(B)(ii)(VIII), staff proposes to use one unit of measurement to describe the size of Asbestos-Containing Material (ACM) or facility or part/components of a facility affected by demolition or renovation; staff also proposes to remove all size description language in excess of surface area in square feet.

In subclause (d)(1)(B)(ii)(X), staff proposes to remove the language of Class II nonfriable asbestos-containing material becoming crumbled, pulverized, or reduced to powder. This maintains the proposed definitional change to Asbestos-Containing Material (ACM) to include

Class II nonfriable ACM, and upholds the District's position that materials that would be considered nonfriable ACM, including Category II nonfriable as defined in NESHAP, have the potential to be broken, crumbled, pulverized, or reduced to powder in the course of demolition or renovation activities and shall be treated as ACM.

In subclause (d)(1)(B)(ii)(XII), staff proposes additional language to clarify that the Cal/OSHA Registration number is in relation to renovation activities.

In subclause (d)(1)(B)(ii)(XIV), staff proposes additional language requiring the Department of Toxic Substances Control (DTSC) Registration Number and expiration date of the ACWM transporters in order to align with DTSC waste transporter compliance requirements.

In subclause (d)(1)(B)(ii)(XVI), staff proposes to include additional language clarifying that the trained person supervising the activities described in the notification is an employee of the renovation or demolition operator.

Staff proposes the addition of three new subclauses, (d)(1)(B)(ii)(XVII), (d)(1)(B)(ii)(XVIII), and (d)(1)(B)(ii)(XVIV), which contain new rule language clarifying specific information that shall also be provided on the notifications to enhance compliance verification pertaining to demolition notifications, asbestos survey reports, and facility surveys. The proposed rule language for the all of the above mentioned subclauses under clause (d)(1)(B)(i) are shown as follows:

(II) Name, address and telephone number of both the site owner and operator of the facility, at least one ~~supervising person~~supervisor, and the asbestos removal contractor~~, owner or operator~~;

(IV) Description of the facility or affected part of the facility to be demolished or renovated including the size (measured in ~~square meters or~~ square feet), ~~and~~, number of floors~~)~~, age, and present or prior uses of the facility;

(VI) Scheduled project start~~ing~~ and ~~completion~~ end dates of demolition or renovation. ~~Notifications shall also include the ACM removal starting and completion dates for demolition or renovation; p~~Planned renovation activities involving individual ~~n~~Nonscheduled ~~r~~Renovation ~~o~~Operations need only include the beginning and ending dates of the report period ~~as described in~~ in accordance with subclause (d)(1)(B)(i)(~~II~~III);

  (1) For projects that do not conform to the traditional Monday through Friday work schedule, a Schedule of Work shall be included as part of the notification and updated as soon as the change of schedule is known, but no later than the first work shift when the change of schedule takes effect.

  (2) For projects that suffer a delay due to events outside their control after the Start Date including, but not limited to, flood, fire, or earthquake; an updated Schedule of Work shall be submitted as soon as the delay is known, but no later than the start of the work shift that was delayed. A

reason for the delay shall be included with the updated Schedule of Work.

(VIII) A separate estimate for each of the amounts of friable, Class I, and Class II nonfriable asbestos-containing material to be removed from the facility in terms of ~~length of pipe in linear feet,~~ surface area in square feet~~ on other facility components, or volume in cubic feet if off the facility components. The total as equivalent surface area in square feet shall also be reported~~;

(X) Description of steps to be followed in the event that unexpected ACM is found ~~or Class II nonfriable asbestos-containing material becomes crumbled, pulverized, or reduced to powder~~;

(XII) Cal/OSHA Registration number - for renovation activities;

(XIV) Name, address, Department of Toxic Substances Control (DTSC) Registration Number and expiration date, and telephone number of transporters used to transport ACWM off-site;

(XV) Procedures, including analytical methods, used to detect the presence of friable and nonfriable asbestos-containing material; ~~and~~

(XVI) Signed certification that at least one person employed by the renovation or demolition operator who has been trained as required in subparagraph (d)(1)(G) will be ~~supervise~~supervising ~~the stripping and removal~~ the activities described by this notification~~.~~;

(XVII) Demolition notifications shall also include, if applicable: the name of the renovation operator that removed ACM; the end date for the removal of the ACM; and the quantity of ACM removed;

(XVIII) The name, address, telephone number and, either:

(1) A valid Cal/OSHA certification number of the person who was contracted to complete the asbestos survey report, and the date of the asbestos survey report; or,

(2) A valid Cal/OSHA approved AHERA building inspector certification number of the person employed by the facility who completed the facility survey and the date of the asbestos survey report.

Clause (d)(1)(B)(iv) – Proposed Revised Language

Staff proposes revisions and additional rule language to subclause (d)(1)(B)(iv)(III), (IV), and (V), in efforts to clarify the additional information that is required for notifications of all emergency renovation activities.

In subclause (d)(1)(B)(iv)(III), staff proposes to delete the words “sudden, unexpected” from the current rule language and then reference to the proposed definition of Emergency Renovation in paragraph (c)(16).

In subclause (d)(1)(B)(iv)(IV), staff proposes to add new rule language to reference an Emergency Renovation as defined in paragraph (c)(16). This proposed language clarifies that in order to meet the District's definition of an emergency renovation, the description of the emergency should contain the considerations precisely defined in paragraph (c)(16), which in turn will facilitate obtaining an emergency waiver from submitting the notification 14 calendar days (10 working days) prior to beginning any demolition or renovation activities.

In subclause (d)(1)(B)(iv)(V), staff proposes rule language clarifying what an emergency letter shall contain in order to certify that the emergency renovation is in response to an actual emergency. The new rule language requires that the emergency declaration letter contain both the signatures of the person affected by the emergency (e.g., the property owner) and an authorized representative of the renovation or demolition operator. If the renovation or demolition operator does not wish to sign the emergency declaration letter, then document must be signed in the presence of a Public Notary. In addition, the emergency declaration letter must contain attestations under penalty of perjury that the information in the emergency letter is true and correct. This proposed rule language is intended to discourage submission of fraudulent emergency letters (i.e., the letter contains a false signature of the property owner), discourage the misuse of emergency renovation notifications, and lays out feasible options for certifying the validity and accuracy of emergency declaration letters while minimizing delays to projects (as a result of the emergency). The proposed rule language for subclauses (d)(1)(B)(iv)(III), (d)(1)(B)(iv)(IV), (d)(1)(B)(iv)(V), are as follows:

> *(III) A description of the ~~sudden, unexpected~~ event that meets the parameters of the definition in paragraph (c)(16);*
>
> *(IV) An explanation of how the event, that meets the parameters of the definition in paragraph (c)(16), caused an unsafe condition, or would cause equipment damage or an unreasonable financial burden; and~~.~~,*
>
> *(V) A ~~signed~~ letter with a valid signature from the person directly affected by the emergency, such as the property owner or property manager, attesting to the circumstances of the emergency. The letter shall contain in the signature section the following statement, "I certify (or declare) under penalty of perjury under the laws of the State of California that the foregoing is true and correct." Both the person affected by the emergency and an authorized representative for the renovation or demolition operator shall sign the certification or declaration on the same page. In lieu of a renovation operator signature, the person affected by the emergency shall sign the letter in the presence of a public notary and obtain and attach that notary's certificate of acknowledgement or jurat for the letter's signing.*

Clause (d)(1)(B)(v) – Proposed Revised Language

Staff proposes revisions and additional rule language to clause (d)(1)(B)(v) to clarify and update the requirements for notification updates. Staff proposes the addition of a new subclause, (d)(1)(B)(v)(I), to address the condition of cancellation to a notified project and when the notification shall be updated with the cancellation. As a result, staff proposes the changes to the numbers of the subsequent subclauses as deemed necessary.

In the proposed revisions to subclauses (d)(1)(B)(v)(II), (d)(1)(B)(v)(III), (d)(1)(B)(v)(IV), and (d)(1)(B)(v)(V), staff proposes to include rule language that notification updates shall be made through the District Rule 1403 Notification Web Application to streamline all revisions to the quantity of asbestos, starting date, and end date. In addition, this affirms that the only changes allowed to notifications on the Web Application are for these three conditions. Staff also proposes to remove outdated language to reflect that notifications are now to be in an electronic format. In subclauses (d)(1)(B)(v)(III), (IV), (V) and (VI) staff seeks to enhance consistency and improve clarification in the rule language by replacing "starting date" with "start date" and by replacing "completion date" with "end date."

Additionally, in subclause (d)(1)(B)(v)(VI), staff seeks to enhance consistency and clarification in the rule language by adding the word "one" in addition to the numerical version of one, and by removing the word "written" just before "notification update".

The proposed rule language for all the subclauses under clause (d)(1)(B)(v) are shown as follows:

(I) Cancellation

Projects that will not be conducted as notified shall be cancelled no later than the notified start date.

(~~I~~II) Change in Quantity of Asbestos

A change in the quantity of affected asbestos of 20 percent or more from the notified amount shall be reported to the District by providing a notification update in the District Rule 1403 Notification Web Application as soon as the information becomes available, but not later than the project end date, unless otherwise specified in an approved Procedure 5.

(~~II~~III) Later Start~~ing~~ Date

A delay in the start~~ing~~ date of any demolition or renovation activity shall be reported to the District by providing a notification update in the District Rule 1403 Notification Web Application as soon as the information becomes available, but no later than the original start date.

(~~III~~IV)Earlier Start~~ing~~ Date

A change in the start~~ing~~ date of any demolition or renovation activity to an earlier start~~ing~~ date shall be reported to the District by providing a notification update in the District Rule 1403 Notification Web Application no later than 10 working days before any demolition or renovation activities begin.

(~~IV~~V)~~Completion~~ End Date Change

~~Changes in the completion date shall be reported to the District at least two (2) calendar days before the original scheduled completion date.~~ In the event renovations or demolitions are not completed, are delayed, or are completed

ahead of schedule, the District shall be notified by providing a notification update in the District Rule 1403 Notification Web Application as soon as possible, but no later than the following ~~business~~ day.

(VI) Planned Renovation Progress Report
Notifications for on-going planned renovation operations in which the scheduled start~~ing~~ and ~~completions~~end dates are more than one (1) year apart shall be updated, every year of the operation by December 17, unless the most recent ~~written~~ notification update was postmarked or delivered after October 1 of that year and include the amount of ACM removed and the amount of ACM remaining to be removed.

Clause (d)(1)(C)(i) – Proposed Revised Language

Staff proposes to replace "SCAQMD" with "District" to maintain rule language uniformity. The proposed new language is as follows:

(i) All ACM and Class II asbestos-containing material shall be removed from a facility prior to any demolition by intentional burning. All demolition by intentional burning shall be performed in accordance with District Rule 444 – Open Burning.

Clause (d)(1)(C)(ii) – Proposed Revised Language

Staff proposes to add "scraping" to the existing rule language of subclause (d)(1)(C)(ii)(IV) to comprehensively address the activities that may be involved in the removal of ACM. The inclusion of "scraping" as a specific activity is relevant and consistent with 29 CFR 1926.1101(b) and 29 CFR 1926.1101(g)(8)(i)(D), which collectively describe "scraping" as an activity conducted during the removal of asbestos-containing mastic from floors, during which asbestos fibers may be released. Staff also proposes to replace "must" with "shall" to maintain rule language uniformity while preserving and imposing a legal obligation on the regulated community. Staff proposes to remove the phrase "or Class II nonfriable ACM" from the existing rule language of subclause (d)(1)(C)(ii)(V) as ACM is defined, in the current proposed version, as "any material that contains more than one percent (1.0%) asbestos including friable ACM, Class I nonfriable ACM and Class II nonfriable ACM." Finally, staff proposes additional rule language in subclause (d)(1)(C)(ii)(VI) to address the discovery of any disturbed, damaged, or suspected ACM outside of containment or the work area with specific instructions and procedures to be followed in this event. The proposed new rule language for the subclauses is as follows:

(IV) If the renovation or demolition activity involves any mechanical force such as, but not limited to, scraping, sanding, sandblasting, cutting, or abrading and thus would render the materials friable, they ~~must~~shall be removed prior to the renovation or demolition.

(V) If for any reason, any renovation or demolition results in an associated disturbance of ACM ~~or Class II nonfriable ACM~~ outside of a containment or work area then, prior to continuing with any renovation or demolition activity, the owner/operator shall secure, stabilize and survey the affected facility areas and submit and obtain an approved Procedure 5 plan, prior to any asbestos clean-up.

(VI) If any disturbed, damaged, or suspected ACM is discovered outside of a containment or work area then, prior to continuing with any renovation or demolition activity, the owner/operator shall secure, stabilize and survey the affected facility areas and submit and obtain an approved Procedure 5 plan, prior to any asbestos clean-up.

Clause (d)(1)(D)(i) – Proposed Revised Language

Staff proposes to add a space to “glovebag” to separate “glove” from “bag” to the existing rule language of subclause (d)(1)(D)(i)(II) for both clarity and consistency with 29 CFR 1926.1101(g) and current Cal/OSHA requirements. Additionally, staff is proposing to replace “Section” with “Part” and remove the outdated “Appendix G” for clarity and consistency. Staff proposes a revision to existing rule language of item (d)(1(D)(I)(III)(4) stating only non-power tools shall be used “to remove nonfriable ACM” to provide clarification. Staff also proposes a grammatical correction to subclause (d)(1(D)(I)(IV) to enhance clarity. The proposed new language is as follows:

(II) Procedure 2 - Glove bag

Remove ACM by the glove bag method or mini enclosures designed and operated according to 29 CFR ~~Section~~1926.1101(g), ~~Appendix G,~~ and current Cal/OSHA requirements.

(III) Procedure 3 - Adequate Wetting

Procedure 3 shall only be used to remove nonfriable asbestos-containing materials, using the following techniques:

(4) Only non-power tools shall be used to remove nonfriable ACM.

(IV) Procedure 4 - Dry Removal

~~Obtain written~~Written approval shall first be obtained from the Executive Officer's designee prior to using dry removal methods for the control of asbestos emissions when adequate wetting procedures in the renovation work area would unavoidably damage equipment or present a safety hazard. Dry removal methods may include one or more of the following:

Clause (d)(1)(D)(ii) – Proposed Revised Language

Staff proposes to add the phrase “any amount of” to existing rule language in subclause (d)(1)(D)(ii)(I) to make the requirement absolute and free of any quantity-based confusions.

Staff also proposes to remove “or Class II nonfriable ACM” for clarity and consistency with the overall rule language, as ACM, by the proposed definition, includes Class II nonfriable materials. Staff also proposes to add additional rule language consisting of “or disturbance,” from “a natural disaster including, but not limited to,” fire, “flood, or” explosion to both clarify and be consistent with NESHAP’s presentation of what constitutes an unplanned, natural disaster, which includes “flood.” Staff is also proposing the inclusion of Procedure 4 as an approved alternative along with Procedure 5, particularly if and when dry removal is to be performed. Finally, staff is proposing to add additional rule language to clause (d)(1)(D)(ii) by adding subclause (d)(1)(D)(ii)(II) further clarifying that unassessed materials of which have been presumed or assumed to be ACM also require the submission of a Procedure 4 or 5 Approved Alternative. The proposed new language is as follows:

(I) No person shall remove or strip any amount of ACM ~~or Class II nonfriable ACM~~ that has suffered any damage or disturbance ~~from fire, explosion, or natural disaster~~ without the use of a Procedure 4 or 5 Approved Alternative. The causes of damage or disturbance include, but are not limited to, fire, flood, explosion, or other natural disaster.

(II) Notifications for materials that cannot be assessed for damage such as, but not limited to, subterranean piping, where the asbestos consultant has presumed or assumed the material to be asbestos-containing, shall be submitted as a Procedure 4 or 5 Approved Alternative. A facility survey is still required in accordance with subparagraph (d)(1)(A).

Clause (d)(1)(F) – Proposed Revised Language

Staff proposes to revise existing rule language by expressing the units for temperature in their unabbreviated forms (e.g., Celsius instead of C and Fahrenheit instead of F) in subparagraph (d)(1)(F) to provide clarity and rule consistency. Additionally, for subclause (d)(1)(F)(ii), staff is proposing to express “2” in text form in addition to the numeric 2. The proposed new language is as follows:

(F) When the temperature at the point of wetting is below 0^{o} *Celsius (32*^{o} *Fahrenheit), the wetting provisions of subparagraph (d)(1)(D) shall be superseded by the following requirements:*

(ii) The temperature in the area containing the facility components shall be recorded at the beginning, middle, and end of each workday during periods when wetting operations are suspended due to freezing temperatures. Daily temperature records shall be available for inspection by the District during normal business hours at the demolition or renovation site. Records shall be retained for at least two (2) years.

Clause (d)(1)(G) – Proposed Revised Language

Staff proposes to replace “Representative” with “Supervisor” to specify the level of authority, training, and responsibility deemed appropriate as an effective representative of the worksite. In addition, staff proposes to remove rule language that refers to “stripping, removing, handling, or disturbing of ACM” and replace it with “activities described in the notification.” The proposed new language is as follows:

(G) On-Site ~~Representative~~ Supervisor

At least one on-site ~~representative~~supervisor, such as a foreman, manager, or other authorized representative, trained in accordance with the provisions of paragraphs (i)(1) ~~and~~or (i)(~~3~~2), shall be present during the ~~stripping, removing, handling, or disturbing of ACM~~activites described in the notification. Evidence that the required training has been completed shall be posted at the demolition or renovation site and made available for inspection by the Executive Officer's designee.

Clause (d)(1)(H) – Proposed Revised Language

Staff proposes to replace lower-cased “copies” of subclause (d)(1)(H)(iii) to upper-cased “Copies.” For enhanced clarity and consistency, staff proposes to replace “pursuant to” with “in accordance with”, and omit the unnecessary “and”. Similarly, for subclause (d)(1)(H)(iv), staff proposes to replace lower-cased “copies” with upper-cased “Copies”, replace “pursuant to” with “in accordance with”, and add a semi-colon to the end. Additionally, staff proposes additional rule language to clause (d)(1)(H) with subclauses (d)(1)(H)(v), (d)(1)(H)(vi), and (d)(1)(H)(vii) mandating the owner or operator maintain the required training certificate(s) for both the supervisors and workers along with all required records and logs. The proposed new language is as follows:

(iii) ~~c~~Copies of surveys, conducted ~~pursuant to~~ in accordance with subparagraph (d)(1)(A); ~~and~~

(iv) ~~c~~Copies of notifications submitted ~~pursuant to~~ in accordance with subparagraph (d)(1)(B)~~.~~;

(v) Copies of the training certificate(s) demonstrating that the on-site supervisor has been trained in accordance with paragraphs (i)(1) or (i)(3);

(vi) Copies of all current training certificates demonstrating that workers have successfully completed the Abatement Worker course, or refresher course as applicable, in accordance with AHERA; and,,

(vii) Copies of all supervisor logs or equivalent records documenting the demolition or renovation activities at the project site.

Subdivision (e) Warning Labels, Signs, and Markings

Staff proposes to update the existing rule language and provide clarity which will assist the regulated community in complying with the identification requirements of asbestos related health hazards. The additional revisions make the rule language consistent with identification requirements specified by federal and state Occupational Safety and Health Administration (OSHA). These changes are shown in strikeout/underline rule language format.

Subparagraph (e)(1) – Warning Labels, Signs, and Markings

Staff proposes revisions to rule language in subparagraph (e)(1)(A) to cite parts of the OSHA asbestos general standard and the applicable parts in the current OSHA asbestos construction standard, which contains requirements more appropriate to the scope of work in renovation and demolition activities subject to Rule 1403. Staff also proposes to remove presentations of the warning label/sign information specified in the associated regulation citations in order to retain consistency if there are future changes in the OSHA standard. Currently, 29 CFR 1910.1001(j)(2) contains language requiring employers and building owners to treat certain installed materials as ACM, which is irrelevant to warning label/sign information. Additionally, 29 CFR Part 1926.58 has been redesignated to 1926.1101. Staff proposes additional rule language in subparagraph (e)(1)(B) clarifying the necessity of visible and readable container labels for identification and compliance verification purposes for asbestos waste generation and transport. The proposed rule language is as follows:

(A) *Warning labels for leak-tight containers and wrapping shall have letters of sufficient size and contrast as to be readily visible and legible, and shall contain ~~the following~~all information~~, or~~ as specified by Occupational Safety and Health Standards of the Department of Labor, Occupational Safety and Health Administration (OSHA) under 29 CFR ~~1910.1001(j)(2) or 1926.58(k)(2)(iii),~~ ~~1926.1101(k)(7)(ii)(A) and 29 CFR 1926.1101(k)(7)(ii)(C)~~ 1926.1101(k)(8), or current Cal/OSHA requirements~~:~~.*

~~CAUTION~~

~~Contains Asbestos Fibers~~

~~Avoid Opening or Breaking Container~~

~~Breathing Asbestos is Hazardous to Your Health~~

~~Or~~

~~DANGER~~

~~CONTAINS ASBESTOS FIBERS~~

~~AVOID CREATING DUST~~

~~CANCER AND LUNG DISEASE HAZARD~~

(B) Leak-tight containers that are transported off-site shall be labeled with the name of the waste generator and the location at which the waste was generated. The location description shall include the street address. The label shall be clearly visible and readable from the outside of the container.

Paragraph (e)(2) – Active Waste Disposal Sites:

Staff proposes rule language revisions to paragraph (e)(2) and subparagraphs (e)(2)(B) and (D) to clarify the existing rule language. Subparagraph (e)(2) was revised to clarity that operation of an Active Waste Disposal Site must meet all of the provisions in subparagraphs (e)(2)(A) through (D). Subparagraph (e)(2)(B) was revised to spell out the word "centimeters". Subparagraph (e)(2)(D) was revised by including the number "2" after the word "two" to maintain rule clarity and consistency. The proposed changes are as follows:

(2) Active Waste Disposal Sites
No person shall operate an active waste disposal site unless warning signs are conspicuously posted and meet all of the following requirements:

(B) Conform to the requirements for 51 ~~cm~~ centimeters x 36 ~~cm~~ centimeters (20 inches x 14 inches) upright format signs specified in 29 CFR 1910.145 (d)(4) and this subparagraph;

(D) Have spacing between any two (2) lines at least equal to the height of the upper of the two (2) lines.

Paragraph (e)(3) – Warning Labels, Signs, and Markings/Transportation Vehicles:

Staff proposes rule language revisions to paragraph (e)(3) and subparagraphs (e)(3)(B) and (C) to clarify and maintain consistency in the existing rule language. Subparagraph (e)(3) was revised to clarity that operation of Transportation Vehicles must meet all of the provisions in subparagraphs (e)(3)(A) through (D). Subparagraph (e)(3)(B) was revised to spell out the word "centimeters" and properly cite "subparagraph." Subparagraph (e)(3)(C) was revised to properly cite "subparagraph." Subparagraph (e)(2)(D) was revised by including the number "2" after the word "two." The proposed changes are as follows:

(3) Transportation Vehicles
Markings for transportation vehicles shall meet all of the following requirements:

(B) Conform to the requirements for 51 ~~cm~~centimeters x 36 ~~cm~~ centimeters (20 inches x 14 inches) upright format signs specified in 29 CFR 1910.145(d)(4) and this subparagraph; ~~and~~

(C) Display the following legend in the lower panel with letter sizes and styles of a visibility at least equal to those specified in this subparagraph:

Legend	*Notation*
DANGER	*2.5 cm (1 inch) Sans Serif, Gothic or Block*
ASBESTOS DUST HAZARD	*2.5 cm (1 inch) Sans Serif, Gothic or Block*
CANCER AND LUNG DISEASE HAZARD	*1.9 cm (3/4 inch) Sans Serif, Gothic or Block*
Authorized Personnel Only	*14 Point Gothic*

; and

(D) *Have spacing between any two lines at least equal to the height of the upper of the two (2) lines.*

Subdivision (g) Recordkeeping

Staff proposes to include a new subparagraph, (g)(1)(G), which contains rule language clarifying specific records that shall be maintained in addition to the records specified in the existing rule language. This new rule language enhances compliance verification and enforcement pertaining to all contracted activity related to a renovation or demolition. The proposed subparagraph is as follows:

(G) A copy of all contracts the owner or operator has entered into for the performance of labor in a demolition or renovation activity or the related removal of waste.

Subdivision (h) Sampling Protocol and Test Methods

Staff is proposing to clarify existing sampling requirements and insert additional rule language which will assist the regulated community with understanding the sampling protocols of Rule 1403 that were not properly denoted within existing rule language. The proposals are shown as strikeout/underline rule language format.

Paragraph (h)(1) – Proposed Revised Language

In 1989, Rule 1403 was adopted by the SCAQMD governing board and the staff report accompanying those rule adoption proceedings explained that Rule 1403 would refer to 40 CFR 768.107 for the sampling protocol guidelines. In other words, an asbestos consultant was to refer to 40 CFR 768.107 and follow those guidelines for bulk sampling of materials that will be sent to a NVLAP certified laboratory to determine the asbestos content of suspected ACM. Rule 1403 (version adopted on 10/06/1989) stated in clause (d)(1)(C), "*Follow the provisions* *of 40 Code of Federal Regulations (CFR) 763.107 for bulk sampling friable material and paragraph (g) of this rule for the analytical procedure used to determine the presence and percentage of asbestos-containing material in the bulk sample."*

In 1994, Rule 1403 was amended and the rule language in clause (d)(1)(C) was moved to new paragraph (h)(1), but the language still referred to 40 CFR 763.107. Rule 1403 (version adopted on 04/08/1994) stated in paragraph (h)(1), *"Follow the provisions of 40 Code of Federal Regulations (CFR) 763.107 for bulk sampling friable material and paragraph (g) of this rule for the analytical procedure used to determine the presence and percentage of asbestos-containing material in the bulk sample."*

The rule language from this CFR is as follows:

<u>40 CFR 763.107 Sampling friable material</u>

(a) If friable materials are found in a school building local education agencies shall identify each distinct sampling area of friable materials within the school building take at least three samples from locations distributed throughout the sampling area and label each sample container with a sample identification number unique to the sampling location and building.

(b) Officials should consult "Asbestos Containing Materials in School Buildings: A Guidance Document" Part 1 Chapter 5 for further information on sampling procedures.

In 2006, Rule 1403 was amended and the rule language in paragraph (h)(1) changed the CFR reference from 40 CFR 763.107 to 40 CFR 763.86 and that remained the reference in the subsequent 2007 rule amendment. Rule 1403 (versions adopted on 11/03/2006 & 10/05/2007) stated in paragraph (h)(1), "*Sampling of materials suspected to contain asbestos, to comply with this rule, shall be conducted following the provisions of 40 CFR Part 763.86."*

The rule language from this CFR is as follows:

<u>40 CFR 763.86</u>

(a) Surfacing material. An accredited inspector shall collect, in a statistically random manner that is representative of the homogeneous area, bulk samples from each homogeneous area of friable surfacing material that is not assumed to be ACM, and shall collect the samples as follows:

(1) At least three bulk samples shall be collected from each homogeneous area that is 1,000 ft^2 or less, except as provided in § 763.87(c)(2).

(2) At least five bulk samples shall be collected from each homogeneous area that is greater than 1,000 ft^2 but less than or equal to 5,000 ft^2, except as provided in § 763.87(c)(2).

(3) At least seven bulk samples shall be collected from each homogeneous area that is greater than 5,000 ft^2, except as provided in § 763.87(c)(2).

(b) Thermal system insulation. (1) Except as provided in paragraphs (b) (2) through (4) of this section and § 763.87(c), an accredited inspector shall collect, in a randomly distributed

manner, at least three bulk samples from each homogeneous area of thermal system insulation that is not assumed to be ACM.

(2) Collect at least one bulk sample from each homogeneous area of patched thermal system insulation that is not assumed to be ACM if the patched section is less than 6 linear or square feet.

(3) In a manner sufficient to determine whether the material is ACM or not ACM, collect bulk samples from each insulated mechanical system that is not assumed to be ACM where cement or plaster is used on fittings such as tees, elbows, or valves, except as provided under § 763.87(c)(2).

(4) Bulk samples are not required to be collected from any homogeneous area where the accredited inspector has determined that the thermal system insulation is fiberglass, foam glass, rubber, or other non-ACBM.

(c) Miscellaneous material. In a manner sufficient to determine whether material is ACM or not ACM, an accredited inspector shall collect bulk samples from each homogeneous area of friable miscellaneous material that is not assumed to be ACM.

(d) Nonfriable suspected ACBM. If any homogeneous area of nonfriable suspected ACBM is not assumed to be ACM, then an accredited inspector shall collect, in a manner sufficient to determine whether the material is ACM or not ACM, bulk samples from the homogeneous area of nonfriable suspected ACBM that is not assumed to be ACM.

SCAQMD adopted Rule 1403 as a more stringent regulation than that the NESHAP (e.g. regulating both friable and non-friable materials) and the original rule language referred to 40 CFR 763.107; which required a minimum of three (3) samples of suspected ACM for analysis to determine asbestos content. SCAQMD staff has interpreted Rule 1403 sampling protocol to mean that a minimum number of bulk samples for all suspected ACM is three (3) - including friable and non-friable materials.

Additionally, the American Society for Testing and Materials (ASTM) has published an ASTM standard, ASTM E2356-14 “Standard Practice for Comprehensive Building Asbestos Surveys,” where it regularly recommends a minimum of three (3) samples to be obtained when sampling suspected ACM. Here are some citations from the ASTM:

6.1.4.1 Under this practice, a minimum of three bulk samples representative of each different homogeneous area of suspect material to be sampled shall be collected and analyzed to prove that the material sampled is not ACM.

6.4.6.2 A minimum of three bulk samples representative of each distinct homogeneous area of suspect thermal system insulation material (TSI) should be collected. One sample should be collected of each TSI patch. For the purpose of this practice, a patch is a distinct location or replacement or repair which is less than or equal to 6.0 ft (1.82 m) or 6.0 ft^2 ($0.557m^2$).

6.4.6.3 A minimum of *<u>three</u>* *bulk samples shall be collected of each homogeneous miscellaneous material, except that a single sample may suffice for small manufactured items such as HVAC vibration dampeners, gaskets and friction products. This exception applies to individual components of less than 6 ft^2 (0.557 m^2) in size and not to multiple installations of similar components.*

6.4.6.4 A minimum of *<u>three</u>* *bulk samples shall be collected of surfacing materials of less than 1000 ft^2 (93 m^2). A minimum of five bulk samples shall be collected of homogeneous surfacing materials ranging between 1000 to 5000 ft^2 (93 to 465 m^2) and a minimum of seven bulk samples shall be collected of surfacing material >5000 ft^2 (465 m^2).*

Staff seeks to clarify the sampling protocol by proposing a minimum number of samples for all suspected ACM and remove any uncertainty in Rule 1403 to better protect public health and safety. Staff proposes revisions to existing rule language in paragraph (h)(1) by removing unnecessary language and any reference to the CFR's. Staff proposes additions to existing rule language under paragraph (h)(1) with specific sampling protocols to clarify the minimum number of samples that must be obtained to comply with Rule 1403. The proposed rule language for paragraph (h)(1) is as follows:

(h)(1) Sampling of materials suspected to contain asbestos~~, to comply with this rule,~~ shall be conducted ~~following the provisions of 40 CFR Part 763.86~~ <u>as follows:</u>

<u>(A) Bulk samples shall be collected from each homogeneous area of friable surfacing material that is not assumed to be ACM as follows:</u>

<u>(i) A minimum of three samples shall be collected from each area of homogeneous material that is 1,000 square feet or less, except as provided in subparagraph (h)(1)(D);</u>

<u>(ii) A minimum of five samples shall be collected from each area of homogeneous material that is greater than 1,000 square feet but less than 5,000 square feet, except as provided in subparagraph (h)(1)(D); and,</u>

<u>(iii) A minimum of seven samples shall be collected from each area of homogeneous material that is greater than, or equal to, 5,000 square feet, except as provided in subparagraph (h)(1)(D).</u>

<u>(B) Bulk samples shall be collected from each homogeneous area of friable non-surfacing material that is not assumed to be ACM as follows:</u>

<u>(i) A minimum of three samples shall be collected from each homogeneous material; except as provided in subparagraph (h)(1)(D).</u>

(C) Bulk samples shall be collected from each homogeneous area of Class I and Class II non-friable material that is not assumed to be ACM as follows:

(i) A minimum of one sample shall be collected from each area of homogeneous material that is 16 square feet or less; and,

(ii) A minimum of three samples shall be collected from each area of homogeneous material that is greater than 16 square feet, except as provided in subparagraph (h)(1)(D).

(D) A homogeneous area shall be determined to be ACM based on a finding that the results of at least one sample collected from that area shows that asbestos is present in an amount greater than one percent (1.0%).

(E) A homogeneous area is considered not to contain ACM only if the results of all samples required to be collected from the area show asbestos in amounts of one percent (1.0%) or less, in accordance with subparagraphs (h)(1)(A) through (C);

(F) When composite sampling is performed of layered materials, analysis shall be performed in accordance with subparagraph (h)(2)(C).

Paragraph (h)(2) – Proposed Revised Language

Staff is proposing to clarify existing test method requirements and insert additional rule language which will assist the regulated community in understanding Rule 1403 and the required methods of analysis for determining asbestos content in bulk samples.

Rule 1403, as it is currently written, states:
"Analysis of materials for asbestos, to comply with this rule, shall be determined by using SCAQMD Method 300-91 as detailed in the District's Laboratory Methods of Analysis for Enforcement Samples manual, or by using the Method specified in Appendix A, Subpart F, 40 CFR Part 763, Section 1, Polarized Light Microscopy. Asbestos analyses performed to comply with this rule must be undertaken by laboratories accredited by the National Voluntary Laboratory Accreditation Program (NVLAP)."

Staff proposes revisions to existing rule language in paragraph (h)(2) to clarify approved test methods to determine asbestos content, remove obsolete language, and provide consistency with the NESHAP. "Appendix A, Subpart F, 40 CFR Part 763, Section 1, Polarized Light Microscopy" has since been moved to "40 CFR Part 763 Appendix E to Subpart E" and staff proposes revisions to paragraph (h)(2) and cite the proper CFR, and removing "SCAQMD Method 300-91;" which is a method that is not recognized by the EPA to determine asbestos content. Additionally, staff proposes a revision to paragraph (h)(2) with the addition of "EPA Method for the Determination of Asbestos in Bulk Building Materials (EPA/600/R93/116);"

which is the contemporary test method and guidelines for determining asbestos content. Either of these test methods, "40 CFR Part 763 Appendix E to Subpart E" or "EPA/600/R93/116" are acceptable methods to comply with Rule 1403. Staff is proposing these revisions to clarify the approved test methods, provide the most accurate results possible, and remain in-line with the NESHAP. The proposed rule language for paragraph (h)(2) is as follows:

> *(h)(2) Analysis of materials ~~for~~suspected to contain asbestos~~, to comply with this rule,~~ shall be determined ~~by using SCAQMD Method 300-91 as detailed in the District's Laboratory Methods of Analysis for Enforcement Samples manual, or~~ by using the Methods specified in ~~Appendix A, Subpart F, 40 CFR Part 763, Section 1~~ 40 CFR Part 763 Appendix E to Subpart E~~, or by using Polarized Light Microscopy (PLM)~~ or the EPA Method for the Determination of Asbestos in Bulk Building Materials (EPA/600/R-93/116). Asbestos analyses performed to comply with this rule ~~must~~shall be undertaken by laboratories accredited by the National Voluntary Laboratory Accreditation Program (NVLAP). ACM shall be determined as follows:*

Staff proposes additions to existing rule language in subparagraph (h)(2)(A) to provide clarification and guidance by stating that any sample that is analyzed with Polarized Light Microscopy (PLM) and determined to not contain asbestos does not have to be point counted, but a minimum of three (3) subsamples must be analyzed by PLM to verify that no asbestos is present. EPA provided guidance with the issuance of Applicability Determination Index, control number C-112 where it is stated *"It should be noted that samples in which no asbestos is detected during analysis by polarized light microscopy (PLM) do not have to be point counted. However, a minimum of three slide mounts should be prepared and examined in their entirety by PLM to determine if asbestos is present."* The proposed rule language for subparagraph (h)(2)(A) is as follows:

> *(A) A sample in which no asbestos is detected by Polarized Light Microscopy (PLM) does not have to be point counted. However, to confirm no asbestos was detected, survey reports shall document three (3) subsamples were prepared and examined in their entirety;*

Staff proposes additions to existing rule language in subparagraph (h)(2)(B) to provide clarification and guidance by stating any sample in which the amount of asbestos is determined to be under 10%, the facility owner may direct the asbestos consultant to presume or assume the sample to be ACM, or the owner/operator shall perform further testing to report the results more precisely. Currently, the NESHAP requires a test referred to as 400-point counting; which can produce results with accuracy down to a quarter (1/4) percent asbestos. Staff believes this change is necessary because, during the review of survey reports, the laboratory asserts that sample results contain "trace" amounts or "less than one percent (1.0%)" asbestos. However, they have only been analyzed using PLM and this test alone is not recognized as being accurate enough to determine if a sample is less than one percent (1.0%). PLM is a qualitative test method and while it has been utilized to determine the quantity of asbestos, it is not recognized as method accurate enough to determine very low percentages of asbestos content. Referring again to the EPA Applicability Determination Index, control number C-112, which states "If the amount by visual estimation appears to be less than 10 percent, the owner or operator may (1) assume the amount to be greater than 1 percent and treat the material as asbestos-containing material, or (2) require verification of the amount by *point counting*" (emphasis added). Furthermore, the Occupation Safety and Health Administration (OSHA) regulation 1910.1001 App J - Polarized Light Microscopy of Asbestos -- Non-Mandatory also states that one of the disadvantages of PLM is "significant bias in the low range especially near 1%. EPA tried to remedy this by requiring a mandatory *point counting* scheme for samples less than 10%" (emphasis added). The EPA and OSHA recognize that PLM, by itself, is not accurate enough to determine if a sample is greater than, or less than, one percent (1.0%) and the EPA's remedy to this deficiency is to require point counting for any sample that is less than ten percent (10%); which is not presumed or assumed to be greater than one percent (1.0%).

In addition, the regulated community may choose to use a more stringent test method; which may yield more accurate results. However, SCAQMD staff proposes point counting to harmonize with the NESHAP and better protect public health and safety. The option is available for the owner/operator choosing to assume or presume the material contains more than one percent (1.0%) and avoid this additional test. The proposed rule language for paragraph (h)(2)(B) is as follows:

> *(B) For a sample in which the amount of asbestos is detected and determined by PLM to be less than 10%, the facility owner or operator may direct the asbestos consultant to presume or assume the amount to be greater than one percent (1.0%) asbestos and treat the material as ACM, or the amount must be verified as follows:*
>
> > *(i) ACM content shall be determined by a minimum 400-point counting or a more stringent method including, but not limited to, 1,000-point counting, point counting with gravimetric reduction, or Transmission Electron Microscopy (TEM);*

Staff proposes additions to existing rule language in subparagraph (h)(2)(C) to provide clarification and guidance by stating composited samples must be separated and each layer must be analyzed individually. Composite samples are building material samples where there are separate materials contained within one sample; often referred to as layered samples (e.g. flooring with attached mastic/adhesive). EPA provides guidance on how to analyze layered samples instructing the laboratory to separate each material, or layer, and analyze each layer independently for asbestos content. In Federal Register document published at 60 Fed. Reg. 65243 (December 19, 1995), the EPA speaks about situations where one or more layers are present in building samples which may contain asbestos. EPA states, *"If the result of the composite analysis shows that the average content for the multi-layered system (across the layers) is greater than one percent, then the multi-layered system must be treated as asbestos-containing and analysis by layers is not necessary. <u>If the result of the composite sample analysis indicates that the multi-layered system as a whole contains asbestos in the amount of one percent or less, but greater than none detected, **then analysis by layers is required** to ensure that no layer in the system contains greater than one percent asbestos.</u> If any layer contains greater than one percent asbestos, that layer must be treated as asbestos containing. This will have the effect of requiring all layers in a multi-layered system to be treated as asbestos containing if the layers cannot be separated without disturbing the asbestos-containing layer. Once any one layer is shown to have greater than one percent asbestos, further analysis of the other layers is not necessary if all the layers will be treated as asbestos containing."*

Staff recognizes that the EPA excludes wall systems as stated earlier in this FR document, *"This clarification basically stated that all multi-layered systems <u>**except for wall systems where joint compound was used only at the joints and nail holes**</u> must be analyzed as separate materials, and results were not allowed to be combined to determine average asbestos content (continuing the policy that dilution of an asbestos-containing material is not allowed)."* In essence the EPA does not require analysis of each layer of material within a wall system. EPA allows for the wall system (wallboard, joint compound, and tape) to be homogenized into one material (e.g. blended together) and analyzed as one (1) material; which is referred to as composited analysis. It is common knowledge within industry that the majority of asbestos will be contained within the joint compound and when composited together with the wallboard and tape that this will ultimately dilute the sample. After diluted, this sample will be analyzed and the probable result will be less than one-percent (1.0%). Staff believes that the extent with which joint compound is used to cover only wallboard joints and nail holes is not detectable underneath painted surfaces and contends that the use of joint compound to finish wall systems, even to simply cover the joints and nails holes, is extensive. When joint compound is used as an add-on material for skim coating a wall system or texturizing a wall, the EPA does not allow for composited analysis. Figures 1, 2 and 3 show examples of unfinished wall systems demonstrating the broad use of joint compound to finish a wall system:

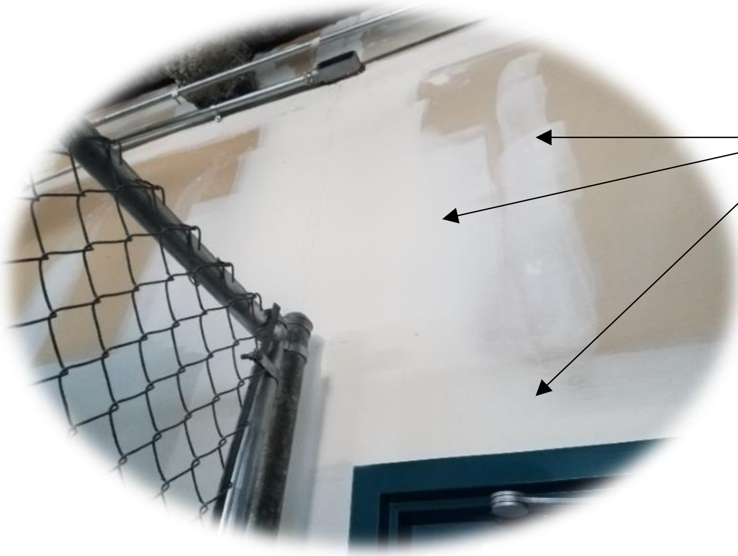


Figure 1: Photo of an unfinished wall system with widespread application of joint compound to cover wallboard joints. In this scenario the joint compound would be categorized as covering wallboard joints and nail holes. If this joint compound contained two-percent (2%) asbestos, but the composited analysis of this multi-layered system was less than one-percent (1%), then it would not be subject to Rule 1403 and could be removed without controls.

Figure 2: Photo of the application of joint compound to cover nail holes, but demonstrating that compound isn't covering small nail holes, but applied much more liberally.

Figure 3: Photo of a partially painted wall system with paint (right side) covering joint compound and concealing where it was applied to the wall system

As demonstrated in Figures 1, 2, and 3, the use of joint compound can be applied in such a way as to almost be a skim coat and the extent of its use is not quantifiable underneath a painted surface. Due to the difficulty of determining the extent of joint compound use and the prevalence of joint compound that contains greater than two percent (2%) asbestos, staff believes that there could still be a risk of asbestos contamination resulting from the disturbance of wall systems that have an asbestos content less than one percent (1%) by composite analysis. As such, all wall systems must be renovated (abated) in compliance with Rule 1403 if any part of the wall system (wallboard, joint compound, or joint tape) as analyzed separately has an asbestos content greater than one percent (1.0%). This position is not a change in implementation of Rule 1403. So far in 2018, our compliance staff has received 3,700 notifications for wallboard renovation or demolition projects that total up to 7,500,000 square feet of wall systems.

Staff proposes additions to existing rule language in subparagraph (h)(2)(C) to provide clarification and guidance that all composite samples of multi-layered systems shall be separated by layers, analyzed individually, and reported independently. Nothing within this proposal prohibits the analysis for composited samples, but for purposes of complying with Rule 1403, and the removal of wall systems, all separable layers must be analyzed and reported separately for asbestos content. If any layer shows the results greater than one-percent (1.0%), then it must be removed in accordance with Rule 1403. The proposed rule language for paragraph (h)(2)(C) is as follows:

> *(C) The analysis of composite samples of multi-layered material including, but not limited to, stucco (base and scratch coat) and wall systems is prohibited for the quantification of asbestos content. All separable layers shall be analyzed and reported separately for asbestos content;*

Staff proposes the addition to existing rule language in subparagraph (h)(2)(D) to provide clarification that if any single sample that is analyzed and shown to be ACM, then the subsequent samples need not be analyzed. Commonly referred to as “stop at the first positive,” staff proposes to formalize this with rule language. The proposed rule language for paragraph (h)(2)(D) is as follows:

> *(D) If any analysis is performed which shows a single sample greater than one percent (1.0%) ACM, then an asbestos consultant may forego analysis of subsequent samples and presume or assume subsequent samples are greater than one percent (1.0%) ACM.*

Subdivision (i) Training Requirements

Staff is proposing to clarify rule language with minor corrections. These revised training requirements are shown in strikeout/underline rule language format.

Paragraph (i)(1) – Proposed New Language

Staff proposes changing "supervisory personnel" to "Supervisors," a defined term in Subdivision (c) – Definitions, and the person who shall obtain and maintain AHERA accreditation. In addition, staff proposes to use the acronym "AHERA" for Asbestos Hazard Emergency Response Act. The proposed rule language for subparagraph (i)(1)(A) is as follows:

> *(~~1~~A) On-site ~~supervisory personnel~~ Supervisors shall successfully complete the Asbestos Abatement Contractor/Supervisor course pursuant to the ~~Asbestos Hazard Emergency Response Act (~~AHERA~~)~~, and obtain and maintain accreditation as an AHERA Asbestos Abatement Contractor/Supervisor.*

Paragraph (i)(3) – Proposed New Language

Staff proposes changing "supervisory personnel" to "Supervisors," a defined term in Subdivision (c) – Definitions, and one of the persons who shall maintain proper training. Staff proposes changing "on" the provisions of this rule to "in accordance with" the provisions of this rule. In addition, staff proposes proper citation of the CFR in reference. The proposed rule language for subparagraph (i)(1)(C) is as follows:

> *(~~3~~C) ~~Supervisory personnel~~ Supervisors and workers shall be trained ~~on~~ in accordance with the provisions of this rule as well as on the provisions of 40 CFR Parts 61.145, 61.146, 61.147 and 61.152 (Asbestos NESHAP provisions) and Part ~~763~~40 CFR Part 763, Subpart E, and the means by which to comply with these provisions.*

Subdivision (j) Exemptions

Staff proposes to add two (2) new exemptions and revise eight (8) existing exemptions in the proposed amended rule language to provide clarity of existing exemptions. These new and revised exemptions are shown in strikeout/underline rule language format.

New exemptions in Proposed Amended Rule 1403

Paragraph (j)(1) - Proposed New Language

Staff proposes to add an exemption from paragraph (d)(1) in the event of an extreme emergency that poses and immediate risk to injury or death, that the owner/operator may address the emergency without notifying District in the event suspected ACM is damaged and/or disturbed. Once the hazard has been addressed and the threat has been eliminated, then the activity should stop and the site evaluated for the presence of ACM. The proposed language in paragraph (j)(1) is as follows:

(1) The requirements of paragraph (d)(1) shall not apply to a hazardous situation that poses an immediate risk of injury or death. Once the immediate hazard has been addressed, then activity must stop, and the site must be secured, stabilized, and surveyed for the presence and condition of asbestos-containing and asbestos-contaminated materials. If asbestos-containing materials have been disturbed or damaged as a result of, or as part of the response to, the hazardous situation, a Procedure 4 or 5 (Approved Alternative) clean-up plan must be submitted by the end of the next business day and approved prior to any asbestos clean-up. Written explanation of the hazard and hazard response must be submitted to the District along with the Procedure 4 or 5 clean-up plan.

Paragraph (j)(11) - Proposed New Language

Staff proposes to add an exemption from the electronic notification requirements under subparagraph (d)(1)(B). Staff proposes new rule language that will not require electronic notification by an owner-occupant of a residential single-unit dwelling, as defined in subdivision (c), who personally conducts a demolition activity at that dwelling. Paper notifications will be allowed for these projects. The proposed language in paragraph (d)(11) is as follows:

(11) The District-approved electronic notification requirements of subparagraph (d)(1)(B) shall not apply to an owner-occupant of a residential single-unit dwelling, as defined in subdivision (c), who personally conducts a demolition activity at that dwelling. Notification shall be submitted by paper only.

Revisions to exemptions in Proposed Amended Rule 1403

Paragraph (j)(1) – Proposed Revised Language

Staff proposes to change the paragraph number to (j)(2) as deemed appropriate and clarify that the requirements of subparagraph (d)(1)(B) still apply to Procedures 4 and 5, even if less than 100 square feet of surface are of ACM are removed. Procedures 4 and 5 pertain to damaged or disturbed ACM and there are not exemptions based upon square footage. Staff also proposes to capitalize "Planned Renovation" and "Nonscheduled Renovation Operations" since these are considered titles. The proposed rule language in paragraph (d)(2) is as follows:

(~~1~~2) The notification requirements of subparagraph (d)(1)(B) and the training requirements of subdivision (i) shall not apply to renovation activities, other than Procedures 4 and 5, or ~~p~~Planned ~~r~~Renovation activities which involve ~~n~~Nonscheduled ~~r~~Renovation ~~o~~Operations, in which less than 100 square feet of surface area of ACM are removed or stripped.

Paragraph (j)(2) – Proposed Revised Language

Staff proposes to change the paragraph number to (j)(3) as deemed appropriate and change the rule language and capitalize “Planned Renovation” and “Nonscheduled Renovation Operations” since these are considered titles. The proposed rule language in paragraph (d)(3) is as follows:

> (~~2~~3) *The notification requirements of subparagraph (d)(1)(B) and the training requirements of subdivision (i) shall not apply to ~~p~~Planned ~~r~~Renovation activities which involve ~~n~~Nonscheduled ~~r~~Renovation ~~o~~Operations, in which the total quantity of ACM to be removed or stripped within each calendar year of activity is less than 100 square feet of surface area.*

Paragraph (j)(3) – Proposed Revised Language

Staff proposes to change the paragraph number to (j)(4) as deemed appropriate and clarify that the requirements of subclauses (d)(1)(A)(iii)(IV) through (IX) and subclause (d)(1)(B)(ii)(XV), which pertain to survey information, are not required when suspected material is treated as ACM and removed appropriately. Staff also proposes rule language requiring an asbestos consultant to state in an asbestos survey report that the material is presumed or assumed to be ACM. The proposed rule language paragraph (j)(4) is as follows:

> (~~3~~4) *For asbestos survey reports where the material is presumed or assumed to be ACM by the asbestos consultant, ~~Clauses~~ subclauses (d)(1)(A)(iii)(IV) through (IX) and ~~subclause~~ (d)(1)(B)(ii)(XV) shall not apply ~~to the owner or operator of any renovation or demolition activity~~, when the suspected material is treated as ACM when being removed, stripped, collected, handled, and disposed of in accordance with the provisions of this rule. The asbestos consultant shall state in the asbestos survey that the material is presumed or assumed to be ACM.*

Paragraph (j)(4) – Proposed Revised Language

Staff proposes to change the paragraph number to (j)(5) as deemed appropriate and clarify that the requirements of clauses (d)(1)(A)(iv), which pertain to licensing of the asbestos consultant, are not required when less than 100 square feet of surface area of ACM are removed. Labor Code, Section 6501.5 specifically refers to asbestos work that is greater than 100 square feet so, for the purpose of simplification, staff has removed this reference to the Labor Code. The proposed rule language in paragraph (j)(5) is as follows:

> (~~4~~5) *The portion of clause (d)(1)(A)(iv) or (v) which requires Cal/OSHA certification shall not apply to persons performing work ~~not subject to the certification requirement established by regulations pursuant to the Labor Code, Section 6501.5~~ in which less than 100 square feet of surface area of ACM are removed or stripped.*

Paragraph (j)(6) – Proposed Revised Language

Staff proposes to change the paragraph number to (j)(7) as deemed appropriate and clarify that the requirements of clauses (d)(1)(A)(iv), which pertain to Cal/OSHA registration, are not required when less than 100 square feet of surface area of ACM are removed. Labor Code, Section 6501.5 specifically refers to asbestos work that is greater than 100 square feet so, for the purpose of simplification, staff has removed this reference to the Labor Code. The proposed rule language in paragraph (j)(7) is as follows:

> *(~~6~~7) Subclause (d)(1)(B)(ii)(XII) and clause (d)(1)(H)(ii), requiring Cal/OSHA registration, shall not apply to persons performing work ~~not subject to the registration requirement established pursuant to the Labor Code, Section 6501.5~~ in which less than 100 square feet of surface area of ACM is removed or stripped.*

Paragraph (j)(8) – Proposed Revised Language

Staff proposes to change the paragraph number to (j)(9) as deemed appropriate and change the word "phrase" to "item" which is the proper rule order citation. In addition, staff proposes to add scraping to the prohibited methods of removal in order to qualify for this exemption. The proposed rule language in paragraph (j)(9) is as follows:

> *(~~8~~9) The handling requirements of ~~phrases~~items (d)(1)(D)(i)(I)(2), (d)(1)(D)(i)(I)(5), and (d)(1)(D)(i)(I)(6), the training requirements of paragraphs (i)(1) and (i)(2), the reporting of training certificate requirement of subclause (d)(1)(B)(ii)(XVI), and the on-site proof of training requirement of subparagraph (d)(1)(G) and subdivision (i) shall not apply to the exclusive removal of asbestos-containing packings, gaskets, resilient floor covering and asphalt roofing products which are not friable, have not become friable, and have not been subjected to scraping, sanding, grinding, cutting, or abrading.*

Paragraph (j)(9) – Proposed Revised Language

Staff proposes to change the paragraph number to (j)(10) as deemed appropriate and clarify who may qualify as an owner-occupant and use this exemption to avoid complying with the provisions of Rule 1403. Staff proposes adding a reference to the definition of a residential single-unit dwelling, and clarifying that the owner-operator must reside at the property and solely and personally conduct the renovation. The proposed rule language in paragraph (j)(10) is as follows:

> *(~~9~~10) The provisions of this rule shall not apply to an owner-occupant, as defined in paragraph (c)(33), of a residential single-unit dwelling, as defined in paragraph (c)(40), who resides at the property and solely and personally conducts a renovation activity at that dwelling.*

Paragraph (j)(11) – Proposed Revised Language

Staff proposes to change the paragraph number to (j)(12) as deemed appropriate, and clarify this exemption by adding a reference to the definition of a residential single-unit dwelling. The proposed rule language is as follows:

> *(~~10~~12) The survey requirements of subparagraph (d)(1)(A) shall not apply to renovation activities of residential single-unit dwellings, as defined in paragraph (c)(40), in which less than 100 square feet of surface area of ACM are removed or stripped.*

RULE 1403 – ASBESTOS EMISSIONS FROM RENOVATION/DEMOLITION ACTIVITIES

CHAPTER 3: KEY ISSUES OF PROPOSED AMENDED RULE 1403

- SUMMARY OF KEY ISSUES
- KEY ISSUES CONCERNING THE ENFORCEMENT OF RULE 1403
- KEY ISSUES FOR THE REGULATED COMMUNITY

SUMMARY OF KEY ISSUES

Staff has conducted five (5) Working Group Meetings (WGM's) to gather information from stakeholders and present the position for amending Rule 1403 – Asbestos Emissions from Demolition/Renovation Activities.

The first two meetings were organized to present basic information about the health effects from asbestos exposure, common areas of exposure to asbestos, current rule requirements, and some common issues that District compliance staff has encountered while enforcing Rule 1403. The goal was to work with stakeholders to find areas of agreement, smooth out some of the areas of contention, and find common ground to move forward with the amendment process.

During WGM's #3 and #4, staff presented draft rule language to the stakeholders in order to garner early feedback on the initial proposals and continue ongoing discussions. The plan to release draft rule language facilitated a lot of feedback and some of the rule language has undergone more than a few changes. Staff has summarized key issues and how the rule language addresses, if possible, these subjects. Staff has also committed resources to develop an enhanced frequently asked questions (FAQ) document. These FAQ's will assist the regulated community in addressing many compliance questions which were not spoken to with any particular proposed rule revision.

Key issues concerning the enforcement of Rule 1403

The common issues encountered by District staff which have resulted in proposed amendments to Rule 1403 are as follows:

- Incomplete on-site sampling of suspected ACM including, but not limited to, inadequate number of samples
- Incomplete survey reports lacking basic information including, but not limited to, sampling information, asbestos consultant information, and site diagrams
- Uncertainty with lab results including, but not limited to, improper analysis (determination of less than 1.0% asbestos without proper test method), compositing or combining materials for analysis leading to diluted results, and inadequate chain of custody
- Improper use of Emergency Notifications to start projects without delay when Rule 1403 and the NESHAP require a 10 business day (14 calendar days) notification period to allow for inspection scheduling
- Notifications lacking necessary information including, but not limited to, OSHA and Department of Toxic Substance Control (DTSC) registration numbers, asbestos consultant information, training certificates, site owners, and on-site personnel
- Inadequate recordkeeping and the lack of availability of on-site records

With the proposed rule language, staff has addressed many of these concerns while removing ambiguity that has led to a misunderstanding between District staff and the regulated community. While there are other proposed changes in the rule language, this is simply a summary of the key issues encountered by our compliance staff.

Incomplete on-site sampling of suspected ACM

Staff has proposed language in paragraph (h)(1) to address sampling requirements. Staff has clarified the number of samples required for homogeneous material and set minimum quantities based upon surface area of material. While the regulated community may contend that the sampling protocol is too burdensome or impractical, District staff asserts that these minimum standards are consistent with current EPA guidance and necessary to assure that ACM is uncovered in efforts to further protect public health and safety.

Incomplete survey reports

Staff has proposed language in clauses (d)(1)(A)(i) through (v) which will close some of the uncertainty with what information is required when inspecting, surveying, sampling, and assessing the presence of asbestos within a facility. Staff provides clarification in the rule language that a certified asbestos consultant must perform the survey, and spells out more clearly what types of information shall be included with a survey report.

Uncertainty with lab results

Staff has proposed rule language in paragraph (h)(2) to address the test method that must be utilized to quantify and determine accurately the asbestos content of a sample. If any sample is analyzed at trace levels, or less than 1.0%, with PLM, then proposed rule language will require 400-point counting, at the minimum, to verify the asbestos content. This language is not a novel idea, but is supported by EPA documents and guidance. While the regulated community may find the approach as onerous, this method is in-line with the NESHAP. Additionally, nothing precludes the regulated community from performing other methods proven to be as accurate, if not more so, then 400-point counting. There is, also, nothing to prohibit the regulated community from assuming or presuming any material is asbestos containing and avoid these testing procedures; which is addressed with an exemption in paragraph (j)(4). Staff has proposed additional rule language in subparagraph (h)(2)(D) to clarify that the regulated community may stop the analysis of subsequent bulk samples if the first sample bares a positive result of asbestos greater than 1.0%.

Improper use of Emergency Notifications

Staff has proposed rule language in subclause (d)(1)(B)(iv)(V) which will require either that the owner and the contractor sign the emergency declaration letter or the owner must have the emergency letter notarized to verify the identity of the signer. Staff proposes this rule language because, at times, the emergency letter is being used to bypass the 10 working day waiting period. Emergency letters have been submitted fraudulently and even signed by persons other than the owner/operator of the facility. Additionally, staff proposes language that the letter must contain a legal disclaimer stating that the person signing the documents is signifying that the information contained within is true and correct.

Notifications lacking necessary information

Staff has proposed rule language with revisions in subclauses (d)(1)(B)(ii)(I) through (XVI) and the addition of subclauses (d)(1)(B)(ii)(XVII) through (XVIV) to clarify precisely the information that shall be required with the Notification.

Inadequate recordkeeping and the lack of availability of on-site records

Staff has proposed rule language with revisions in clauses (d)(1)(H)(i) through (iv) and the addition of clauses (d)(1)(H)(v) through (vii) to clarify precisely the information that shall be required for on-site records.

Key issues from the regulated community

During the five (5) WGM's with stakeholders, many concerns were raised about the proposed amendments to Rule 1403. As mentioned previously, staff addressed many of the concerns through the FAQ document; which includes answers to compliance questions that are not addressed by the rule amendment. Many of the topics discussed were more about a misunderstanding, rather than a mandate to revise the rule. Below is a list of the key issues from the regulated community:

- The proposed amendments are going to require unnecessary sampling
- The NESHAP allows for composite analysis of wall systems; which Rule 1403 will disallow
- Previous management and enforcement of Rule 1403 allowed for shorter notification periods for essential public services (water, electricity, and gas)
- Whenever there is a change to the start date, end date, or the quantity of asbestos abated, the system charges a fee; which seems excessive
- Emergency notifications are denied because staff doesn't believe it is truly an emergency
- The proposed amendments do not allow for AHERA trained building inspectors to perform surveys at their place of employment; which is allowed by Cal/OSHA
- Previous surveys will become invalidated when the proposed rule language is adopted
- Requiring three (3) samples for very small areas is impractical
- The start date and end dates for a project are ambiguous and should be clarified

With the proposed rule language, staff has addressed many of these concerns, and removed ambiguity. Many more questions have been addressed and answered in the FAQ's. While there are other proposed changes in the rule language, the following is a summary of the key issues brought up by the regulated community and addressed by staff.

<u>The proposed amendments are going to require unnecessary sampling</u>

Staff stands by the sampling protocol and the proposed rule language to require a minimum number of samples based upon square footage. Rule 1403 was adopted in 1989 with the inclusion of friable and non-friable materials as regulated ACM. As stated earlier in this report, the American Society for Testing and Materials (ASTM) has published an ASTM standard, ASTM E2356-14 "Standard Practice for Comprehensive Building Asbestos Surveys," where it recommends a minimum of three (3) samples to be obtained when sampling suspected ACM. Sections 6.1.4, 6.4.6.2, 6.4.6.3, and 6.4.6.4 consider <u>three</u> (3) bulk samples as the minimum standard for sampling of suspected ACM.

<u>Previous management and enforcement of Rule 1403 allowed for shorter notification periods for essential public services (water, electricity, and gas)</u>

Rule 1403 subclause (d)(1)(B)(i)(I) requires that a notification shall be submitted to the District no later than 10 working days (14 calendar days) before any demolition or renovation activities other than emergency demolition, emergency renovation, planned renovations involving individual Nonscheduled Renovation Operations begin. Current staff is unaware of any practices by previous management, but both the NESHAP and Rule 1403 require this notification period to have opportunity for enforcement officials to perform inspections as time allows. We are unable to be less stringent than the NESHAP in establishing requirements for renovation/demolition activities involving asbestos.

Staff has proposed new language to define an Emergency Renovation as "any renovation that was not planned and results from <u>an imminent threat to public health and safety,</u> a sudden unexpected event that results in unsafe conditions<u>, or encountering previously unknown ACM during demolition or excavation</u>." Staff will consider waiving the 10-day notification period if the situation meets any of these three (3) conditions independently from one another. Staff, also, considers any situation that may result in injury or death, and must be corrected ASAP, as something that a facility does not need to pause for notification. After the immediate threat is contained, the owner/operator shall secure, stabilize and survey the affected facility areas and submit and obtain an approved Procedure 5 plan, prior to any asbestos clean-up. Proposed Amended Rule 1403 language will be included to clarify that these steps (secure, stabilize, and survey) are also required for disturbed suspect ACM resulting from a sudden unexpected event.

If disturbed or damaged Asbestos-Containing Material (ACM) is in the public right-of-way and cannot be adequately secured and stabilized, this is considered an immediate threat to public health and safety, and the abatement contractor responsible for the clean-up should call the Asbestos Hotline at (909) 396-2336 (during SCAQMD regular business hours [Tuesday through Friday, 7 AM to 5:30 PM]) or 1-800-CUT-SMOG (after regular SCAQMD hours), and request to speak to an asbestos supervisor to immediately review a Procedure 5 notification.

The NESHAP allows for composite analysis of wall systems, but Rule 1403 will prohibit

Staff stands by the understanding that Rule 1403 currently requires analysis of each individual layer of a wall system and is attempting to clarify this position with the proposed rule language to remove all ambiguity. Currently Rule 1403 clause (d)(1)(A)(i) states that *"The survey shall include the inspection, identification, and quantification of all friable, and Class I and Class II non-friable asbestos-containing material, and any physical sampling of materials."* By utilizing composite analysis of any bulk sample, the result would not meet the intention of the currently written rule. Combining materials for analysis, which is by definition a composited analysis, would not identify and/or quantify all homogeneous friable and Class I and Class II non-friable ACM. We also note that at least one other jurisdiction, the Texas Department of Health Services, does not allow for the analysis of composited samples for wall systems for purposes of abatement in public buildings. Finally, in their Construction Standard for Asbestos, OSHA explicitly does not allow for composite analysis of wall systems, citing the potential risk of asbestos exposure to joint compound even though it is a relatively small portion of the wall system.

When the invisible asbestos fibers are inhaled, they can remain in the lungs for a long time, increasing the risk for severe health problems such as lung cancer, mesothelioma, and asbestosis (Cannizzo, J.V. (2004). Asbestos: a legal primer for Air Force installation attorneys. Air Force Law Review, 54, 39-64). Suspected ACM in construction materials such as wallboard systems, had, at one time, affected nearly 1.3 million people in the construction industry (United States Department of Labor. OSHA Fact Sheet. Asbestos. DEP FS-3507. 01/2014 and United States Department of Labor. Fact Sheet No. OSHA 92-06. Better Protection against Asbestos in the Workplace). Death certificates of drywall construction workers have been found to indicate mesothelioma and excess lung cancer deaths (Boelter, Xia, & Dell, 2014, p. 860). Staff understands that the use of joint compound containing greater than two percent (2%) asbestos was widespread in the industry, and that in many cases is used in a way more approximating a skim coat than merely to cover taping joints and nail holes. With today's active construction industry, activities related to renovation and demolition are expected to increase proportionally, and, as a consequence, exposure to asbestos from the disturbance, or removal, of ACM is expected to rise in turn. Therefore, SCAQMD staff recognizes and considers wallboard systems a significant potential asbestos source warranting regulation under the provisions of Rule 1403.

Whenever there is a change to the start date, end date, or the quantity of asbestos abated, the system charges a fee; which seems excessive

Fee rules and policies are set through SCAQMD Rule 301 – Permitting and Associated Fees and cannot be addressed by an amendment to Rule 1403. Staff recognizes this is a valid concern and will work with the rule developers when Rule 301 is opened for amendments and put forward the regulated communities concerns about the fees.

Emergency notifications are denied because staff doesn't believe it is truly an emergency

Staff has proposed new language to define an Emergency Renovation as "any renovation that was not planned and results from an imminent threat to public health and safety, a sudden unexpected event that results in unsafe conditions, or encountering previously unknown ACM during demolition or excavation." Staff will consider waiving the 10-day notification period if the situation meets any of these three (3) conditions independently from one another. Staff believes this additional rule language will help alleviate some concerns where previous emergencies did not meet the definition; which required a sudden and unexpected event to occur along with imminent threat to public health and safety.

The proposed amendments do not allow for AHERA trained building inspectors to perform surveys at their place of employment; which is allowed by Cal/OSHA

Staff has contacted Cal/OSHA and clarified that employees may perform inspections, surveys, and obtain samples if they possess a current and valid certificate from a Cal/OSHA approved AHERA building inspector training course. Staff has proposed new rule language in clause (d)(1)(A)(v) to correct this omission.

Previous surveys will become invalidated when the proposed rule language is adopted

Previous surveys will not become invalidated if the governing adopts the proposed rule language. However, previous survey reports that show sample results which are less than 1.0% must have been point counted and the minimum number of three (3) samples must have been analyzed to be validated as a proper survey under the current rule language.

Requiring three (3) samples for very small areas is impractical

Staff is proposing new rule language for small areas of Class I & Class II non-friable materials. Staff has proposed new rule language in subparagraph (h)(1)(A) that only one (1) sample will be required for each homogeneous area that is less than 16 square feet of Class I or Class II non-friable suspected ACM.

The start date and end dates for a project are ambiguous and should be clarified

Staff has proposed new rule language to address this ambiguity. The start date and end dates will have clear descriptions within Subdivision (c) – definitions.

RULE 1403 – ASBESTOS EMISSIONS FROM RENOVATION/DEMOLITION ACTIVITIES

CHAPTER 4: IMPACT ASSESSMENT OF PROPOSED AMENDED RULE 1403

- EMISSION IMPACT ASSESSMENT
- COST ANALYSIS
- INCREMENTAL COST EFFECTIVENESS
- CALIFORNIA ENVIRONMENTAL QUALITY ACT
- SOCIOECONOMIC ASSESSMENT
- COMPARATIVE ANALYSIS
- DRAFT CONCLUSIONS AND RECOMMEDATIONS

EMISSION IMPACT ASSESSMENT

Staff does not anticipate any real quantifiable emission reductions or increases, since the proposed amendment seeks to align Rule 1403 with the NESHAP, other California APCDs/AQMDs, and District prior practices, will not lead to major changes in operations, and thus will be administrative in nature.

COST ANALYSIS

The proposed amendment to Rule 1403 is not expected to have a net cost impact, since industry will be able to continue business as usual and operate in a similar manner to the current rule. Staff determined that any additional cost to surveys and/or increased sampling may be offset by deciding more frequently to presume or assume the presence of asbestos and not accruing the laboratory expense of analysis. Additionally, staff has proposed language to clarify that lab analyses may cease after the first positive result which indicates a sample is ACM. Therefore, the cost burden is not substantial and the associated costs are expected to be minimal.

INCREMENTAL COST-EFFECTIVENESS

Proposed Amended Rule 1403 will not result in emission reductions and therefore no incremental cost analysis is required under Health and Safety Code § 40920.6.

CALIFORNIA ENVIRONMENTAL QUALITY ACT

Staff has reviewed the proposed project pursuant to California Environmental Quality Act (CEQA) Guidelines §15002(k)(1) and has concluded that the proposed project is administrative in nature because it merely involves clarifying rule language to reflect existing practice, which does not create any new adverse impacts to the environment. Therefore, it can be seen with certainty that there is no possibility that the proposed project may have a significant effect on the environment and, therefore, is exempt from CEQA pursuant to CEQA Guidelines §15061(b)(3). Upon approval of the proposed project, a notice of exemption will be prepared pursuant to CEQA Guidelines §15062 and sent for posting to the county clerks in the four counties within the jurisdiction of the SCAQMD.

SOCIOECONOMIC ASSESSMENT

No socioeconomic impact assessment was performed for the proposed amendments, because the proposed amendments are administrative in nature and will not significantly affect air quality or emissions limitations.

COMPARATIVE ANALYSIS

No comparative analysis is necessary. Health and Safety Code § 40727.2 states that a comparative analysis is not required if the proposed amended rule "….does not impose a new emission limit or standard."

DRAFT CONCLUSIONS AND RECOMMENDATIONS

Staff recommends Rule 1403 – Asbestos Emissions from Renovation/Demolition Activities be amended as proposed.

RULE 1403 – ASBESTOS EMISSIONS FROM RENOVATION/DEMOLITION ACTIVITIES

CHAPTER 5: PUBLIC COMMENTS

PUBLIC COMMENTS AND RESPONSES

Public comments and staff responses will be addressed following the Public Workshop.

RULE 1403 – ASBESTOS EMISSIONS FROM RENOVATION/DEMOLITION ACTIVITIES

APPENDIX - REFERENCES

- Appendix J TO § 1910.1001 - Polarized Light Microscopy of Asbestos
- Asbestos NESHAP - 40 CFR Subpart M
- Asbestos-Containing Materials in Schools (AHERA) - 40 CFR Part 763, Subpart E
- Attachment H from the 1989 Rule 1403 Staff Report: Referencing 40 CFR section 768.107 for sampling protocol
- EPA Test Method EPA/600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials
- Federal Register Document 95–30797: Asbestos NESHAP Clarification Regarding Analysis of Multi-Layered Systems
- Interim Method of the Determination of Asbestos in Bulk Insulation Samples - 40 CFR Appendix E to Subpart E of Part 763
- OSHA Standards Interpretation 1926.1101: Potential for Legal/Compliance Problems with OSHA's Asbestos Standards dated November 5, 1996
- Texas Department of State Health Services: Analysis of Joint Compound for Asbestos Content
- US-EPA Applicability Determination Index Control No. C-112: Point Counting dated May 8, 1991
- US-EPA: Report No. 15-P-0168: EPA Should Update Guidance to Address the Release of Potentially Harmful Quantities of Asbestos That Can Occur Under EPA's Asbestos Demolition Standard

Appendix J TO § 1910.1001 - Polarized Light Microscopy of Asbestos telephone directory for listings of local chapters.

APPENDIX J TO §1910.1001—POLARIZED LIGHT MICROSCOPY OF ASBESTOS—NON-MANDATORY

Method number: ID–191
Matrix: Bulk

Collection Procedure

Collect approximately 1 to 2 grams of each type of material and place into separate 20 mL scintillation vials.

Analytical Procedure

A portion of each separate phase is analyzed by gross examination, phase-polar examination, and central stop dispersion microscopy.

Commercial manufacturers and products mentioned in this method are for descriptive use only and do not constitute endorsements by USDOL–OSHA. Similar products from other sources may be substituted.

1. Introduction

This method describes the collection and analysis of asbestos bulk materials by light microscopy techniques including phase-polar illumination and central-stop dispersion microscopy. Some terms unique to asbestos analysis are defined below:

Amphibole: A family of minerals whose crystals are formed by long, thin units which have two thin ribbons of double chain silicate with a brucite ribbon in between. The shape of each unit is similar to an ‘‘I beam’’. Minerals important in asbestos analysis include cummingtonite-grunerite, crocidolite, tremolite-actinolite and anthophyllite.

Asbestos: A term for naturally occurring fibrous minerals. Asbestos includes chrysotile, cummingtonite-grunerite asbestos (amosite), anthophyllite asbestos, tremolite asbestos, crocidolite, actinolite asbestos and any of these minerals which have been chemically treated or altered. The precise chemical formulation of each species varies with the location from which it was mined. Nominal compositions are listed:

Chrysotile	$Mg_3\ Si_2\ O_5(OH)_4$
Crocidolite (Riebeckite asbestos)	$Na_2\ Fe_3^{2+}\ Fe_2^{3+}\ Si_8\ O_{22}(OH)_2$
Cummingtonite-Grunerite asbestos (Amosite)	$(Mg,Fe)_7\ Si_8\ O_{22}(OH)_2$
Tremolite-Actinolite asbestos	$Ca_2(Mg,Fe)_5\ Si_8\ O_{22}(OH)_2$
Anthophyllite asbestos	$(Mg,Fe)_7\ Si_8\ O_{22}(OH)_2$

Asbestos Fiber: A fiber of asbestos meeting the criteria for a fiber. (See section 3.5.)

Aspect Ratio: The ratio of the length of a fiber to its diameter usually defined as ‘‘length : width’’, e.g. 3:1.

Brucite: A sheet mineral with the composition $Mg(OH)_2$.

Central Stop Dispersion Staining (microscope): This is a dark field microscope technique that images particles using only light refracted by the particle, excluding light that travels through the particle unrefracted. This is usually accomplished with a McCrone objective or other arrangement which places a circular stop with apparent aperture equal to the objective aperture in the back focal plane of the microscope.

Cleavage Fragments: Mineral particles formed by the comminution of minerals, especially those characterized by relatively parallel sides and moderate aspect ratio.

Differential Counting: The term applied to the practice of excluding certain kinds of fibers from a phase contrast asbestos count because they are not asbestos.

Fiber: A particle longer than or equal to 5 μm with a length to width ratio greater than or equal to 3:1. This may include cleavage fragments. (see section 3.5 of this appendix).

Phase Contrast: Contrast obtained in the microscope by causing light scattered by small particles to destructively interfere with unscattered light, thereby enhancing the visibility of very small particles and particles with very low intrinsic contrast.

Phase Contrast Microscope: A microscope configured with a phase mask pair to create phase contrast. The technique which uses this is called Phase Contrast Microscopy (PCM).

Phase-Polar Analysis: This is the use of polarized light in a phase contrast microscope. It is used to see the same size fibers that are visible in air filter analysis. Although fibers finer than 1 μm are visible, analysis of these is inferred from analysis of larger bundles that are usually present.

Phase-Polar Microscope: The phase-polar microscope is a phase contrast microscope which has an analyzer, a polarizer, a first order red plate and a rotating phase condenser all in place so that the polarized light image is enhanced by phase contrast.

Sealing Encapsulant: This is a product which can be applied, preferably by spraying, onto an asbestos surface which will seal the surface so that fibers cannot be released.

Serpentine: A mineral family consisting of minerals with the general composition $Mg_3(Si2O_5(OH)_4$ having the magnesium in brucite layer over a silicate layer. Minerals important in asbestos analysis included in this family are chrysotile, lizardite, antigorite.

1.1. History

Light microscopy has been used for well over 100 years for the determination of mineral species. This analysis is carried out using specialized polarizing microscopes as well as bright field microscopes. The identification of minerals is an on-going process with many new minerals described each year. The first recorded use of asbestos was in Finland about 2500 B.C. where the material was used in the mud wattle for the wooden huts the people lived in as well as strengthening for pottery. Adverse health aspects of the mineral were noted nearly 2000 years ago when Pliny the Younger wrote about the poor health of slaves in the asbestos mines. Although known to be injurious for centuries, the first modern references to its toxicity were by the British Labor Inspectorate when it banned asbestos dust from the workplace in 1898. Asbestosis cases were described in the literature after the turn of the century. Cancer was first suspected in the mid 1930's and a causal link to mesothelioma was made in 1965. Because of the public concern for worker and public safety with the use of this material, several different types of analysis were applied to the determination of asbestos content. Light microscopy requires a great deal of experience and craft. Attempts were made to apply less subjective methods to the analysis. X-ray diffraction was partially successful in determining the mineral types but was unable to separate out the fibrous portions from the non-fibrous portions. Also, the minimum detection limit for asbestos analysis by X-ray diffraction (XRD) is about 1%. Differential Thermal Analysis (DTA) was no more successful. These provide useful corroborating information when the presence of asbestos has been shown by microscopy; however, neither can determine the difference between fibrous and non-fibrous minerals when both habits are present. The same is true of Infrared Absorption (IR).

When electron microscopy was applied to asbestos analysis, hundreds of fibers were discovered present too small to be visible in any light microscope. There are two different types of electron microscope used for asbestos analysis: Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM). Scanning Electron Microscopy is useful in identifying minerals. The SEM can provide two of the three pieces of information required to identify fibers by electron microscopy: morphology and chemistry. The third is structure as determined by Selected Area Electron Diffraction—SAED which is performed in the TEM. Although the resolution of the SEM is sufficient for very fine fibers to be seen, accuracy of chemical analysis that can be performed on the fibers varies with fiber diameter in fibers of less than 0.2 μ m diameter. The TEM is a powerful tool to identify fibers too small to be resolved by light microscopy and should be used in conjunction with this method when necessary. The TEM can provide all three pieces of information required for fiber identification. Most fibers thicker than 1 μ m can adequately be defined in the light microscope. The light microscope remains as the best instrument for the determination of mineral type. This is because the minerals under investigation were first described analytically with the light microscope. It is inexpensive and gives positive identification for most samples analyzed. Further, when optical techniques are inadequate, there is ample indication that alternative techniques should be used for complete identification of the sample.

1.2. Principle

Minerals consist of atoms that may be arranged in random order or in a regular arrangement. Amorphous materials have atoms in random order while crystalline materials have long range order. Many materials are transparent to light, at least for small particles or for thin sections. The properties of these materials can be investigated by the effect that the material has on light passing through it. The six asbestos minerals are all crystalline with particular properties that have been identified and cataloged. These six minerals are anisotropic. They have a regular array of atoms, but the arrangement is not the same in all directions. Each major direction of the crystal presents a different regularity. Light photons travelling in each of these main directions will encounter different electrical neighborhoods, affecting the path and time of travel. The techniques outlined in this method use the fact that light traveling through fibers or crystals in different directions will behave differently, but predictably. The behavior of the light as it travels through a crystal can be measured and compared with known or determined values to identify the mineral species. Usually, Polarized Light Microscopy (PLM) is performed with strain-free objectives on a bright-field microscope platform. This would limit the resolution of the microscope to about 0.4 μm. Because OSHA requires the counting and identification of fibers visible in phase contrast, the phase contrast platform is used to visualize the fibers with the polarizing elements added into the light path. Polarized light methods cannot identify fibers finer than about 1 μm in diameter even though they are visible. The finest fibers are usually identified by inference from the presence of larger, identifiable fiber bundles. When fibers are present, but not identifiable by light microscopy, use either SEM or TEM to determine the fiber identity.

1.3. Advantages and Disadvantages

The advantages of light microcopy are:

(a) Basic identification of the materials was first performed by light microscopy and gross analysis. This provides a large base of published information against which to check analysis and analytical technique.

(b) The analysis is specific to fibers. The minerals present can exist in asbestiform, fibrous, prismatic, or massive varieties all at the same time. Therefore, bulk methods of analysis such as X-ray diffraction, IR analysis, DTA, etc. are inappropriate where the material is not known to be fibrous.

(c) The analysis is quick, requires little preparation time, and can be performed on-site if a suitably equipped microscope is available.

The disadvantages are:

(a) Even using phase-polar illumination, not all the fibers present may be seen. This is a problem for very low asbestos concentrations where agglomerations or large bundles of fibers may not be present to allow identification by inference.

(b) The method requires a great degree of sophistication on the part of the microscopist. An analyst is only as useful as his mental catalog of images. Therefore, a microscopist's accuracy is enhanced by experience. The mineralogical training of the analyst is very important. It is the basis on which subjective decisions are made.

(c) The method uses only a tiny amount of material for analysis. This may lead to sampling bias and false results (high or low). This is especially true if the sample is severely inhomogeneous.

(d) Fibers may be bound in a matrix and not distinguishable as fibers so identification cannot be made.

1.4. Method Performance

1.4.1. This method can be used for determination of asbestos content from 0 to 100% asbestos. The detection limit has not been adequately determined, although for selected samples, the limit is very low, depending on the number of particles examined. For mostly homogeneous, finely divided samples, with no difficult fibrous interferences, the detection limit is below 1%. For inhomogeneous samples (most samples), the detection limit remains undefined. NIST has conducted proficiency testing of laboratories on a national scale. Although each round is reported statistically with an average, control limits, etc., the results indicate a difficulty in establishing precision especially in the low concentration range. It is suspected that there is significant bias in the low range especially near 1%. EPA tried to remedy this by requiring a mandatory point counting scheme for samples less than 10%. The point counting procedure is tedious, and may introduce significant biases of its own. It has not been incorporated into this method.

1.4.2. The precision and accuracy of the quantitation tests performed in this method are unknown. Concentrations are easier to determine in commercial products where asbestos was deliberately added because the amount is usually more than a few percent. An analyst's results can be ''calibrated'' against the known amounts added by the manufacturer. For geological samples, the degree of homogeneity affects the precision.

1.4.3. The performance of the method is analyst dependent. The analyst must choose carefully and not necessarily randomly the portions for analysis to assure that detection of asbestos occurs when it is present. For this reason, the analyst must have adequate training in sample preparation, and experience in the location and identification of asbestos in samples. This is usually accomplished through substantial on-the-job training as well as formal education in mineralogy and microscopy.

1.5. Interferences

Any material which is long, thin, and small enough to be viewed under the microscope can be considered an interference for asbestos. There are literally hundreds of interferences in workplaces. The techniques described in this method are normally sufficient to eliminate the interferences. An analyst's success in eliminating the interferences depends on proper training.

Asbestos minerals belong to two mineral families: the serpentines and the amphiboles. In the serpentine family, the only common fibrous mineral is chrysotile. Occasionally, the mineral antigorite occurs in a fibril habit with morphology similar to the amphiboles. The amphibole minerals consist of a score of different minerals of which only five are regulated by federal standard: amosite, crocidolite, anthophyllite asbestos, tremolite asbestos and actinolite asbestos. These are the only amphibole minerals that have been commercially exploited for their fibrous properties; however, the rest can and do occur occasionally in asbestiform habit.

In addition to the related mineral interferences, other minerals common in building material may present a problem for some microscopists: gypsum, anhydrite, brucite, quartz fibers, talc fibers or ribbons, wollastonite, perlite, attapulgite, etc. Other fibrous materials commonly present in workplaces are: fiberglass, mineral wool, ceramic wool, refractory ceramic fibers, kevlar, nomex, synthetic fibers, graphite or carbon fibers, cellulose (paper or wood) fibers, metal fibers, etc.

Matrix embedding material can sometimes be a negative interference. The analyst may not be able to easily extract the fibers from the matrix in order to use the method. Where possible, remove the matrix before the analysis, taking careful note of the loss of weight. Some common matrix materials are: vinyl, rubber, tar, paint, plant fiber, cement, and epoxy. A further negative interference is that the asbestos fibers themselves may be either too small to be seen in Phase contrast Microscopy (PCM) or of a very low fibrous quality, having the appearance of plant fibers. The analyst's ability to deal with these materials increases with experience.

1.6. Uses and Occupational Exposure

Asbestos is ubiquitous in the environment. More than 40% of the land area of the United States is composed of minerals which may contain asbestos. Fortunately, the actual formation of great amounts of asbestos is relatively rare. Nonetheless, there are locations in which environmental exposure can be severe such as in the Serpentine Hills of California.

There are thousands of uses for asbestos in industry and the home. Asbestos abatement workers are the most current segment of the population to have occupational exposure to great amounts of asbestos. If the material is undisturbed, there is no exposure. Exposure occurs when the asbestos-containing material is abraded or otherwise disturbed during maintenance operations or some other activity. Approximately 95% of the asbestos in place in the United States is chrysotile.

Amosite and crocidolite make up nearly all the difference. Tremolite and anthophyllite make up a very small percentage. Tremolite is found in extremely small amounts in certain chrysotile deposits. Actinolite exposure is probably greatest from environmental sources, but has been identified in vermiculite containing, sprayed-on insulating materials which may have been certified as asbestos-free.

1.7. Physical and Chemical Properties

The nominal chemical compositions for the asbestos minerals were given in Section 1. Compared to cleavage fragments of the same minerals, asbestiform fibers possess a high tensile strength along the fiber axis. They are chemically inert, non- combustible, and heat resistant. Except for chrysotile, they are insoluble in Hydrochloric acid (HCl). Chrysotile is slightly soluble in HCl. Asbestos has high electrical resistance and good sound absorbing characteristics. It can be woven into cables, fabrics or other textiles, or matted into papers, felts, and mats.

1.8. Toxicology (This Section is for Information Only and Should Not Be Taken as OSHA Policy)

Possible physiologic results of respiratory exposure to asbestos are mesothelioma of the pleura or peritoneum, interstitial fibrosis, asbestosis, pneumoconiosis, or respiratory cancer. The possible consequences of asbestos exposure are detailed in the NIOSH Criteria Document or in the OSHA Asbestos Standards 29 CFR 1910.1001 and 29 CFR 1926.1101 and 29 CFR 1915.1001.

2. Sampling Procedure

2.1. Equipment for Sampling

(a) Tube or cork borer sampling device
(b) Knife
(c) 20 mL scintillation vial or similar vial
(d) Sealing encapsulant

2.2. Safety Precautions

Asbestos is a known carcinogen. Take care when sampling. While in an asbestos-containing atmosphere, a properly selected and fit-tested respirator should be worn. Take samples in a manner to cause the least amount of dust. Follow these general guidelines:

(a) Do not make unnecessary dust.
(b) Take only a small amount (1 to 2 g).
(c) Tightly close the sample container.
(d) Use encapsulant to seal the spot where the sample was taken, if necessary.

2.3. Sampling Procedure

Samples of any suspect material should be taken from an inconspicuous place. Where the material is to remain, seal the sampling wound with an encapsulant to eliminate the potential for exposure from the sample site. Microscopy requires only a few milligrams of material. The amount that will fill a 20 mL scintillation vial is more than adequate. Be sure to collect samples from all layers and phases of material. If possible, make separate samples of each different phase of the material. This will aid in determining the actual hazard. *DO NOT USE ENVELOPES, PLASTIC OR PAPER BAGS OF ANY KIND TO COLLECT SAMPLES.* The use of plastic bags presents a contamination hazard to laboratory personnel and to other samples. When these containers are opened, a bellows effect blows fibers out of the container onto everything, including the person opening the container.

If a cork-borer type sampler is available, push the tube through the material all the way, so that all layers of material are sampled. Some samplers are intended to be disposable. These should be capped and sent to the laboratory. If a non-disposable cork borer is used, empty the contents into a scintillation vial and send to the laboratory. Vigorously and completely clean the cork borer between samples.

2.4 Shipment

Samples packed in glass vials must not touch or they might break in shipment.

(a) Seal the samples with a sample seal over the end to guard against tampering and to identify the sample.

(b) Package the bulk samples in separate packages from the air samples. They may cross-contaminate each other and will invalidate the results of the air samples.

(c) Include identifying paperwork *with* the samples, but not in contact with the suspected asbestos.

(d) To maintain sample accountability, ship the samples by certified mail, overnight express, or hand carry them to the laboratory.

3. Analysis

The analysis of asbestos samples can be divided into two major parts: sample preparation and microscopy. Because of the different asbestos uses that may be encountered by the analyst, each sample may need different preparation steps. The choices are outlined below. There are several different tests that are performed to identify the asbestos species and determine the percentage. They will be explained below.

3.1. Safety

(a) Do not create unnecessary dust. Handle the samples in HEPA-filter equipped hoods. If samples are received in bags, envelopes or other inappropriate container, open them only in a hood having a face velocity at or greater than 100 fpm. Transfer a small amount to a scintillation vial and only handle the smaller amount.

(b) Open samples in a hood, never in the open lab area.

(c) Index of refraction oils can be toxic. Take care not to get this material on the skin. Wash immediately with soap and water if this happens.

(d) Samples that have been heated in the muffle furnace or the drying oven may be hot. Handle them with tongs until they are cool enough to handle.

(e) Some of the solvents used, such as THF (tetrahydrofuran), are toxic and should only be handled in an appropriate fume hood and according to instructions given in the Material Safety Data Sheet (MSDS).

3.2. Equipment

(a) Phase contrast microscope with 10x, 16x and 40x objectives, 10x wide-field eyepieces, G–22 Walton-Beckett graticule, Whipple disk, polarizer, analyzer and first order red or gypsum plate, 100 Watt illuminator, rotating position condenser with oversize phase rings, central stop dispersion objective, Kohler illumination and a rotating mechanical stage.

(b) Stereo microscope with reflected light illumination, transmitted light illumination, polarizer, analyzer and first order red or gypsum plate, and rotating stage.

(c) Negative pressure hood for the stereo microscope

(d) Muffle furnace capable of 600 °C

(e) Drying oven capable of 50—150 °C

(f) Aluminum specimen pans

(g) Tongs for handling samples in the furnace

(h) High dispersion index of refraction oils (Special for dispersion staining.)

n = 1.550
n = 1.585
n = 1.590
n = 1.605
n = 1.620
n = 1.670
n = 1.680
n = 1.690

(i) A set of index of refraction oils from about n=1.350 to n=2.000 in n=0.005 increments. (Standard for Becke line analysis.)

(j) Glass slides with painted or frosted ends 1×3 inches 1mm thick, precleaned.

(k) Cover Slips 22×22 mm, #1½

(l) Paper clips or dissection needles

(m) Hand grinder

(n) Scalpel with both #10 and #11 blades

(o) 0.1 molar HCl

(p) Decalcifying solution (Baxter Scientific Products) Ethylenediaminetetraacetic Acid,

Tetrasodium	0.7 g/l
Sodium Potassium Tartrate	8.0 mg/liter
Hydrochloric Acid	99.2 g/liter
Sodium Tartrate	0.14 g/liter

(q) Tetrahydrofuran (THF)

(r) Hotplate capable of 60 °C

(s) Balance

(t) Hacksaw blade

(u) Ruby mortar and pestle

3.3. Sample Pre-Preparation

Sample preparation begins with pre-preparation which may include chemical reduction of the matrix, heating the sample to dryness or heating in the muffle furnace. The end result is a sample which has been reduced to a powder that is sufficiently fine to fit under the cover slip. Analyze different phases of samples separately, e.g., tile and the tile mastic should be analyzed separately as the mastic may contain asbestos while the tile may not.

(a) *Wet samples*

Samples with a high water content will not give the proper dispersion colors and must be dried prior to sample mounting. Remove the lid of the scintillation vial, place the bottle in the drying oven and heat at 100 °C to dryness (usually about 2 h). Samples which are not submitted to the lab in glass must be removed and placed in glass vials or aluminum weighing pans before placing them in the drying oven.

(b) *Samples With Organic Interference—Muffle Furnace*

These may include samples with tar as a matrix, vinyl asbestos tile, or any other organic that can be reduced by heating. Remove the sample from the vial and weigh in a balance to determine the weight of the submitted portion. Place the sample in a muffle furnace at 500 °C for 1 to 2 h or until all obvious organic material has been removed. Retrieve, cool and weigh again to determine the weight loss on ignition. This is necessary to determine the asbestos content of the submitted sample, because the analyst will be looking at a reduced sample.

NOTE: Heating above 600 °C will cause the sample to undergo a structural change which, given sufficient time, will convert the chrysotile to forsterite. Heating even at lower temperatures for 1 to 2 h may have a measurable effect on the optical properties of the minerals. If the analyst is unsure of what to expect, a sample of standard asbestos should be heated to the same temperature for the same length of time so that it can be examined for the proper interpretation.

(c) *Samples With Organic Interference—THF*

Vinyl asbestos tile is the most common material treated with this solvent, although, substances containing tar will sometimes yield to this treatment. Select a portion of the material and then grind it up if possible. Weigh the sample and place it in a test tube. Add sufficient THF to dissolve the organic matrix. This is usually about 4 to 5 mL. *Remember, THF is highly flammable.* Filter the remaining material through a tared silver membrane, dry and weigh to determine how much is left after the solvent extraction. Further process the sample to remove carbonate or mount directly.

(d) *Samples With Carbonate Interference*

Carbonate material is often found on fibers and sometimes must be removed in order to perform dispersion microscopy. Weigh out a portion of the material and place it in a test tube. Add a sufficient amount of 0.1 M HCl or decalcifying solution in the tube to react all the carbonate as evidenced by gas formation; i.e., when the gas bubbles stop, add a little more solution. If no more gas forms, the reaction is complete. Filter the material out through a tared silver membrane, dry and weigh to determine the weight lost.

3.4. Sample Preparation

Samples must be prepared so that accurate determination can be made of the asbestos type and amount present. The following steps are carried out in the low-flow hood (a low-flow hood has less than 50 fpm flow):

(1) If the sample has large lumps, is hard, or cannot be made to lie under a cover slip, the grain size must be reduced. Place a small amount between two slides and grind the material between them or grind a small amount in a clean mortar and pestle. The choice of whether to use an alumina, ruby, or diamond mortar depends on the hardness of the material. Impact damage can alter the asbestos mineral if too much mechanical shock occurs. (Freezer mills can completely destroy the observable crystallinity of asbestos and should not be used). For some samples, a portion of material can be shaved off with a scalpel, ground off with a hand grinder or hack saw blade.

The preparation tools should either be disposable or cleaned thoroughly. Use vigorous scrubbing to loosen the fibers during the washing. Rinse the implements with copious amounts of water and air-dry in a dust-free environment.

(2) If the sample is powder or has been reduced as in (1) above, it is ready to mount. Place a glass slide on a piece of optical tissue and write the identification on the painted or frosted end. Place two drops of index of refraction medium n=1.550 on the slide. (The medium n=1.550 is chosen because it is the matching index for chrysotile. Dip the end of a clean paper-clip or dissecting needle into the droplet of refraction medium on *the slide* to moisten it. Then dip the probe into the powder sample. Transfer what sticks on the probe to the slide. The material on the end of the probe should have a diameter of about 3 mm for a good mount. If the material is very fine, less sample may be appropriate. For non-powder samples such as fiber mats, forceps should be used to transfer a small amount of material to the slide. Stir the material in the medium on the slide, spreading it out and making the preparation as uniform as possible. Place a cover-slip on the preparation by gently lowering onto the slide and allowing it to fall ‘‘trapdoor’’ fashion on the preparation to push out any bubbles. Press gently on the cover slip to even out the distribution of particulate on the slide. If there is insufficient mounting oil on the slide, one or two drops may be placed near the edge of the coverslip on the slide. Capillary action will draw the necessary amount of liquid into the preparation. Remove excess oil with the point of a laboratory wiper.

Treat at least two different areas of each phase in this fashion. Choose representative areas of the sample. It may be useful to select particular areas or fibers for analysis. This is useful to identify asbestos in severely inhomogeneous samples.

When it is determined that amphiboles may be present, repeat the above process using the appropriate high-dispersion oils until an identification is made or all six asbestos minerals have been ruled out. Note that percent determination must be done in the index medium 1.550 because amphiboles tend to disappear in their matching mediums.

3.5. Analytical Procedure

NOTE: This method presumes some knowledge of mineralogy and optical petrography.

The analysis consists of three parts: The determination of whether there is asbestos present, what type is present and the determination of how much is present. The general flow of the analysis is:

(1) Gross examination.

(2) Examination under polarized light on the stereo microscope.

(3) Examination by phase-polar illumination on the compound phase microscope.

(4) Determination of species by dispersion stain. Examination by Becke line analysis may also be used; however, this is usually more cumbersome for asbestos determination.

(5) Difficult samples may need to be analyzed by SEM or TEM, or the results from those techniques combined with light microscopy for a definitive identification. Identification of a particle as asbestos requires that it be asbestiform. Description of particles should follow the suggestion of Campbell. (Figure 1)

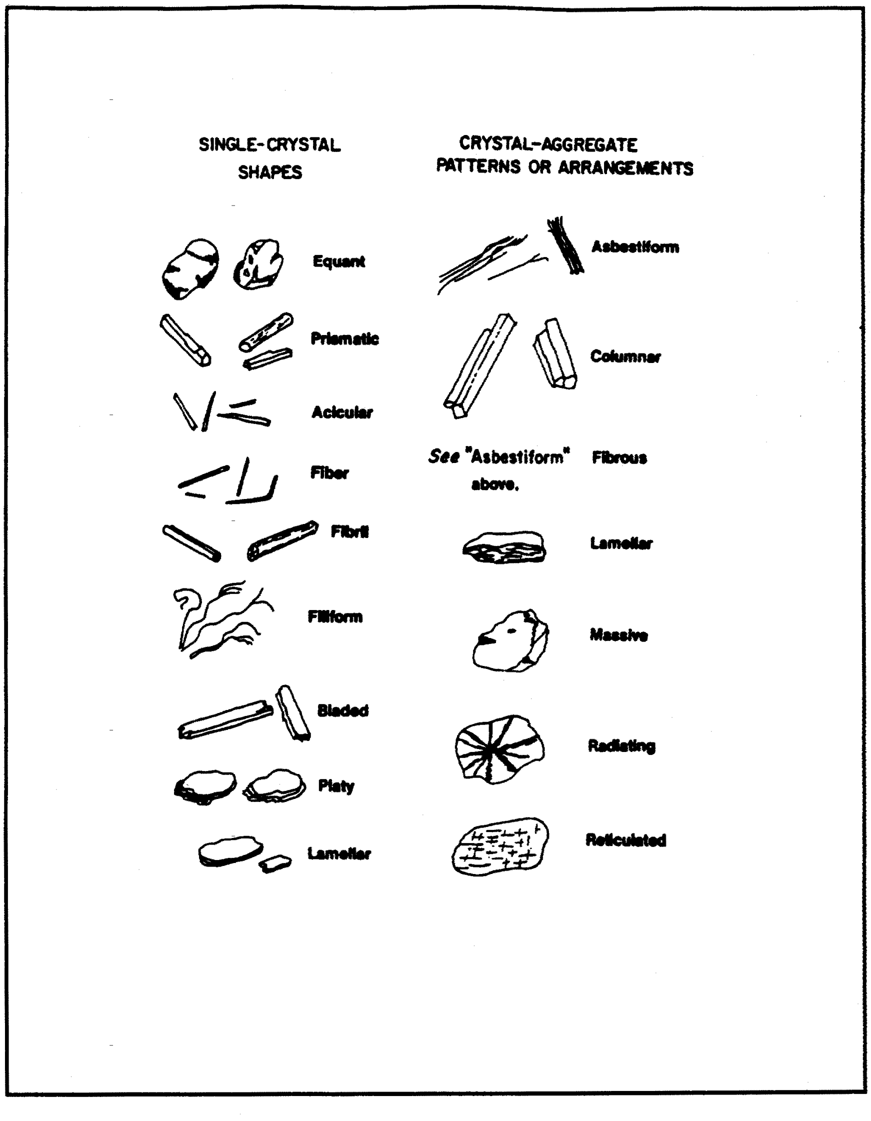


Figure 1. Particle definitions showing mineral growth habits. From the U.S. Bureau of Mines

For the purpose of regulation, the mineral must be one of the six minerals covered and must be in the asbestos growth habit. Large specimen samples of asbestos generally have the gross appearance of wood. Fibers are easily parted from it. Asbestos fibers are very long compared with their widths. The fibers have a very high tensile strength as demonstrated by bending without breaking. Asbestos fibers exist in bundles that are easily parted, show longitudinal fine structure and may be tufted at the ends showing ''bundle of sticks'' morphology. In the microscope some of these properties may not be observable. Amphiboles do not always show striations along their length even when they are asbestos. Neither will they always show tufting. They generally do not show a curved nature except for very long fibers. Asbestos and asbestiform minerals are usually characterized in groups by extremely high aspect ratios (greater than 100:1). While aspect ratio analysis is useful for characterizing populations of fibers, it cannot be used to identify individual fibers of intermediate to short aspect ratio. Observation of many fibers is often necessary to determine whether a sample consists of ''cleavage fragments'' or of asbestos fibers.

Most cleavage fragments of the asbestos minerals are easily distinguishable from true asbestos fibers. This is because true cleavage fragments usually have larger diameters than 1 µm. Internal structure of particles larger than this usually shows them to have no internal fibrillar structure. In addition, cleavage fragments of the monoclinic amphiboles show inclined extinction under crossed polars with no compensator. Asbestos fibers usually show extinction at zero degrees or ambiguous extinction if any at all. Morphologically, the larger cleavage fragments are obvious by their blunt or stepped ends showing prismatic habit. Also, they tend to be acicular rather than filiform.

Where the particles are less than 1 µm in diameter and have an aspect ratio greater than or equal to 3:1, it is recommended that the sample be analyzed by SEM or TEM if there is any question whether the fibers are cleavage fragments or asbestiform particles.

Care must be taken when analyzing by electron microscopy because the interferences are different from those in light microscopy and may structurally be very similar to asbestos. The classic interference is between anthophyllite and biopyribole or intermediate fiber. Use the same morphological clues for electron microscopy as are used for light microscopy, e.g. fibril splitting, internal longitudinal striation, fraying, curvature, etc.

(1) Gross examination:

Examine the sample, preferably in the glass vial. Determine the presence of any obvious fibrous component. Estimate a percentage based on previous experience and current observation. Determine whether any pre- preparation is necessary. Determine the number of phases present. This step may be carried out or augmented by observation at 6 to 40× under a stereo microscope.

(2) After performing any necessary pre-preparation, prepare slides of each phase as described above. Two preparations of the same phase in the same index medium can be made side-by-side on the same glass for convenience. Examine with the polarizing stereo microscope. Estimate the percentage of asbestos based on the amount of birefringent fiber present.

(3) Examine the slides on the phase-polar microscopes at magnifications of 160 and 400×. Note the morphology of the fibers. Long, thin, very straight fibers with little curvature are indicative of fibers from the amphibole family. Curved, wavy fibers are usually indicative of chrysotile. Estimate the percentage of asbestos on the phase-polar microscope under conditions of crossed polars and a gypsum plate. Fibers smaller than 1.0 µm in thickness must be identified by inference to the presence of larger, identifiable fibers and morphology. If no larger fibers are visible, electron microscopy should be performed. At this point, only a tentative identification can be made. Full identification must be made with dispersion microscopy. Details of the tests are included in the appendices.

(4) Once fibers have been determined to be present, they must be identified. Adjust the microscope for dispersion mode and observe the fibers. The microscope has a rotating stage, one polarizing element, and a system for generating dark-field dispersion microscopy (see Section 4.6. of this appendix). Align a fiber with its length parallel to the polarizer and note the color of the Becke lines. Rotate the stage to bring the fiber length perpendicular to the polarizer and note the color. Repeat this process for every fiber or fiber bundle examined. The colors must be consistent with the colors generated by standard asbestos reference materials for a positive identification. In n=1.550, amphiboles will generally show a yellow to straw-yellow color indicating that the fiber indices of refraction are higher than the liquid. If long, thin fibers are noted and the colors are yellow, prepare further slides as above in the suggested matching liquids listed below:

Type of asbestos	Index of refraction
Chrysotile	n=1.550.
Amosite	n=1.670 r 1.680.
Crocidolite	n=1.690.
Anthophyllite	n=1.605 nd 1.620.
Tremolite	n=1.605 and 1.620.
Actinolite	n=1.620.

Where more than one liquid is suggested, the first is preferred; however, in some cases this liquid will not give good dispersion color. Take care to avoid interferences in the other liquid; e.g., wollastonite in n=1.620 will give the same colors as tremolite. In n=1.605 wollastonite will appear yellow in all directions. Wollastonite may be determined under crossed polars as it will change from blue to yellow as it is rotated along its fiber axis by tapping on the cover slip. Asbestos minerals will not change in this way.

Determination of the angle of extinction may, when present, aid in the determination of anthophyllite from tremolite. True asbestos fibers usually have 0° extinction or ambiguous extinction, while cleavage fragments have more definite extinction.

Continue analysis until both preparations have been examined and all present species of asbestos are identified. If there are no fibers present, or there is less than 0.1% present, end the analysis with the minimum number of slides (2).

(5) Some fibers have a coating on them which makes dispersion microscopy very difficult or impossible. Becke line analysis or electron microscopy may be performed in those cases. Determine the percentage by light microscopy. TEM analysis tends to overestimate the actual percentage present.

(6) Percentage determination is an estimate of occluded area, tempered by gross observation. Gross observation information is used to make sure that the high magnification microscopy does not greatly over- or under- estimate the amount of fiber present. This part of the analysis requires a great deal of experience. Satisfactory models for asbestos content analysis have not yet been developed, although some models based on metallurgical grain-size determination have found some utility. Estimation is more easily handled in situations where the grain sizes visible at about 160× are about the same and the sample is relatively homogeneous.

View all of the area under the cover slip to make the percentage determination. View the fields while moving the stage, paying attention to the clumps of material. These are not usually the best areas to perform dispersion microscopy because of the interference from other materials. But, they are the areas most likely to represent the accurate percentage in the sample. Small amounts of asbestos require slower scanning and more frequent analysis of individual fields.

Report the area occluded by asbestos as the concentration. This estimate does not generally take into consideration the difference in density of the different species present in the sample. For most samples this is adequate. Simulation studies with similar materials must be carried out to apply microvisual estimation for that purpose and is beyond the scope of this procedure.

(7) Where successive concentrations have been made by chemical or physical means, the amount reported is the percentage of the material in the ‘‘as submitted’’ or original state. The percentage determined by microscopy is multiplied by the fractions remaining after pre-preparation steps to give the percentage in the original sample. For example:

Step 1. 60% remains after heating at 550 °C for 1 h. Step 2. 30% of the residue of step 1 remains after dissolution of carbonate in 0.1 m HCl.

Step 3. Microvisual estimation determines that 5% of the sample is chrysotile asbestos.

The reported result is:

R=(Microvisual result in percent)×(Fraction remaining after step 2)×(Fraction remaining of original sample after step 1)

R=(5)×(.30)×(.60)=0.9%

(8) Report the percent and type of asbestos present. For samples where asbestos was identified, but is less than 1.0%, report ‘‘Asbestos present, less than 1.0%.’’ There must have been at least two observed fibers or fiber bundles in the two preparations to be reported as present. For samples where asbestos was not seen, report as ‘‘None Detected.’’

4. Auxiliary Information

Because of the subjective nature of asbestos analysis, certain concepts and procedures need to be discussed in more depth. This information will help the analyst understand why some of the procedures are carried out the way they are.

4.1. Light

Light is electromagnetic energy. It travels from its source in packets called quanta. It is instructive to consider light as a plane wave. The light has a direction of travel. Perpendicular to this and mutually perpendicular to each other, are two vector components. One is the magnetic vector and the other is the electric vector. We shall only be concerned with the electric vector. In this description, the interaction of the vector and the mineral will describe all the observable phenomena. From a light source such a microscope illuminator, light travels in all different direction from the filament.

In any given direction away from the filament, the electric vector is perpendicular to the direction of travel of a light ray. While perpendicular, its orientation is random about the travel axis. If the electric vectors from all the light rays were lined up by passing the light through a filter that would only let light rays with electric vectors oriented in one direction pass, the light would then be *POLARIZED.*

Polarized light interacts with matter in the direction of the electric vector. This is the polarization direction. Using this property it is possible to use polarized light to probe different materials and identify them by how they interact with light.

The speed of light in a vacuum is a constant at about 2.99×10^8 m/s. When light travels in different materials such as air, water, minerals or oil, it does not travel at this speed. It travels slower. This slowing is a function of both the material through which the light is traveling and the wavelength or frequency of the light. In general, the more dense the material, the slower the light travels. Also, generally, the higher the frequency, the slower the light will travel. The ratio of the speed of light in a vacuum to that in a material is called the index of refraction (n). It is usually measured at 589 nm (the sodium D line). If white light (light containing all the visible wavelengths) travels through a material, rays of longer wavelengths will travel faster than those of shorter wavelengths, this separation is called dispersion. Dispersion is used as an identifier of materials as described in Section 4.6.

4.2. Material Properties

Materials are either amorphous or crystalline. The difference between these two descriptions depends on the positions of the atoms in them. The atoms in amorphous materials are randomly arranged with no long range order. An example of an amorphous material is glass. The atoms in crystalline materials, on the other hand, are in regular arrays and have long range order. Most of the atoms can be found in highly predictable locations. Examples of crystalline material are salt, gold, and the asbestos minerals.

It is beyond the scope of this method to describe the different types of crystalline materials that can be found, or the full description of the classes into which they can fall. However, some general crystallography is provided below to give a foundation to the procedures described.

With the exception of anthophyllite, all the asbestos minerals belong to the monoclinic crystal type. The unit cell is the basic repeating unit of the crystal and for monoclinic crystals can be described as having three unequal sides, two 90° angles and one angle not equal to 90°. The orthorhombic group, of which anthophyllite is a member has three unequal sides and three 90° angles. The unequal sides are a consequence of the complexity of fitting the different atoms into the unit cell. Although the atoms are in a regular array, that array is not symmetrical in all directions. There is long range order in the three major directions of the crystal. However, the order is different in each of the three directions. This has the effect that the index of refraction is different in each of the three directions. Using polarized light, we can investigate the index of refraction in each of the directions and identify the mineral or material under investigation. The indices α, β, and γ are used to identify the lowest, middle, and highest index of refraction respectively. The x direction, associated with α is called the fast axis. Conversely, the z direction is associated with γ and is the slow direction. Crocidolite has α along the fiber length making it ‘‘length-fast’’. The remainder of the asbestos minerals have the γ axis along the fiber length. They are called ‘‘length-slow’’. This orientation to fiber length is used to aid in the identification of asbestos.

4.3. Polarized Light Technique

Polarized light microscopy as described in this section uses the phase-polar microscope described in Section 3.2. A phase contrast microscope is fitted with two polarizing elements, one below and one above the sample. The polarizers have their polarization directions at right angles to each other. Depending on the tests performed, there may be a compensator between these two polarizing elements. Light emerging from a polarizing element has its electric vector pointing in the polarization direction of the element. The light will not be subsequently transmitted through a second element set at a right angle to the first element. Unless the light is altered as it passes from one element to the other, there is no transmission of light.

4.4. Angle of Extinction

Crystals which have different crystal regularity in two or three main directions are said to be anisotropic. They have a different index of refraction in each of the main directions. When such a crystal is inserted between the crossed polars, the field of view is no longer dark but shows the crystal in color. The color depends on the properties of the crystal. The light acts as if it travels through the crystal along the optical axes. If a crystal optical axis were lined up along one of the polarizing directions (either the polarizer or the analyzer) the light would appear to travel only in that direction, and it would blink out or go dark. The difference in degrees between the fiber direction and the angle at which it blinks out is called the angle of extinction. When this angle can be measured, it is useful in identifying the mineral. The procedure for measuring the angle of extinction is to first identify the polarization direction in the microscope. A commercial alignment slide can be used to establish the polarization directions or use anthophyllite or another suitable mineral. This mineral has a zero degree angle of extinction and will go dark to extinction as it aligns with the polarization directions. When a fiber of anthophyllite has gone to extinction, align the eyepiece reticle or graticule with the fiber so that there is a visual cue as to the direction of polarization in the field of view. Tape or otherwise secure the eyepiece in this position so it will not shift.

After the polarization direction has been identified in the field of view, move the particle of interest to the center of the field of view and align it with the polarization direction. For fibers, align the fiber along this direction. Note the angular reading of the rotating stage. Looking at the particle, rotate the stage until the fiber goes dark or ‘‘blinks out’’. Again note the reading of the stage. The difference in the first reading and the second is an angle of extinction.

The angle measured may vary as the orientation of the fiber changes about its long axis. Tables of mineralogical data usually report the maximum angle of extinction. Asbestos forming minerals, when they exhibit an angle of extinction, usually do show an angle of extinction close to the reported maximum, or as appropriate depending on the substitution chemistry.

4.5. Crossed Polars with Compensator

When the optical axes of a crystal are not lined up along one of the polarizing directions (either the polarizer or the analyzer) part of the light travels along one axis and part travels along the other visible axis. This is characteristic of birefringent materials.

The color depends on the difference of the two visible indices of refraction and the thickness of the crystal. The maximum difference available is the difference between the α and the γ axes. This maximum difference is usually tabulated as the birefringence of the crystal.

For this test, align the fiber at 45° to the polarization directions in order to maximize the contribution to each of the optical axes. The colors seen are called retardation colors. They arise from the recombination of light which has traveled through the two separate directions of the crystal. One of the rays is retarded behind the other since the light in that direction travels slower. On recombination, some of the colors which make up white light are enhanced by constructive interference and some are suppressed by destructive interference. The result is a color dependent on the difference between the indices and the thickness of the crystal. The proper colors, thicknesses, and retardations are shown on a Michel-Levy chart. The three items, retardation, thickness and birefringence are related by the following relationship:

$R=t(n_{\gamma}—n_{\alpha})$

R=retardation, t=crystal thickness in μm, and

$n_{\alpha,\gamma}$=indices of refraction.

Examination of the equation for asbestos minerals reveals that the visible colors for almost all common asbestos minerals and fiber sizes are shades of gray and black. The eye is relatively poor at discriminating different shades of gray. It is very good at discriminating different colors. In order to compensate for the low retardation, a compensator is added to the light train between the polarization elements. The compensator used for this test is a gypsum plate of known thickness and birefringence. Such a compensator when oriented at 45° to the polarizer direction, provides a retardation of 530 nm of the 530 nm wavelength color. This enhances the red color and gives the background a characteristic red to red-magenta color. If this ‘‘full-wave’’ compensator is in place when the asbestos preparation is inserted into the light train, the colors seen on the fibers are quite different. Gypsum, like asbestos has a fast axis and a slow axis. When a fiber is aligned with its fast axis in the same direction as the fast axis of the gypsum plate, the ray vibrating in the slow direction is retarded by both the asbestos and the gypsum. This results in a higher retardation than would be present for either of the two minerals. The color seen is a second order blue. When the fiber is rotated 90° using the rotating stage, the slow direction of the fiber is now aligned with the fast direction of the gypsum and the fast direction of the fiber is aligned with the slow direction of the gypsum. Thus, one ray vibrates faster in the fast direction of the gypsum, and slower in the slow direction of the fiber; the other ray will vibrate slower in the slow direction of the gypsum and faster in the fast direction of the fiber. In this case, the effect is subtractive and the color seen is a first order yellow. As long as the fiber thickness does not add appreciably to the color, the same basic colors will be seen for all asbestos types except crocidolite. In crocidolite the colors will be weaker, may be in the opposite directions, and will be altered by the blue absorption color natural to crocidolite. Hundreds of other materials will give the same colors as asbestos, and therefore, this test is not definitive for asbestos. The test is useful in discriminating against fiberglass or other amorphous fibers such as some synthetic fibers. Certain synthetic fibers will show retardation colors different than asbestos; however, there are some forms of polyethylene and aramid which will show morphology and retardation colors similar to asbestos minerals. This test must be supplemented with a positive identification test when birefringent fibers are present which can not be excluded by morphology. This test is relatively ineffective for use on fibers less than 1 µm in diameter. For positive confirmation TEM or SEM should be used if no larger bundles or fibers are visible.

4.6. Dispersion Staining

Dispersion microscopy or dispersion staining is the method of choice for the identification of asbestos in bulk materials. Becke line analysis is used by some laboratories and yields the same results as does dispersion staining for asbestos and can be used in lieu of dispersion staining. Dispersion staining is performed on the same platform as the phase-polar analysis with the analyzer and compensator removed. One polarizing element remains to define the direction of the light so that the different indices of refraction of the fibers may be separately determined. Dispersion microscopy is a dark-field technique when used for asbestos. Particles are imaged with scattered light. Light which is unscattered is blocked from reaching the eye either by the back field image mask in a McCrone objective or a back field image mask in the phase condenser. The most convenient method is to use the rotating phase condenser to move an oversized phase ring into place. The ideal size for this ring is for the central disk to be just larger than the objective entry aperture as viewed in the back focal plane. The larger the disk, the less scattered light reaches the eye. This will have the effect of diminishing the intensity of dispersion color and will shift the actual color seen. The colors seen vary even on microscopes from the same manufacturer. This is due to the different bands of wavelength exclusion by different mask sizes. The mask may either reside in the condenser or in the objective back focal plane. It is imperative that the analyst determine by experimentation with asbestos standards what the appropriate colors should be for each asbestos type. The colors depend also on the temperature of the preparation and the exact chemistry of the asbestos. Therefore, some slight differences from the standards should be allowed. This is not a serious problem for commercial asbestos uses. This technique is used for identification of the indices of refraction for fibers by recognition of color. There is no direct numerical readout of the index of refraction. Correlation of color to actual index of refraction is possible by referral to published conversion tables. This is not necessary for the analysis of asbestos. Recognition of appropriate colors along with the proper morphology are deemed sufficient to identify the commercial asbestos minerals. Other techniques including SEM, TEM, and XRD may be required to provide additional information in order to identify other types of asbestos.

Make a preparation in the suspected matching high dispersion oil, e.g., n=1.550 for chrysotile. Perform the preliminary tests to determine whether the fibers are birefringent or not. Take note of the morphological character. Wavy fibers are indicative of chrysotile while long, straight, thin, frayed fibers are indicative of amphibole asbestos. This can aid in the selection of the appropriate matching oil. The microscope is set up and the polarization direction is noted as in Section 4.4. Align a fiber with the polarization direction. Note the color. This is the color parallel to the polarizer. Then rotate the fiber rotating the stage 90° so that the polarization direction is across the fiber. This is the perpendicular position. Again note the color. Both colors must be consistent with standard asbestos minerals in the correct direction for a positive identification of asbestos. If only one of the colors is correct while the other is not, the identification is not positive. If the colors in both directions are bluish-white, the analyst has chosen a matching index oil which is higher than the correct matching oil, e.g. the analyst has used n=1.620 where chrysotile is present. The next lower oil (Section 3.5.) should be used to prepare another specimen. If the color in both directions is yellow-white to straw-yellow-white, this indicates that the index of the oil is lower than the index of the fiber, e.g. the preparation is in n=1.550 while anthophyllite is present. Select the next higher oil (Section 3.5.) and prepare another slide. Continue in this fashion until a positive identification of all asbestos species present has been made or all possible asbestos species have been ruled out by negative results in this test. Certain plant fibers can have similar dispersion colors as asbestos. Take care to note and evaluate the morphology of the fibers or remove the plant fibers in pre- preparation. Coating material on the fibers such as carbonate or vinyl may destroy the dispersion color. Usually, there will be some outcropping of fiber which will show the colors sufficient for identification. When this is not the case, treat the sample as described in Section 3.3. and then perform dispersion staining. Some samples will yield to Becke line analysis if they are coated or electron microscopy can be used for identification.

5. References

5.1. Crane, D.T., *Asbestos in Air,* OSHA method ID160, Revised November 1992.

5.2. Ford, W.E., *Dana's Textbook of Mineralogy;* Fourth Ed.; John Wiley and Son, New York, 1950, p. vii.

5.3. Selikoff,.I.J., Lee, D.H.K., *Asbestos and Disease,* Academic Press, New York, 1978, pp. 3,20.

5.4. *Women Inspectors of Factories.* Annual Report for 1898, H.M. Statistical Office, London, p. 170 (1898).

5.5. Selikoff, I.J., Lee, D.H.K., *Asbestos and Disease,* Academic Press, New York, 1978, pp. 26,30.

5.6. Campbell, W.J., et al, *Selected Silicate Minerals and Their Asbestiform Varieties,* United States Department of the Interior, Bureau of Mines, Information Circular 8751, 1977.

5.7. *Asbestos,* Code of Federal Regulations, 29 CFR 1910.1001 and 29 CFR 1926.58.

5.8. *National Emission Standards for Hazardous Air Pollutants; Asbestos NESHAP Revision,* FEDERAL REGISTER, Vol. 55, No. 224, 20 November 1990, p. 48410.

5.9. Ross, M. *The Asbestos Minerals: Definitions, Description, Modes of Formation, Physical and Chemical Properties and Health Risk to the Mining Community,* Nation Bureau of Standards Special Publication, Washington, DC, 1977.

5.10. Lilis, R., Fibrous Zeolites and Endemic Mesothelioma in Cappadocia, Turkey, *J. Occ Medicine*, 1981, 23,(8),548–550.

5.11. *Occupational Exposure to Asbestos—1972*, U.S. Department of Health, Education and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, HSM–72–10267.

5.12. Campbell, W.J., et al, Relationship of Mineral Habit to Size *Characteristics for Tremolite Fragments and Fibers*, United States Department of the Interior, Bureau of Mines, Information Circular 8367, 1979.

5.13. Mefford, D., DCM Laboratory, Denver, private communication, July 1987.

5.14. Deer, W.A., Howie, R.A., Zussman, J., *Rock Forming Minerals*, Longman, Thetford, UK, 1974.

5.15. Kerr, P.F., *Optical Mineralogy;* Third Ed. McGraw-Hill, New York, 1959.

5.16. Veblen, D.R. (Ed.), *Amphiboles and Other Hydrous Pyriboles—Mineralogy, Reviews in Mineralogy*, Vol 9A, Michigan, 1982, pp 1–102.

5.17. Dixon, W.C., *Applications of Optical Microscopy in the Analysis of Asbestos* and Quartz, ACS Symposium Series, No. 120, Analytical Techniques in Occupational Health Chemistry, 1979.

5.18. Polarized Light Microscopy, McCrone Research Institute, Chicago, 1976.

5.19. Asbestos Identification, McCrone Research Institute, G & G printers, Chicago, 1987.

5.20. McCrone, W.C., Calculation of Refractive Indices from Dispersion Staining Data, The Microscope, No 37, Chicago, 1989.

5.21. Levadie, B. (Ed.), *Asbestos and Other Health Related Silicates*, ASTM Technical Publication 834, ASTM, Philadelphia 1982.

5.22. Steel, E. and Wylie, A., Riordan, P.H. (Ed.), Mineralogical Characteristics of Asbestos, *Geology of Asbestos Deposits*, pp. 93–101, SME–AIME, 1981.

5.23. Zussman, J., The Mineralogy of Asbestos, *Asbestos: Properties, Applications and Hazards*, pp. 45–67 Wiley, 1979.

[51 FR 22733, June 20, 1986, as amended at 51 FR 37004, Oct. 17, 1986; 52 FR 17754, 17755, May 12, 1987; 53 FR 35625, September 14, 1988; 54 FR 24334, June 7, 1989; 54 FR 29546, July 13, 1989; 54 FR 52027, Dec. 20, 1989, 55 FR 3731, Feb. 5, 1990; 55 FR 34710, Aug. 24, 1990; 57 FR 24330, June 8, 1992; 59 FR 41057, Aug. 10, 1994; 60 FR 9625, Feb. 21, 1995; 60 FR 33344, June 28, 1995; 60 FR 33984–33987, June 29, 1995; 61 FR 5508, Feb. 13, 1996; 61 FR 43457, Aug. 23, 1996; 63 FR 1285, Jan. 8, 1998]

§ 1910.1002 Coal tar pitch volatiles; interpretation of term.

As used in § 1910.1000 (Table Z-1), coal tar pitch volatiles include the fused polycyclic hydrocarbons which volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter. Asphalt (CAS 8052–42–4, and CAS 64742–93–4) is not covered under the ‘‘coal tar pitch volatiles’’ standard.

[48 FR 2768, Jan. 21, 1983]

§ 1910.1003 13 Carcinogens (4-Nitrobiphenyl, etc.).

(a) *Scope and application*. (1) This section applies to any area in which the 13 carcinogens addressed by this section are manufactured, processed, repackaged, released, handled, or stored, but shall not apply to transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3) and (4) of this section. The 13 carcinogens are the following:

4-Nitrobiphenyl, Chemical Abstracts Service Register Number (CAS No.) 92933;
alpha-Naphthylamine, CAS No. 134327;
methyl chloromethyl ether, CAS No. 107302;
3,′-Dichlorobenzidine (and its salts) CAS No. 91941;
bis-Chloromethyl ether, CAS No. 542881;
beta-Naphthylamine, CAS No. 91598;
Benzidine, CAS No. 92875;
4-Aminodiphenyl, CAS No. 92671;
Ethyleneimine, CAS No. 151564;
beta-Propiolactone, CAS No. 57578;
2-Acetylaminofluorene, CAS No. 53963;
4-Dimethylaminoazo-benezene, CAS No. 60117; and
N-Nitrosodimethylamine, CAS No. 62759.

(2) This section shall not apply to the following:

(i) Solid or liquid mixtures containing less than 0.1 percent by weight or volume of 4–Nitrobiphenyl; methyl chloromethyl ether; bis-chloromethyl ether; beta-Naphthylamine; benzidine or 4–Aminodiphenyl; and

(ii) Solid or liquid mixtures containing less than 1.0 percent by weight or volume of alpha-Naphthylamine; 3,′-Dichlorobenzidine (and its salts); Ethyleneimine; beta-Propiolactone; 2-Acetylaminofluorene; 4-Dimethylaminoazobenzene, or N-Nitrosodimethylamine.

(b) *Definitions.* For the purposes of this section:

Absolute filter is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 μ m particles.

Authorized employee means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

Asbestos NESHAP - 40 CFR Subpart M

(C) The date of each determination of the maximum concentration point, as described in § 61.139(h), and a brief reason for the determination.

(ii) For each vapor incinerator, the date and duration of each exceedance of the boundary parameters recorded under § 61.139(i)(6) and a brief description of the corrective action taken.

(iii) For each vapor incinerator, the date and duration of each period specified as follows:

(A) Each period recorded under § 61.139(i)(7)(i) when the vent stream is diverted from the control device or has no flow rate;

(B) Each period recorded under § 61.139(i)(7)(ii) when the vent stream is diverted from the control device; and

(C) Each period recorded under § 61.139(i)(7)(iii) when the vent stream is diverted from the control device, when the car seal is broken, when the valve is unlocked, or when the valve position has changed.

(iv) For each vapor incinerator, the owner or operator shall specify the method of monitoring chosen under paragraph (f)(2) of this section in the first semiannual report. Any time the owner or operator changes that choice, he shall specify the change in the first semiannual report following the change.

[56 FR 47407, Sept. 19, 1991, as amended at 64 FR 7467, Feb. 12, 1999; 65 FR 62157, Oct. 17, 2000]

Subpart M—National Emission Standard for Asbestos

AUTHORITY: 42 U.S.C. 7401, 7412, 7414, 7416, 7601.

SOURCE: 49 FR 13661, Apr. 5, 1984, unless otherwise noted.

§ 61.140 Applicability.

The provisions of this subpart are applicable to those sources specified in §§ 61.142 through 61.151, 61.154, and 61.155.

[55 FR 48414, Nov. 20, 1990]

§ 61.141 Definitions.

All terms that are used in this subpart and are not defined below are given the same meaning as in the Act and in subpart A of this part.

Active waste disposal site means any disposal site other than an inactive site.

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 means the asbestiform varieties of serpentinite (chrysotile), riebeckite (crocidolite), cummingtonite-grunerite, anthophyllite, and actinolite-tremolite.

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 renovation operations, this term also includes regulated asbestos-containing material waste and materials contaminated with asbestos including disposable equipment and clothing.

Asbestos mill means any facility engaged in converting, or in any intermediate step in converting, asbestos ore into commercial asbestos. Outside storage of asbestos material is not considered a part of the asbestos mill.

Asbestos tailings means any solid waste that contains asbestos and is a product of asbestos mining or milling operations.

Asbestos waste from control devices means any waste material that contains asbestos and is collected by a pollution control device.

Category I nonfriable asbestos-containing material (ACM) means asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos as determined using the method specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy.

Category II nonfriable ACM means any material, excluding Category I nonfriable ACM, containing more than 1 percent asbestos as determined using the methods specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

Commercial asbestos means any material containing asbestos that is extracted from ore and has value because of its asbestos content.

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.

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.

Fabricating means any processing (*e.g.*, cutting, sawing, drilling) of a manufactured product that contains commercial asbestos, with the exception of processing at temporary sites (field fabricating) for the construction or restoration of facilities. In the case of friction products, fabricating includes bonding, debonding, grinding, sawing, drilling, or other similar operations performed as part of fabricating.

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 1 percent asbestos as determined using the method specified in appendix E, subpart E, 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.

Fugitive source means any source of emissions not controlled by an air pollution control device.

Glove bag means a sealed compartment with attached inner gloves used for the handling of asbestos-containing materials. Properly installed and used, glove bags provide a small work area enclosure typically used for small-scale asbestos stripping operations. Information on glove-bag installation, equipment and supplies, and work practices is contained in the Occupational Safety and Health Administration's (OSHA's) final rule on occupational exposure to asbestos (appendix G to 29 CFR 1926.58).

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).

Leak-tight means that solids or liquids cannot escape or spill out. It also means dust-tight.

Malfunction means any sudden and unavoidable failure of air pollution control equipment or process equipment or of a process to operate in a normal or usual manner so that emissions of asbestos are increased. Failures of equipment shall not be considered malfunctions if they are caused in any way by poor maintenance, careless operation, or any other preventable upset conditions, equipment breakdown, or process failure.

Manufacturing means the combining of commercial asbestos—or, in the case of woven friction products, the combining of textiles containing commercial asbestos—with any other material(s), including commercial asbestos, and the processing of this combination into a product. Chlorine production is considered a part of manufacturing.

Natural barrier means a natural object that effectively precludes or deters access. Natural barriers include physical obstacles such as cliffs, lakes or other large bodies of water, deep and wide ravines, and mountains. Remoteness by itself is not a natural barrier.

Nonfriable asbestos-containing material means any material containing more than 1 percent asbestos as determined using the method specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy, that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

Nonscheduled renovation operation means a renovation operation necessitated by the routine failure of equipment, which is expected to occur within a given period based on past operating experience, but for which an exact date cannot be predicted.

Outside air means the air outside buildings and structures, including, but not limited to, the air under a bridge or in an open air ferry dock.

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.

Particulate asbestos material means finely divided particles of asbestos or material containing asbestos.

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 1 percent asbestos as determined using polarized light microscopy according to the method specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy.

Roadways means surfaces on which vehicles travel. This term includes public and private highways, roads, streets, parking areas, and driveways.

Strip means to take off RACM from any part of a facility or facility components.

Structural member means any load-supporting member of a facility, such as beams and load supporting walls; or any nonload-supporting member, such as ceilings and nonload-supporting walls.

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.

Working day means Monday through Friday and includes holidays that fall on any of the days Monday through Friday.

[49 FR 13661, Apr. 5, 1984; 49 FR 25453, June 21, 1984, as amended by 55 FR 48414, Nov. 20, 1990; 56 FR 1669, Jan. 16, 1991; 60 FR 31920, June 19, 1995]

§61.142 Standard for asbestos mills.

(a) Each owner or operator of an asbestos mill shall either discharge no visible emissions to the outside air from that asbestos mill, including fugitive sources, or use the methods specified by §61.152 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

(b) Each owner or operator of an asbestos mill shall meet the following requirements:

(1) Monitor each potential source of asbestos emissions from any part of the mill facility, including air cleaning devices, process equipment, and buildings that house equipment for material processing and handling, at least once each day, during daylight hours, for visible emissions to the outside air during periods of operation. The monitoring shall be by visual observation of at least 15 seconds duration per source of emissions.

(2) Inspect each air cleaning device at least once each week for proper operation and for changes that signal the potential for malfunction, including, to the maximum extent possible without dismantling other than opening the device, the presence of tears, holes, and abrasions in filter bags and for dust deposits on the clean side of bags. For air cleaning devices that cannot be inspected on a weekly basis according to this paragraph, submit to the Administrator, and revise as necessary, a written maintenance plan to include, at a minimum, the following:

(i) Maintenance schedule.

(ii) Recordkeeping plan.

(3) Maintain records of the results of visible emissions monitoring and air cleaning device inspections using a format similar to that shown in Figures 1 and 2 and include the following:

(i) Date and time of each inspection.

(ii) Presence or absence of visible emissions.

(iii) Condition of fabric filters, including presence of any tears, holes, and abrasions.

(iv) Presence of dust deposits on clean side of fabric filters.

(v) Brief description of corrective actions taken, including date and time.

(vi) Daily hours of operation for each air cleaning device.

(4) Furnish upon request, and make available at the affected facility during normal business hours for inspection by the Administrator, all records required under this section.

(5) Retain a copy of all monitoring and inspection records for at least 2 years.

(6) Submit semiannually a copy of visible emission monitoring records to the Administrator if visible emissions occurred during the report period. Semiannual reports shall be postmarked by the 30th day following the end of the six-month period.

Date of inspection (mo/day/yr)	Time of inspection (a.m./p.m.)	Air cleaning device or fugitive source designation or number	Visible emissions observed (yes/no), corrective action taken	Daily operating hours	Inspector's initials

Figure 1. Record of Visible Emission Monitoring

1. Air cleaning device designation or number ____________

2. Date of inspection ______ ______ ______ ______

3. Time of inspection ______ ______ ______ ______

4. Is air cleaning device operating properly (yes/no) ______ ______ ______ ______

5. Tears, holes, or abrasions in fabric filter (yes/no) ______ ______ ______ ______

6. Dust on clean side of fabric filters (yes/no) ______ ______ ______ ______

7. Other signs of malfunctions or potential malfunctions (yes/no) ______ ______ ______ ______

8. Describe other malfunctions or signs of potential malfunctions. ____

9. Describe corrective action(s) taken. ____________

10. Date and time corrective action taken ______ ______ ______ ______

11. Inspected by

(Print/Type Name) (Title) (Signature) (Date)

(Print/Type Name) (Title) (Signature) (Date)

Figure 2. Air Cleaning Device Inspection Checklist

[55 FR 48416, Nov. 20, 1990, as amended at 64 FR 7467, Feb. 12, 1999]

§61.143 Standard for roadways.

No person may construct or maintain a roadway with asbestos tailings or asbestos-containing waste material on that roadway, unless, for asbestos tailings.

(a) It is a temporary roadway on an area of asbestos ore deposits (asbestos mine): or

(b) It is a temporary roadway at an active asbestos mill site and is encapsulated with a resinous or bituminous binder. The encapsulated road surface must be maintained at a minimum frequency of once per year to prevent dust emissions; or

(c) It is encapsulated in asphalt concrete meeting the specifications contained in section 401 of Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP–85, 1985, or their equivalent.

[55 FR 48419, Nov. 20, 1990; 56 FR 1669, Jan. 16, 1991]

§ 61.144 Standard for manufacturing.

(a) *Applicability*. This section applies to the following manufacturing operations using commercial asbestos.

(1) The manufacture of cloth, cord, wicks, tubing, tape, twine, rope, thread, yarn, roving, lap, or other textile materials.

(2) The manufacture of cement products.

(3) The manufacture of fireproofing and insulating materials.

(4) The manufacture of friction products.

(5) The manufacture of paper, millboard, and felt.

(6) The manufacture of floor tile.

(7) The manufacture of paints, coatings, caulks, adhesives, and sealants.

(8) The manufacture of plastics and rubber materials.

(9) The manufacture of chlorine utilizing asbestos diaphragm technology.

(10) The manufacture of shotgun shell wads.

(11) The manufacture of asphalt concrete.

(b) *Standard*. Each owner or operator of any of the manufacturing operations to which this section applies shall either:

(1) Discharge no visible emissions to the outside air from these operations or from any building or structure in which they are conducted or from any other fugitive sources; or

(2) Use the methods specified by § 61.152 to clean emissions from these operations containing particulate asbestos material before they escape to, or are vented to, the outside air.

(3) Monitor each potential source of asbestos emissions from any part of the manufacturing facility, including air cleaning devices, process equipment, and buildings housing material processing and handling equipment, at least once each day during daylight hours for visible emissions to the outside air during periods of operation. The monitoring shall be by visual observation of at least 15 seconds duration per source of emissions.

(4) Inspect each air cleaning device at least once each week for proper operation and for changes that signal the potential for malfunctions, including, to the maximum extent possible without dismantling other than opening the device, the presence of tears, holes, and abrasions in filter bags and for dust deposits on the clean side of bags. For air cleaning devices that cannot be inspected on a weekly basis according to this paragraph, submit to the Administrator, and revise as necessary, a written maintenance plan to include, at a minimum, the following:

(i) Maintenance schedule.

(ii) Recordkeeping plan.

(5) Maintain records of the results of visible emission monitoring and air cleaning device inspections using a format similar to that shown in Figures 1 and 2 and include the following.

(i) Date and time of each inspection.

(ii) Presence or absence of visible emissions.

(iii) Condition of fabric filters, including presence of any tears, holes and abrasions.

(iv) Presence of dust deposits on clean side of fabric filters.

(v) Brief description of corrective actions taken, including date and time.

(vi) Daily hours of operation for each air cleaning device.

(6) Furnish upon request, and make available at the affected facility during normal business hours for inspection by the Administrator, all records required under this section.

(7) Retain a copy of all monitoring and inspection records for at least 2 years.

(8) Submit semiannually a copy of the visible emission monitoring records to the Administrator if visible emission occurred during the report period. Semiannual reports shall be postmarked by the 30th day following the end of the six-month period.

[49 FR 13661, Apr. 5, 1984, as amended at 55 FR 48419, Nov. 20, 1990; 56 FR 1669, Jan. 16, 1991; 64 FR 7467, Feb. 12, 1999]

§61.145 Standard for demolition and renovation.

(a) *Applicability.* To determine which requirements of paragraphs (a), (b), and (c) of this section apply to the owner or operator of a demolition or renovation activity and prior to the commencement of the demolition or renovation, thoroughly inspect the affected facility or part of the facility where the demolition or renovation operation will occur for the presence of asbestos, including Category I and Category II nonfriable ACM. The requirements of paragraphs (b) and (c) of this section apply to each owner or operator of a demolition or renovation activity, including the removal of RACM as follows:

(1) In a facility being demolished, all the requirements of paragraphs (b) and (c) of this section apply, except as provided in paragraph (a)(3) of this section, if the combined amount of RACM is

(i) At least 80 linear meters (260 linear feet) on pipes or at least 15 square meters (160 square feet) on other facility components, or

(ii) At least 1 cubic meter (35 cubic feet) off facility components where the length or area could not be measured previously.

(2) In a facility being demolished, only the notification requirements of paragraphs (b)(1), (2), (3)(i) and (iv), and (4)(i) through (vii) and (4)(ix) and (xvi) of this section apply, if the combined amount of RACM is

(i) Less than 80 linear meters (260 linear feet) on pipes and less than 15 square meters (160 square feet) on other facility components, and

(ii) Less than one cubic meter (35 cubic feet) off facility components where the length or area could not be measured previously or there is no asbestos.

(3) If the facility is being demolished under an order of a State or local government agency, issued because the facility is structurally unsound and in danger of imminent collapse, only the requirements of paragraphs (b)(1), (b)(2), (b)(3)(iii), (b)(4) (except (b)(4)(viii)), (b)(5), and (c)(4) through (c)(9) of this section apply.

(4) In a facility being renovated, including any individual nonscheduled renovation operation, all the requirements of paragraphs (b) and (c) of this section apply if the combined amount of RACM to be stripped, removed, dislodged, cut, drilled, or similarly disturbed is

(i) At least 80 linear meters (260 linear feet) on pipes or at least 15 square meters (160 square feet) on other facility components, or

(ii) At least 1 cubic meter (35 cubic feet) off facility components where the length or area could not be measured previously.

(iii) To determine whether paragraph (a)(4) of this section applies to planned renovation operations involving individual nonscheduled operations, predict the combined additive amount of RACM to be removed or stripped during a calendar year of January 1 through December 31.

(iv) To determine whether paragraph (a)(4) of this section applies to emergency renovation operations, estimate the combined amount of RACM to be removed or stripped as a result of the sudden, unexpected event that necessitated the renovation.

(5) Owners or operators of demolition and renovation operations are exempt from the requirements of §§61.05(a), 61.07, and 61.09.

(b) *Notification requirements.* Each owner or operator of a demolition or renovation activity to which this section applies shall:

(1) Provide the Administrator with written notice of intention to demolish or renovate. Delivery of the notice by U.S. Postal Service, commercial delivery service, or hand delivery is acceptable.

(2) Update notice, as necessary, including when the amount of asbestos affected changes by at least 20 percent.

(3) Postmark or deliver the notice as follows:

(i) At least 10 working days before asbestos stripping or removal work or any other activity begins (such as site preparation that would break up, dislodge or similarly disturb asbestos material), if the operation is described in paragraphs (a) (1) and (4) (except (a)(4)(iii) and (a)(4)(iv)) of this section. If the operation is as described in paragraph (a)(2) of this section, notification is required 10 working days before demolition begins.

(ii) At least 10 working days before the end of the calendar year preceding the year for which notice is being given for renovations described in paragraph (a)(4)(iii) of this section.

(iii) As early as possible before, but not later than, the following working day if the operation is a demolition ordered according to paragraph (a)(3) of this section or, if the operation is a renovation described in paragraph (a)(4)(iv) of this section.

(iv) For asbestos stripping or removal work in a demolition or renovation operation, described in paragraphs (a) (1) and (4) (except (a)(4)(iii) and (a)(4)(iv)) of this section, and for a demolition described in paragraph (a)(2) of this section, that 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 as follows:

(A) When the asbestos stripping or removal operation or demolition operation covered by this paragraph will begin after the date contained in the notice,

(*1*) Notify the Administrator of the new start date by telephone as soon as possible before the original start date, and

(*2*) Provide the Administrator with a written notice of the new start date as soon as possible before, and no later than, the original start date. Delivery of the updated notice by the U.S. Postal Service, commercial delivery service, or hand delivery is acceptable.

(B) When the asbestos stripping or removal operation or demolition operation covered by this paragraph will begin on a date earlier than the original start date,

(*1*) Provide the Administrator with a written notice of the new start date at least 10 working days before asbestos stripping or removal work begins.

(*2*) For demolitions covered by paragraph (a)(2) of this section, provide the Administrator written notice of a new start date at least 10 working days before commencement of demolition. Delivery of updated notice by U.S. Postal Service, commercial delivery service, or hand delivery is acceptable.

(C) In no event shall an operation covered by this paragraph begin on a date other than the date contained in the written notice of the new start date.

(4) Include the following in the notice:

(i) An indication of whether the notice is the original or a revised notification.

(ii) Name, address, and telephone number of both the facility owner and operator and the asbestos removal contractor owner or operator.

(iii) Type of operation: demolition or renovation.

(iv) Description of the facility or affected part of the facility including the size (square meters [square feet] and number of floors), age, and present and prior use of the facility.

(v) Procedure, including analytical methods, employed to detect the presence of RACM and Category I and Category II nonfriable ACM.

(vi) Estimate of the approximate amount of RACM to be removed from the facility in terms of length of pipe in linear meters (linear feet), surface area in square meters (square feet) on other facility components, or volume in cubic meters (cubic feet) if off the facility components. Also, estimate the approximate amount of Category I and Category II nonfriable ACM in the affected part of the facility that will not be removed before demolition.

(vii) Location and street address (including building number or name and floor or room number, if appropriate), city, county, and state, of the facility being demolished or renovated.

(viii) Scheduled starting and completion dates of asbestos removal work (or any other activity, such as site preparation that would break up, dislodge, or similarly disturb asbestos material) in a demolition or renovation; planned renovation operations involving individual nonscheduled operations shall only include the beginning and ending dates of the report period as described in paragraph (a)(4)(iii) of this section.

(ix) Scheduled starting and completion dates of demolition or renovation.

(x) Description of planned demolition or renovation work to be performed and method(s) to be employed, including demolition or renovation techniques to be used and description of affected facility components.

(xi) Description of work practices and engineering controls to be used to comply with the requirements of this subpart, including asbestos removal and waste-handling emission control procedures.

(xii) Name and location of the waste disposal site where the asbestos-containing waste material will be deposited.

(xiii) A certification that at least one person trained as required by paragraph (c)(8) of this section will supervise the stripping and removal described by this notification. This requirement shall become effective 1 year after promulgation of this regulation.

(xiv) For facilities described in paragraph (a)(3) of this section, the name, title, and authority of the State or local government representative who has ordered the demolition, the date that the order was issued, and the date on which the demolition was ordered to begin. A copy of the order shall be attached to the notification.

(xv) For emergency renovations described in paragraph (a)(4)(iv) of this section, the date and 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.

(xvi) Description of procedures to be followed in the event that unexpected RACM is found or Category II nonfriable ACM becomes crumbled, pulverized, or reduced to powder.

(xvii) Name, address, and telephone number of the waste transporter.

(5) The information required in paragraph (b)(4) of this section must be reported using a form similiar to that shown in Figure 3.

(c) *Procedures for asbestos emission control.* Each owner or operator of a demolition or renovation activity to whom this paragraph applies, according to paragraph (a) of this section, shall comply with the following procedures:

(1) Remove all RACM 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. RACM need not be removed before demolition if:

(i) It is Category I nonfriable ACM that is not in poor condition and is not friable.

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

(iii) It was not accessible for testing and was, therefore, not discovered until after demolition began and, as a result of the demolition, the material 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 adequately wet at all times until disposed of.

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

(2) When a facility component that contains, is covered with, or is coated with RACM is being taken out of the facility as a unit or in sections:

(i) Adequately wet all RACM exposed during cutting or disjoining operations; and

(ii) Carefully lower each unit or section to the floor and to ground level, not dropping, throwing, sliding, or otherwise damaging or disturbing the RACM.

(3) When RACM is stripped from a facility component while it remains in place in the facility, adequately wet the RACM during the stripping operation.

(i) In renovation operations, wetting is not required if:

(A) The owner or operator has obtained prior written approval from the Administrator based on a written application that wetting to comply with this paragraph would unavoidably damage equipment or present a safety hazard; and

(B) The owner or operator uses of the following emission control methods:

(*1*) A local exhaust ventilation and collection system designed and operated to capture the particulate asbestos material produced by the stripping and removal of the asbestos materials. The system must exhibit no visible emissions to the outside air or be designed and operated in accordance with the requirements in § 61.152.

(*2*) A glove-bag system designed and operated to contain the particulate asbestos material produced by the stripping of the asbestos materials.

(*3*) Leak-tight wrapping to contain all RACM prior to dismantlement.

(ii) In renovation operations where wetting would result in equipment damage or a safety hazard, and the methods allowed in paragraph (c)(3)(i) of this section cannot be used, another method may be used after obtaining written approval from the Administrator based upon a determination that it is equivalent to wetting in controlling emissions or to the methods allowed in paragraph (c)(3)(i) of this section.

(iii) A copy of the Administrator's written approval shall be kept at the worksite and made available for inspection.

(4) After a facility component covered with, coated with, or containing RACM has been taken out of the facility as a unit or in sections pursuant to paragraph (c)(2) of this section, it shall be stripped or contained in leak-tight wrapping, except as described in paragraph (c)(5) of this section. If stripped, either:

(i) Adequately wet the RACM during stripping; or

(ii) Use a local exhaust ventilation and collection system designed and operated to capture the particulate asbestos material produced by the stripping. The system must exhibit no visible emissions to the outside air or be designed and operated in accordance with the requirements in § 61.152.

(5) For large facility components such as reactor vessels, large tanks, and steam generators, but not beams (which must be handled in accordance with paragraphs (c)(2), (3), and (4) of this section), the RACM is not required to be stripped if the following requirements are met:

(i) The component is removed, transported, stored, disposed of, or reused without disturbing or damaging the RACM.

(ii) The component is encased in a leak-tight wrapping.

(iii) The leak-tight wrapping is labeled according to § 61.149(d)(1)(i), (ii), and (iii) during all loading and unloading operations and during storage.

(6) For all RACM, including material that has been removed or stripped:

(i) Adequately wet the material and ensure that it remains wet until collected and contained or treated in preparation for disposal in accordance with § 61.150; and

(ii) Carefully lower the material to the ground and floor, not dropping, throwing, sliding, or otherwise damaging or disturbing the material.

(iii) Transport the material to the ground via leak-tight chutes or containers if it has been removed or stripped more than 50 feet above ground level and was not removed as units or in sections.

(iv) RACM contained in leak-tight wrapping that has been removed in accordance with paragraphs (c)(4) and (c)(3)(i)(B)(*3*) of this section need not be wetted.

(7) When the temperature at the point of wetting is below 0 °C (32 °F):

(i) The owner or operator need not comply with paragraph (c)(2)(i) and the wetting provisions of paragraph (c)(3) of this section.

(ii) The owner or operator shall remove facility components containing, coated with, or covered with RACM as units or in sections to the maximum extent possible.

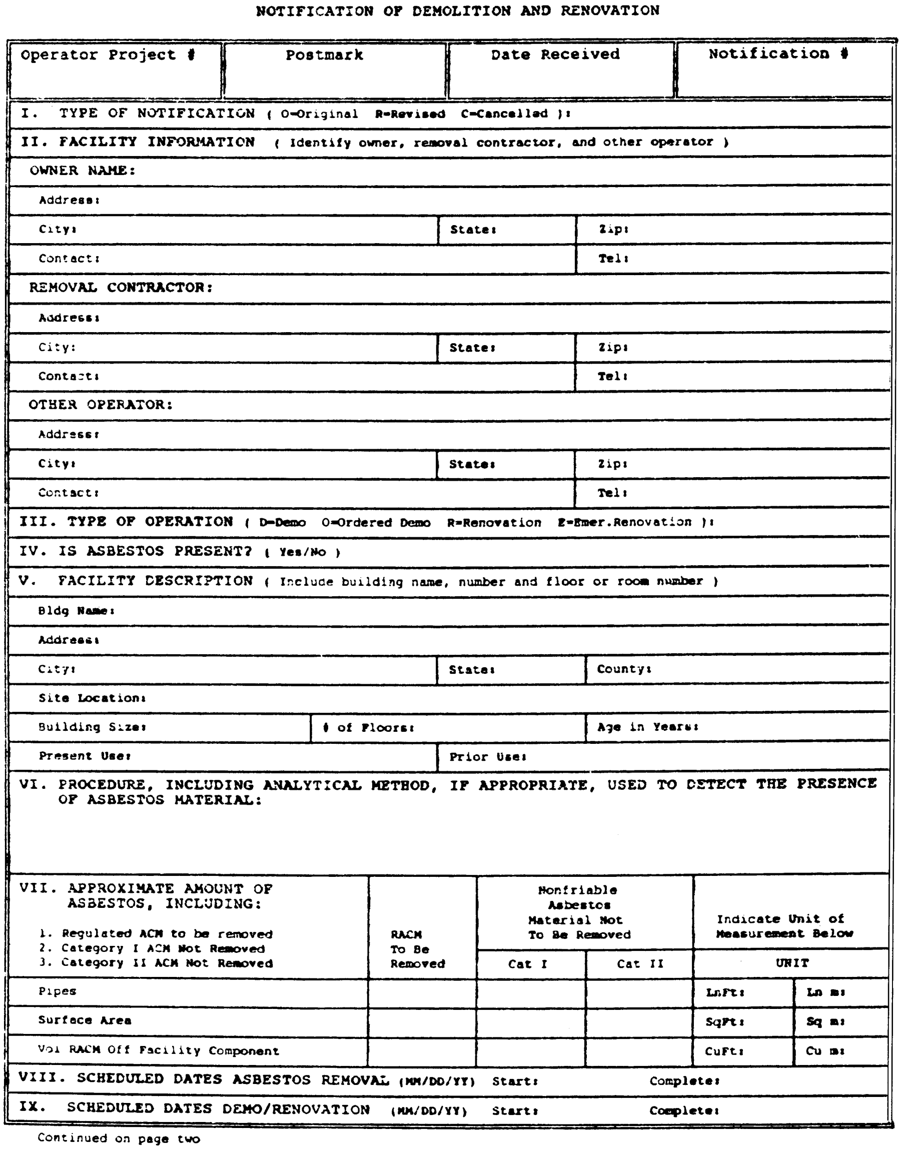
(iii) During periods when wetting operations are suspended due to freezing temperatures, the owner or operator must record the temperature in the area containing the facility components at the beginning, middle, and end of each workday and keep daily temperature records available for inspection by the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

(8) Effective 1 year after promulgation of this regulation, no RACM shall

be stripped, removed, or otherwise handled or disturbed at a facility regulated by this section unless at least one on-site representative, such as a foreman or management-level person or other authorized representative, trained in the provisions of this regulation and the means of complying with them, is present. Every 2 years, the trained on-site individual shall receive refresher training in the provisions of this regulation. The required training shall include as a minimum: applicability; notifications; material identification; control procedures for removals including, at least, wetting, local exhaust ventilation, negative pressure enclosures, glove-bag procedures, and High Efficiency Particulate Air (HEPA) filters; waste disposal work practices; reporting and recordkeeping; and asbestos hazards and worker protection. Evidence that the required training has been completed shall be posted and made available for inspection by the Administrator at the demolition or renovation site.

(9) For facilities described in paragraph (a)(3) of this section, adequately wet the portion of the facility that contains RACM during the wrecking operation.

(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.



NOTIFICATION OF DEMOLITION AND RENOVATION

Operator Project #	Postmark	Date Received	Notification #

I. TYPE OF NOTIFICATION (O=Original R=Revised C=Cancelled):

II. FACILITY INFORMATION (Identify owner, removal contractor, and other operator)

OWNER NAME:

Address:

City:	State:	Zip:
Contact:		Tel:

REMOVAL CONTRACTOR:

Address:

City:	State:	Zip:
Contact:		Tel:

OTHER OPERATOR:

Address:

City:	State:	Zip:
Contact:		Tel:

III. TYPE OF OPERATION (D=Demo O=Ordered Demo R=Renovation E=Emer.Renovation):

IV. IS ASBESTOS PRESENT? (Yes/No)

V. FACILITY DESCRIPTION (Include building name, number and floor or room number)

Bldg Name:

Address:

City:	State:	County:

Site Location:

Building Size:	# of Floors:	Age in Years:
Present Use:	Prior Use:	

VI. PROCEDURE, INCLUDING ANALYTICAL METHOD, IF APPROPRIATE, USED TO DETECT THE PRESENCE OF ASBESTOS MATERIAL:

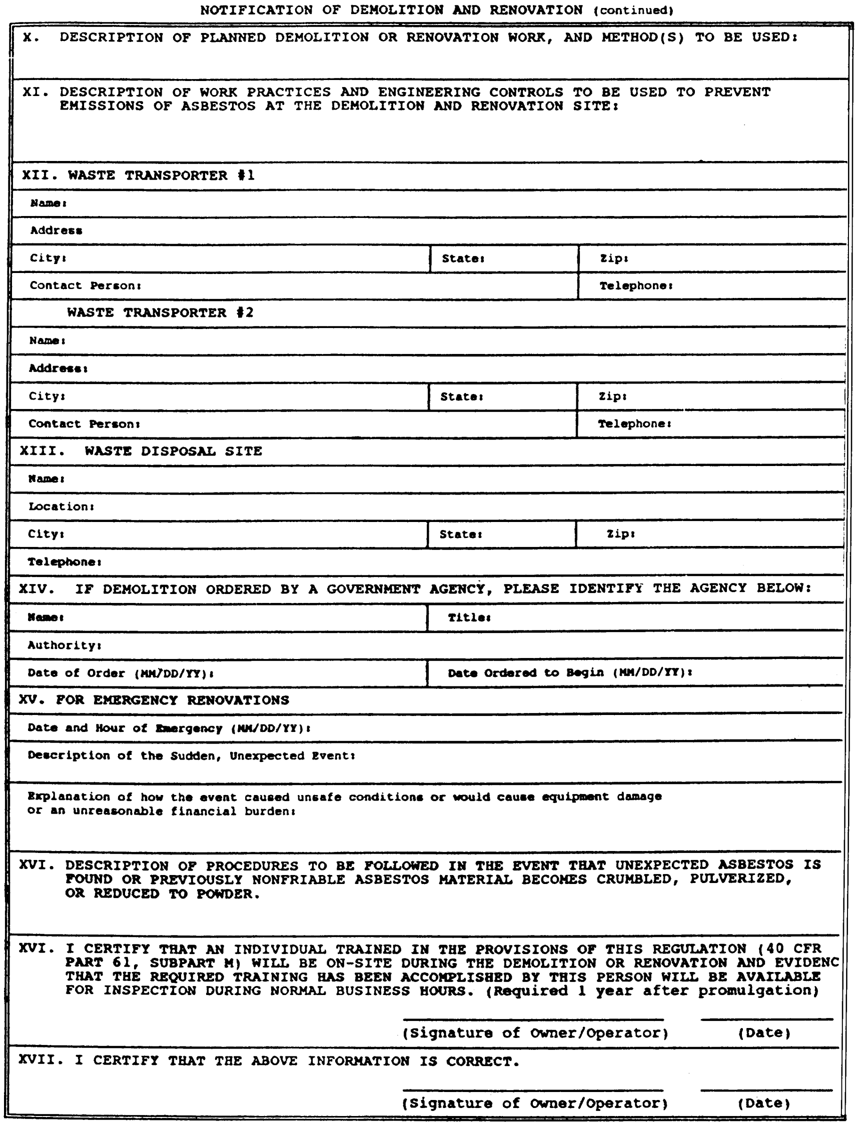
VII. APPROXIMATE AMOUNT OF ASBESTOS, INCLUDING: 1. Regulated ACM to be removed 2. Category I ACM Not Removed 3. Category II ACM Not Removed	RACM To Be Removed	Nonfriable Asbestos Material Not To Be Removed		Indicate Unit of Measurement Below	
		Cat I	Cat II	UNIT	
Pipes				LnFt:	Ln m:
Surface Area				SqFt:	Sq m:
Vol RACM Off Facility Component				CuFt:	Cu m:

VIII. SCHEDULED DATES ASBESTOS REMOVAL (MM/DD/YY) Start: Complete:

IX. SCHEDULED DATES DEMO/RENOVATION (MM/DD/YY) Start: Complete:

Continued on page two

Figure 3. Notification of Demolition and Renovation



NOTIFICATION OF DEMOLITION AND RENOVATION (continued)

X. DESCRIPTION OF PLANNED DEMOLITION OR RENOVATION WORK, AND METHOD(S) TO BE USED:

XI. DESCRIPTION OF WORK PRACTICES AND ENGINEERING CONTROLS TO BE USED TO PREVENT EMISSIONS OF ASBESTOS AT THE DEMOLITION AND RENOVATION SITE:

XII. WASTE TRANSPORTER #1

Name:

Address

City: State: Zip:

Contact Person: Telephone:

WASTE TRANSPORTER #2

Name:

Address:

City: State: Zip:

Contact Person: Telephone:

XIII. WASTE DISPOSAL SITE

Name:

Location:

City: State: Zip:

Telephone:

XIV. IF DEMOLITION ORDERED BY A GOVERNMENT AGENCY, PLEASE IDENTIFY THE AGENCY BELOW:

Name: Title:

Authority:

Date of Order (MM/DD/YY): Date Ordered to Begin (MM/DD/YY):

XV. FOR EMERGENCY RENOVATIONS

Date and Hour of Emergency (MM/DD/YY):

Description of the Sudden, Unexpected Event:

Explanation of how the event caused unsafe conditions or would cause equipment damage or an unreasonable financial burden:

XVI. DESCRIPTION OF PROCEDURES TO BE FOLLOWED IN THE EVENT THAT UNEXPECTED ASBESTOS IS FOUND OR PREVIOUSLY NONFRIABLE ASBESTOS MATERIAL BECOMES CRUMBLED, PULVERIZED, OR REDUCED TO POWDER.

XVI. I CERTIFY THAT AN INDIVIDUAL TRAINED IN THE PROVISIONS OF THIS REGULATION (40 CFR PART 61, SUBPART M) WILL BE ON-SITE DURING THE DEMOLITION OR RENOVATION AND EVIDENC THAT THE REQUIRED TRAINING HAS BEEN ACCOMPLISHED BY THIS PERSON WILL BE AVAILABLE FOR INSPECTION DURING NORMAL BUSINESS HOURS. (Required 1 year after promulgation)

(Signature of Owner/Operator) (Date)

XVII. I CERTIFY THAT THE ABOVE INFORMATION IS CORRECT.

(Signature of Owner/Operator) (Date)

Figure 3. Notification of Demolition and Renovation

[55 FR 48419, Nov. 20, 1990; 56 FR 1669, Jan. 16, 1991]

§ 61.146 Standard for spraying.

The owner or operator of an operation in which asbestos-containing materials are spray applied shall comply with the following requirements:

(a) For spray-on application on buildings, structures, pipes, and conduits, do not use material containing more than 1 percent asbestos as determined using the method specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy, except as provided in paragraph (c) of this section.

(b) For spray-on application of materials that contain more than 1 percent asbestos as determined using the method specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy, on equipment and machinery, except as provided in paragraph (c) of this section:

(1) Notify the Administrator at least 20 days before beginning the spraying operation. Include the following information in the notice:

(i) Name and address of owner or operator.

(ii) Location of spraying operation.

(iii) Procedures to be followed to meet the requirements of this paragraph.

(2) Discharge no visible emissions to the outside air from spray-on application of the asbestos-containing material or use the methods specified by § 61.152 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

(c) The requirements of paragraphs (a) and (b) of this section do not apply to the spray-on application of materials where the asbestos fibers in the materials are encapsulated with a bituminous or resinous binder during spraying and the materials are not friable after drying.

(d) Owners or operators of sources subject to this paragraph are exempt from the requirements of §§ 61.05(a), 61.07 and 61.09.

[49 FR 13661, Apr. 5, 1984. Redesignated and amended at 55 FR 48424, Nov. 20, 1990; 60 FR 31920, June 19, 1995]

§ 61.147 Standard for fabricating.

(a) *Applicability.* This section applies to the following fabricating operations using commercial asbestos:

(1) The fabrication of cement building products.

(2) The fabrication of friction products, except those operations that primarily install asbestos friction materials on motor vehicles.

(3) The fabrication of cement or silicate board for ventilation hoods; ovens; electrical panels; laboratory furniture, bulkheads, partitions, and ceilings for marine construction; and flow control devices for the molten metal industry.

(b) *Standard.* Each owner or operator of any of the fabricating operations to which this section applies shall either:

(1) Discharge no visible emissions to the outside air from any of the operations or from any building or structure in which they are conducted or from any other fugitive sources; or

(2) Use the methods specified by § 61.152 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

(3) Monitor each potential source of asbestos emissions from any part of the fabricating facility, including air cleaning devices, process equipment, and buildings that house equipment for material processing and handling, at least once each day, during daylight hours, for visible emissions to the outside air during periods of operation. The monitoring shall be by visual observation of at least 15 seconds duration per source of emissions.

(4) Inspect each air cleaning device at least once each week for proper operation and for changes that signal the potential for malfunctions, including, to the maximum extent possible without dismantling other than opening the device, the presence of tears, holes, and abrasions in filter bags and for dust deposits on the clean side of bags. For air cleaning devices that cannot be inspected on a weekly basis according to this paragraph, submit to the Administrator, and revise as necessary, a written maintenance plan to include, at a minimum, the following:

(i) Maintenance schedule.

(ii) Recordkeeping plan.

(5) Maintain records of the results of visible emission monitoring and air cleaning device inspections using a format similar to that shown in Figures 1 and 2 and include the following:

(i) Date and time of each inspection.

(ii) Presence or absence of visible emissions.

(iii) Condition of fabric filters, including presence of any tears, holes, and abrasions.

(iv) Presence of dust deposits on clean side of fabric filters.

(v) Brief description of corrective actions taken, including date and time.

(vi) Daily hours of operation for each air cleaning device.

(6) Furnish upon request and make available at the affected facility during normal business hours for inspection by the Administrator, all records required under this section.

(7) Retain a copy of all monitoring and inspection records for at least 2 years.

(8) Submit semiannually a copy of the visible emission monitoring records to the Administrator if visible emission occurred during the report period. Semiannual reports shall be postmarked by the 30th day following the end of the six-month period.

[49 FR 13661, Apr. 5, 1984. Redesignated and amended at 55 FR 48424, Nov. 20, 1991; 64 FR 7467, Feb. 12, 1999]

§61.148 Standard for insulating materials.

No owner or operator of a facility may install or reinstall on a facility component any insulating materials that contain commercial asbestos if the materials are either molded and friable or wet-applied and friable after drying. The provisions of this section do not apply to spray-applied insulating materials regulated under §61.146.

[55 FR 48424, Nov. 20, 1990]

§61.149 Standard for waste disposal for asbestos mills.

Each owner or operator of any source covered under the provisions of §61.142 shall:

(a) Deposit all asbestos-containing waste material at a waste disposal site operated in accordance with the provisions of §61.154; and

(b) Discharge no visible emissions to the outside air from the transfer of control device asbestos waste to the tailings conveyor, or use the methods specified by §61.152 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air. Dispose of the asbestos waste from control devices in accordance with §61.150(a) or paragraph (c) of this section; and

(c) Discharge no visible emissions to the outside air during the collection, processing, packaging, or on-site transporting of any asbestos-containing waste material, or use one of the disposal methods specified in paragraphs (c) (1) or (2) of this section, as follows:

(1) Use a wetting agent as follows:

(i) Adequately mix all asbestos-containing waste material with a wetting agent recommended by the manufacturer of the agent to effectively wet dust and tailings, before depositing the material at a waste disposal site. Use the agent as recommended for the particular dust by the manufacturer of the agent.

(ii) Discharge no visible emissions to the outside air from the wetting operation or use the methods specified by §61.152 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

(iii) Wetting may be suspended when the ambient temperature at the waste disposal site is less than −9.5 °C (15 °F), as determined by an appropriate measurement method with an accuracy of ±1 °C (±2 °F). During periods when wetting operations are suspended, the temperature must be recorded at least at hourly intervals, and records must be retained for at least 2 years in a form suitable for inspection.

(2) Use an alternative emission control and waste treatment method that has received prior written approval by the Administrator. To obtain approval for an alternative method, a written application must be submitted to the Administrator demonstrating that the following criteria are met:

(i) The alternative method will control asbestos emissions equivalent to currently required methods.

(ii) The suitability of the alternative method for the intended application.

(iii) The alternative method will not violate other regulations.

(iv) The alternative method will not result in increased water pollution, land pollution, or occupational hazards.

(d) When waste is transported by vehicle to a disposal site:

(1) Mark vehicles used to transport asbestos-containing waste material during the loading and unloading of the waste so that the signs are visible. The markings must:

(i) Be displayed in such a manner and location that a person can easily read the legend.

(ii) Conform to the requirements for 51 cm × 36 cm (20 in × 14 in) upright format signs specified in 29 CFR 1910.145(d)(4) and this paragraph; and

(iii) Display the following legend in the lower panel with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

Legend	Notation
DANGER	2.5 cm (1 inch) Sans Serif, Gothic or Block
ASBESTOS DUST HAZARD	2.5 cm (1 inch) Sans Serif, Gothic or Block
CANCER AND LUNG DISEASE HAZARD	1.9 cm (¾ inch) Sans Serif, Gothic or Block
Authorized Personnel Only	14 Point Gothic

Spacing between any two lines must be a least equal to the height of the upper of the two lines.

(2) For off-site disposal, provide a copy of the waste shipment record, described in paragraph (e)(1) of this section, to the disposal site owner or operator at the same time as the asbestos-containing waste material is delivered to the disposal site.

(e) For all asbestos-containing waste material transported off the facility site:

(1) Maintain asbestos waste shipment records, using a form similar to that shown in Figure 4, and include the following information:

(i) The name, address, and telephone number of the waste generator.

(ii) The name and address of the local, State, or EPA Regional agency responsible for administering the asbestos NESHAP program.

(iii) The quantity of the asbestos-containing waste material in cubic meters (cubic yards).

(iv) The name and telephone number of the disposal site operator.

(v) The name and physical site location of the disposal site.

(vi) The date transported.

(vii) The name, address, and telephone number of the transporter(s).

(viii) A certification that the contents of this consignment are fully and accurately described 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.

(2) For waste shipments where a copy of the waste shipment record, signed by the owner or operator of the designated disposal site, is not received by the waste generator within 35 days of the date the waste was accepted by the initial transporter, contact the transporter and/or the owner or operator of the designated disposal site to determine the status of the waste shipment.

(3) Report in writing to the local, State, or EPA Regional office responsible for administering the asbestos NESHAP program for the waste generator if a copy of the waste shipment record, signed by the owner or operator of the designated waste disposal site, is not received by the waste generator within 45 days of the date the waste was accepted by the initial transporter. Include in the report the following information:

(i) A copy of the waste shipment record for which a confirmation of delivery was not received, and

(ii) A cover letter signed by the waste generator explaining the efforts taken to locate the asbestos waste shipment and the results of those efforts.

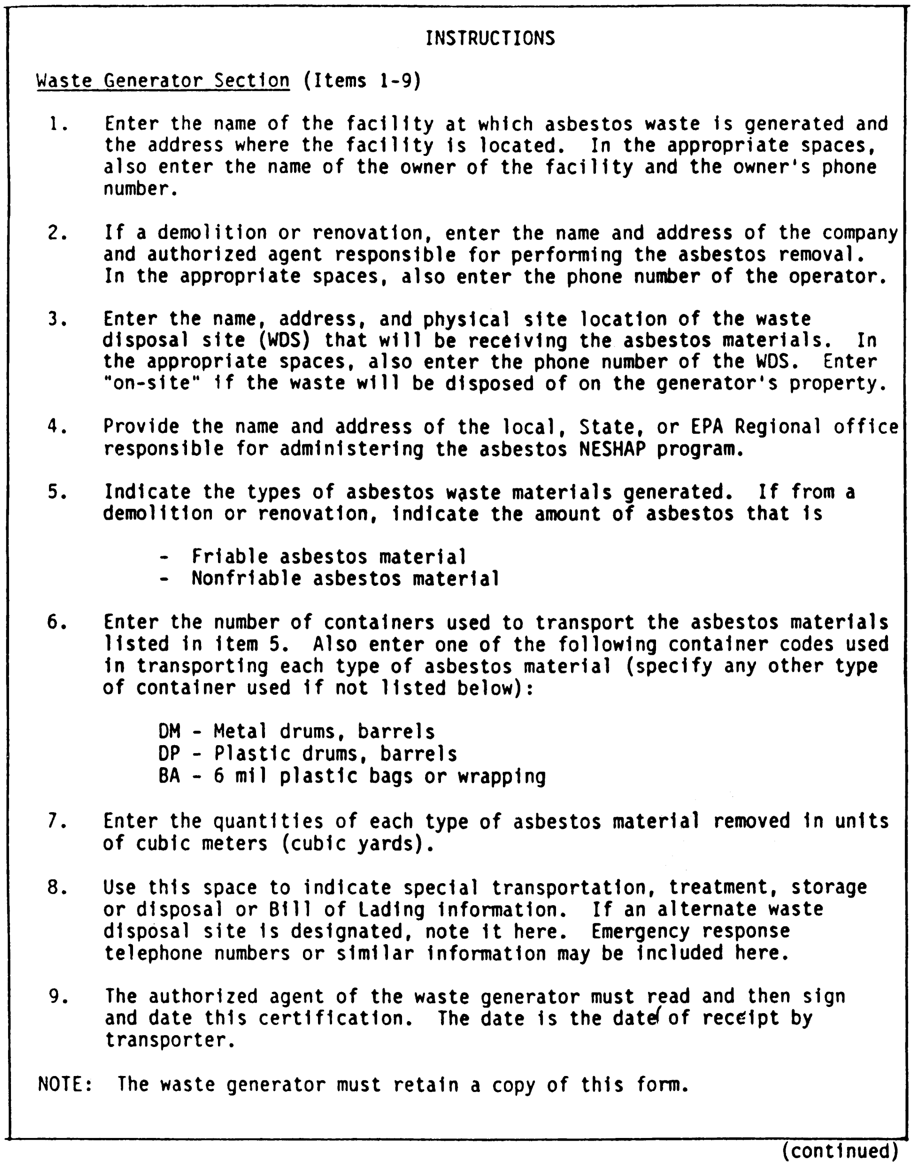
(4) Retain a copy of all waste shipment records, including a copy of the waste shipment record signed by the owner or operator of the designated waste disposal site, for at least 2 years.

(f) Furnish upon request, and make available for inspection by the Administrator, all records required under this section.

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 4. 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.

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.

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

(continued)

Figure 4. Waste Shipment Record

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 4. Waste Shipment Record

§61.150 Standard for waste disposal for manufacturing, fabricating, demolition, renovation, and spraying operations.

Each owner or operator of any source covered under the provisions of §§61.144, 61.145, 61.146, and 61.147 shall comply with the following provisions:

(a) Discharge no visible emissions to the outside air during the collection, processing (including incineration), packaging, or transporting of any asbestos-containing waste material generated by the source, or use one of the emission control and waste treatment methods specified in paragraphs (a) (1) through (4) of this section.

(1) Adequately wet asbestos-containing waste material as follows:

(i) Mix control device asbestos waste to form a slurry; adequately wet other asbestos-containing waste material; and

(ii) Discharge no visible emissions to the outside air from collection, mixing, wetting, and handling operations, or use the methods specified by §61.152 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air; and

(iii) After wetting, seal all asbestos-containing waste material in leak-tight containers while wet; or, for materials that will not fit into containers without additional breaking, put materials into leak-tight wrapping; and

(iv) Label the containers or wrapped materials specified in paragraph (a)(1)(iii) of this section using warning labels specified by Occupational Safety and Health Standards of the Department of Labor, Occupational Safety and Health Administration (OSHA) under 29 CFR 1910.1001(j)(4) or 1926.1101(k)(8). The labels shall be printed in letters of sufficient size and contrast so as to be readily visible and legible.

(v) For asbestos-containing waste material to be transported off the facility site, label containers or wrapped materials with the name of the waste generator and the location at which the waste was generated.

(2) Process asbestos-containing waste material into nonfriable forms as follows:

(i) Form all asbestos-containing waste material into nonfriable pellets or other shapes;

(ii) Discharge no visible emissions to the outside air from collection and processing operations, including incineration, or use the method specified by § 61.152 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

(3) For facilities demolished where the RACM is not removed prior to demolition according to §§ 61.145(c)(1) (i), (ii), (iii), and (iv) or for facilities demolished according to § 61.145(c)(9), adequately wet asbestos-containing waste material at all times after demolition and keep wet during handling and loading for transport to a disposal site. Asbestos-containing waste materials covered by this paragraph do not have to be sealed in leak-tight containers or wrapping but may be transported and disposed of in bulk.

(4) Use an alternative emission control and waste treatment method that has received prior approval by the Administrator according to the procedure described in § 61.149(c)(2).

(5) As applied to demolition and renovation, the requirements of paragraph (a) of this section do not apply to Category I nonfriable ACM waste and Category II nonfriable ACM waste that did not become crumbled, pulverized, or reduced to powder.

(b) All asbestos-containing waste material shall be deposited as soon as is practical by the waste generator at:

(1) A waste disposal site operated in accordance with the provisions of § 61.154, or

(2) An EPA-approved site that converts RACM and asbestos-containing waste material into nonasbestos (asbestos-free) material according to the provisions of § 61.155.

(3) The requirements of paragraph (b) of this section do not apply to Category I nonfriable ACM that is not RACM.

(c) Mark vehicles used to transport asbestos-containing waste material during the loading and unloading of waste so that the signs are visible. The markings must conform to the requirements of §§ 61.149(d)(1) (i), (ii), and (iii).

(d) For all asbestos-containing waste material transported off the facility site:

(1) Maintain waste shipment records, using a form similar to that shown in Figure 4, and include the following information:

(i) The name, address, and telephone number of the waste generator.

(ii) The name and address of the local, State, or EPA Regional office responsible for administering the asbestos NESHAP program.

(iii) The approximate quantity in cubic meters (cubic yards).

(iv) The name and telephone number of the disposal site operator.

(v) The name and physical site location of the disposal site.

(vi) The date transported.

(vii) The name, address, and telephone number of the transporter(s).

(viii) A certification that the contents of this consignment are fully and accurately described 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.

(2) Provide a copy of the waste shipment record, described in paragraph (d)(1) of this section, to the disposal site owners or operators at the same time as the asbestos-containing waste material is delivered to the disposal site.

(3) For waste shipments where a copy of the waste shipment record, signed by the owner or operator of the designated disposal site, is not received by the waste generator within 35 days of the date the waste was accepted by the initial transporter, contact the transporter and/or the owner or operator of the designated disposal site to determine the status of the waste shipment.

(4) Report in writing to the local, State, or EPA Regional office responsible for administering the asbestos NESHAP program for the waste generator if a copy of the waste shipment record, signed by the owner or operator of the designated waste disposal site, is not received by the waste generator within 45 days of the date the waste

was accepted by the initial transporter. Include in the report the following information:

(i) A copy of the waste shipment record for which a confirmation of delivery was not received, and

(ii) A cover letter signed by the waste generator explaining the efforts taken to locate the asbestos waste shipment and the results of those efforts.

(5) Retain a copy of all waste shipment records, including a copy of the waste shipment record signed by the owner or operator of the designated waste disposal site, for at least 2 years.

(e) Furnish upon request, and make available for inspection by the Administrator, all records required under this section.

[55 FR 48429, Nov. 20, 1990; 56 FR 1669, Jan. 16, 1991, as amended at 68 FR 54793, Sept. 18, 2003]

§61.151 Standard for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations.

Each owner or operator of any inactive waste disposal site that was operated by sources covered under §61.142, 61.144, or 61.147 and received deposits of asbestos-containing waste material generated by the sources, shall:

(a) Comply with one of the following:

(1) Either discharge no visible emissions to the outside air from an inactive waste disposal site subject to this paragraph; or

(2) Cover the asbestos-containing waste material with at least 15 centimeters (6 inches) of compacted nonasbestos-containing material, and grow and maintain a cover of vegetation on the area adequate to prevent exposure of the asbestos-containing waste material. In desert areas where vegetation would be difficult to maintain, at least 8 additional centimeters (3 inches) of well-graded, nonasbestos crushed rock may be placed on top of the final cover instead of vegetation and maintained to prevent emissions; or

(3) Cover the asbestos-containing waste material with at least 60 centimeters (2 feet) of compacted nonasbestos-containing material, and maintain it to prevent exposure of the asbestos-containing waste; or

(4) For inactive waste disposal sites for asbestos tailings, a resinous or petroleum-based dust suppression agent that effectively binds dust to control surface air emissions may be used instead of the methods in paragraphs (a) (1), (2), and (3) of this section. Use the agent in the manner and frequency recommended for the particular asbestos tailings by the manufacturer of the dust suppression agent to achieve and maintain dust control. Obtain prior written approval of the Administrator to use other equally effective dust suppression agents. For purposes of this paragraph, any used, spent, or other waste oil is not considered a dust suppression agent.

(b) Unless a natural barrier adequately deters access by the general public, install and maintain warning signs and fencing as follows, or comply with paragraph (a)(2) or (a)(3) of this section.

(1) Display warning signs at all entrances and at intervals of 100 m (328 ft) or less along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material was deposited. The warning signs must:

(i) Be posted in such a manner and location that a person can easily read the legend; and

(ii) Conform to the requirements for 51 cm×36 cm (20″×14″) upright format signs specified in 29 CFR 1910.145(d)(4) and this paragraph; and

(iii) Display the following legend in the lower panel with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

Legend	Notation
Asbestos Waste Disposal Site.	2.5 cm (1 inch) Sans Serif, Gothic or Block
Do Not Create Dust	1.9 cm (¾ inch) Sans Serif, Gothic or Block
Breathing Asbestos is Hazardous to Your Health.	14 Point Gothic.

Spacing between any two lines must be at least equal to the height of the upper of the two lines.

(2) Fence the perimeter of the site in a manner adequate to deter access by the general public.

(3) When requesting a determination on whether a natural barrier adequately deters public access, supply information enabling the Administrator to determine whether a fence or a natural barrier adequately deters access by the general public.

(c) The owner or operator may use an alternative control method that has received prior approval of the Administrator rather than comply with the requirements of paragraph (a) or (b) of this section.

(d) Notify the Administrator in writing at least 45 days prior to excavating or otherwise disturbing any asbestos-containing waste material that has been deposited at a waste disposal site under this section, and follow the procedures specified in the notification. 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 and in no event shall excavation begin earlier than the date specified in the original notification. Include the following information in the notice:

(1) Scheduled starting and completion dates.

(2) Reason for disturbing the waste.

(3) Procedures to be used to control emissions during the excavation, storage, transport, and ultimate disposal of the excavated asbestos-containing waste material. If deemed necessary, the Administrator may require changes in the emission control procedures to be used.

(4) Location of any temporary storage site and the final disposal site.

(e) Within 60 days of a site becoming inactive and after the effective date of this subpart, 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; this notation will in perpetuity notify any potential purchaser of the property that:

(1) The land has been used for the disposal of asbestos-containing waste material;

(2) The survey plot and record of the location and quantity of asbestos-containing waste disposed of within the disposal site required in §61.154(f) have been filed with the Administrator; and

(3) The site is subject to 40 CFR part 61, subpart M.

[49 FR 13661, Apr. 5, 1984, as amended at 53 FR 36972, Sept. 23, 1988. Redesignated and amended at 55 FR 48429, Nov. 20, 1990]

§61.152 Air-cleaning.

(a) The owner or operator who uses air cleaning, as specified in §§61.142(a), 61.144(b)(2), 61.145(c)(3)(i)(B)(*1*), 61.145(c)(4)(ii), 61.145(c)(11)(i), 61.146(b)(2), 61.147(b)(2), 61.149(b), 61.149(c)(1)(ii), 61.150(a)(1)(ii), 61.150(a)(2)(ii), and 61.155(e) shall:

(1) Use fabric filter collection devices, except as noted in paragraph (b) of this section, doing all of the following:

(i) Ensuring that the airflow permeability, as determined by ASTM Method D737–75, does not exceed 9 $m^3/min/m^2$ (30 $ft^3/min/ft^2$) for woven fabrics or $11^3/min/m^2$(35 $ft^3/min/ft^2$) for felted fabrics, except that 12 $m^3/min/m^2$ (40 ft^3min/ft^2) for woven and 14 $m^3/min/m^2$ (45 ft $^3min/ft^2$) for felted fabrics is allowed for filtering air from asbestos ore dryers; and

(ii) Ensuring that felted fabric weighs at least 475 grams per square meter (14 ounces per square yard) and is at least 1.6 millimeters (one-sixteenth inch) thick throughout; and

(iii) Avoiding the use of synthetic fabrics that contain fill yarn other than that which is spun.

(2) Properly install, use, operate, and maintain all air-cleaning equipment authorized by this section. Bypass devices may be used only during upset or emergency conditions and then only for so long as it takes to shut down the operation generating the particulate asbestos material.

(3) For fabric filter collection devices installed after January 10, 1989, provide for easy inspection for faulty bags.

(b) There are the following exceptions to paragraph (a)(1):

(1) After January 10, 1989, if the use of fabric creates a fire or explosion hazard, or the Administrator determines that a fabric filter is not feasible, the Administrator may authorize as a substitute the use of wet collectors designed to operate with a unit contacting energy of at least 9.95

kilopascals (40 inches water gage pressure).

(2) Use a HEPA filter that is certified to be at least 99.97 percent efficient for 0.3 micron particles.

(3) The Administrator may authorize the use of filtering equipment other than described in paragraphs (a)(1) and (b)(1) and (2) of this section if the owner or operator demonstrates to the Administrator's satisfaction that it is equivalent to the described equipment in filtering particulate asbestos material.

[49 FR 13661, Apr. 5, 1984; 49 FR 25453, June 21, 1984, as amended at 51 FR 8199, Mar. 10, 1986. Redesignated and amended at 55 FR 48430, Nov. 20, 1990]

§ 61.153 Reporting.

(a) Any new source to which this subpart applies (with the exception of sources subject to §§ 61.143, 61.145, 61.146, and 61.148), which has an initial startup date preceding the effective date of this revision, shall provide the following information to the Administrator postmarked or delivered within 90 days of the effective date. In the case of a new source that does not have an initial startup date preceding the effective date, the information shall be provided, postmarked or delivered, within 90 days of the initial startup date. Any owner or operator of an existing source shall provide the following information to the Administrator within 90 days of the effective date of this subpart unless the owner or operator of the existing source has previously provided this information to the Administrator. Any changes in the information provided by any existing source shall be provided to the Administrator, postmarked or delivered, within 30 days after the change.

(1) A description of the emission control equipment used for each process; and

(i) If the fabric device uses a woven fabric, the airflow permeability in $m^3/min/m^2$ and; if the fabric is synthetic, whether the fill yarn is spun or not spun; and

(ii) If the fabric filter device uses a felted fabric, the density in g/m^2, the minimum thickness in inches, and the airflow permeability in $m^3/min/m^2$.

(2) If a fabric filter device is used to control emissions,

(i) The airflow permeability in $m^3/min/m^2$ ($ft^3/min/ft^2$) if the fabric filter device uses a woven fabric, and, if the fabric is synthetic, whether the fill yarn is spun or not spun; and

(ii) If the fabric filter device uses a felted fabric, the density in g/m^2 (oz/yd^2), the minimum thickness in millimeters (inches), and the airflow permeability in $m^3/min/m^2$ ($ft^3/min/ft^2$).

(3) If a HEPA filter is used to control emissions, the certified efficiency.

(4) For sources subject to §§ 61.149 and 61.150:

(i) A brief description of each process that generates asbestos-containing waste material; and

(ii) The average volume of asbestos-containing waste material disposed of, measured in m^3/day (yd^3/day); and

(iii) The emission control methods used in all stages of waste disposal; and

(iv) The type of disposal site or incineration site used for ultimate disposal, the name of the site operator, and the name and location of the disposal site.

(5) For sources subject to §§ 61.151 and 61.154:

(i) A brief description of the site; and

(ii) The method or methods used to comply with the standard, or alternative procedures to be used.

(b) The information required by paragraph (a) of this section must accompany the information required by § 61.10. Active waste disposal sites subject to § 61.154 shall also comply with this provision. Roadways, demolition and renovation, spraying, and insulating materials are exempted from the requirements of § 61.10(a). The information described in this section must be reported using the format of appendix A of this part as a guide.

(Sec. 114. Clean Air Act as amended (42 U.S.C. 7414))

[49 FR 13661, Apr. 5, 1984. Redesignated and amended at 55 FR 48430, Nov. 20, 1990; 56 FR 1669, Jan. 16, 1991]

§ 61.154 Standard for active waste disposal sites.

Each owner or operator of an active waste disposal site that receives asbestos-containing waste material from a source covered under § 61.149, 61.150, or

61.155 shall meet the requirements of this section:

(a) Either there must be no visible emissions to the outside air from any active waste disposal site where asbestos-containing waste material has been deposited, or the requirements of paragraph (c) or (d) of this section must be met.

(b) Unless a natural barrier adequately deters access by the general public, either warning signs and fencing must be installed and maintained as follows, or the requirements of paragraph (c)(1) of this section must be met.

(1) Warning signs must be displayed at all entrances and at intervals of 100 m (330 ft) or less along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material is deposited. The warning signs must:

(i) Be posted in such a manner and location that a person can easily read the legend; and

(ii) Conform to the requirements of 51 cm × 36 cm (20″×14″) upright format signs specified in 29 CFR 1910.145(d)(4) and this paragraph; and

(iii) Display the following legend in the lower panel with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

Legend	Notation
Asbestos Waste Disposal Site.	2.5 cm (1 inch) Sans Serif, Gothic or Block.
Do Not Create Dust	1.9 cm (¾ inch) Sans Serif, Gothic or Block.
Breathing Asbestos is Hazardous to Your Health.	14 Point Gothic.

Spacing between any two lines must be at least equal to the height of the upper of the two lines.

(2) The perimeter of the disposal site must be fenced in a manner adequate to deter access by the general public.

(3) Upon request and supply of appropriate information, the Administrator will determine whether a fence or a natural barrier adequately deters access by the general public.

(c) Rather than meet the no visible emission requirement of paragraph (a) of this section, at the end of each operating day, or at least once every 24-hour period while the site is in continuous operation, the asbestos-containing waste material that has been deposited at the site during the operating day or previous 24-hour period shall:

(1) Be covered with at least 15 centimeters (6 inches) of compacted non-asbestos-containing material, or

(2) Be covered with a resinous or petroleum-based dust suppression agent that effectively binds dust and controls wind erosion. Such an agent shall be used in the manner and frequency recommended for the particular dust by the dust suppression agent manufacturer to achieve and maintain dust control. Other equally effective dust suppression agents may be used upon prior approval by the Administrator. For purposes of this paragraph, any used, spent, or other waste oil is not considered a dust suppression agent.

(d) Rather than meet the no visible emission requirement of paragraph (a) of this section, use an alternative emissions control method that has received prior written approval by the Administrator according to the procedures described in §61.149(c)(2).

(e) For all asbestos-containing waste material received, the owner or operator of the active waste disposal site shall:

(1) Maintain waste shipment records, using a form similar to that shown in Figure 4, and include the following information:

(i) The name, address, and telephone number of the waste generator.

(ii) The name, address, and telephone number of the transporter(s).

(iii) The quantity of the asbestos-containing waste material in cubic meters (cubic yards).

(iv) The presence of improperly enclosed or uncovered waste, or any asbestos-containing waste material not sealed in leak-tight containers. Report in writing to the local, State, or EPA Regional office responsible for administering the asbestos NESHAP program for the waste generator (identified in the waste shipment record), and, if different, the local, State, or EPA Regional office responsible for administering the asbestos NESHAP program for the disposal site, by the following working day, the presence of a significant amount of improperly enclosed or uncovered waste. Submit a copy of the waste shipment record along with the report.

(v) The date of the receipt.

(2) As soon as possible and no longer than 30 days after receipt of the waste, send a copy of the signed waste shipment record to the waste generator.

(3) Upon discovering a discrepancy between the quantity of waste designated on the waste shipment records and the quantity actually received, attempt to reconcile the discrepancy with the waste generator. If the discrepancy is not resolved within 15 days after receiving the waste, immediately report in writing to the local, State, or EPA Regional office responsible for administering the asbestos NESHAP program for the waste generator (identified in the waste shipment record), and, if different, the local, State, or EPA Regional office responsible for administering the asbestos NESHAP program for the disposal site. Describe the discrepancy and attempts to reconcile it, and submit a copy of the waste shipment record along with the report.

(4) Retain a copy of all records and reports required by this paragraph for at least 2 years.

(f) Maintain, until closure, records of the location, depth and area, and quantity in cubic meters (cubic yards) of asbestos-containing waste material within the disposal site on a map or diagram of the disposal area.

(g) Upon closure, comply with all the provisions of § 61.151.

(h) Submit to the Administrator, upon closure of the facility, a copy of records of asbestos waste disposal locations and quantities.

(i) Furnish upon request, and make available during normal business hours for inspection by the Administrator, all records required under this section.

(j) Notify the Administrator in writing at least 45 days prior to excavating or otherwise disturbing any asbestos-containing waste material that has been deposited at a waste disposal site and is covered. 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 and in no event shall excavation begin earlier than the date specified in the original notification. Include the following information in the notice:

(1) Scheduled starting and completion dates.

(2) Reason for disturbing the waste.

(3) Procedures to be used to control emissions during the excavation, storage, transport, and ultimate disposal of the excavated asbestos-containing waste material. If deemed necessary, the Administrator may require changes in the emission control procedures to be used.

(4) Location of any temporary storage site and the final disposal site.

(Secs. 112 and 301(a) of the Clean Air Act as amended (42 U.S.C. 7412, 7601(a))

[49 FR 13661, Apr. 5, 1990. Redesignated and amended at 55 FR 48431, Nov. 20, 1990; 56 FR 1669, Jan. 16, 1991]

§ 61.155 Standard for operations that convert asbestos-containing waste material into nonasbestos (asbestos-free) material.

Each owner or operator of an operation that converts RACM and asbestos-containing waste material into nonasbestos (asbestos-free) material shall:

(a) Obtain the prior written approval of the Administrator to construct the facility. To obtain approval, the owner or operator shall provide the Administrator with the following information:

(1) Application to construct pursuant to § 61.07.

(2) In addition to the information requirements of § 61.07(b)(3), a

(i) Description of waste feed handling and temporary storage.

(ii) Description of process operating conditions.

(iii) Description of the handling and temporary storage of the end product.

(iv) Description of the protocol to be followed when analyzing output materials by transmission electron microscopy.

(3) Performance test protocol, including provisions for obtaining information required under paragraph (b) of this section.

(4) The Administrator may require that a demonstration of the process be performed prior to approval of the application to construct.

(b) Conduct a start-up performance test. Test results shall include:

(1) A detailed description of the types and quantities of nonasbestos material, RACM, and asbestos-containing waste material processed, *e.g.*, asbestos cement products, friable asbestos insulation, plaster, wood, plastic, wire, etc. Test feed is to include the full range of materials that will be encountered in actual operation of the process.

(2) Results of analyses, using polarized light microscopy, that document the asbestos content of the wastes processed.

(3) Results of analyses, using transmission electron microscopy, that document that the output materials are free of asbestos. Samples for analysis are to be collected as 8-hour composite samples (one 200-gram (7-ounce) sample per hour), beginning with the initial introduction of RACM or asbestos-containing waste material and continuing until the end of the performance test.

(4) A description of operating parameters, such as temperature and residence time, defining the full range over which the process is expected to operate to produce nonasbestos (asbestos-free) materials. Specify the limits for each operating parameter within which the process will produce nonasbestos (asbestos-free) materials.

(5) The length of the test.

(c) During the initial 90 days of operation,

(1) Continuously monitor and log the operating parameters identified during start-up performance tests that are intended to ensure the production of nonasbestos (asbestos-free) output material.

(2) Monitor input materials to ensure that they are consistent with the test feed materials described during start-up performance tests in paragraph (b)(1) of this section.

(3) Collect and analyze samples, taken as 10-day composite samples (one 200-gram (7-ounce) sample collected every 8 hours of operation) of all output material for the presence of asbestos. Composite samples may be for fewer than 10 days. Transmission electron microscopy (TEM) shall be used to analyze the output material for the presence of asbestos. During the initial 90-day period, all output materials must be stored on-site until analysis shows the material to be asbestos-free or disposed of as asbestos-containing waste material according to § 61.150.

(d) After the initial 90 days of operation,

(1) Continuously monitor and record the operating parameters identified during start-up performance testing and any subsequent performance testing. Any output produced during a period of deviation from the range of operating conditions established to ensure the production of nonasbestos (asbestos-free) output materials shall be:

(i) Disposed of as asbestos-containing waste material according to § 61.150, or

(ii) Recycled as waste feed during process operation within the established range of operating conditions, or

(iii) Stored temporarily on-site in a leak-tight container until analyzed for asbestos content. Any product material that is not asbestos-free shall be either disposed of as asbestos-containing waste material or recycled as waste feed to the process.

(2) Collect and analyze monthly composite samples (one 200-gram (7-ounce) sample collected every 8 hours of operation) of the output material. Transmission electron microscopy shall be used to analyze the output material for the presence of asbestos.

(e) Discharge no visible emissions to the outside air from any part of the operation, or use the methods specified by § 61.152 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

(f) Maintain records on-site and include the following information:

(1) Results of start-up performance testing and all subsequent performance testing, including operating parameters, feed characteristic, and analyses of output materials.

(2) Results of the composite analyses required during the initial 90 days of operation under § 61.155(c).

(3) Results of the monthly composite analyses required under § 61.155(d).

(4) Results of continuous monitoring and logs of process operating parameters required under § 61.155 (c) and (d).

(5) The information on waste shipments received as required in § 61.154(e).

(6) For output materials where no analyses were performed to determine the presence of asbestos, record the

name and location of the purchaser or disposal site to which the output materials were sold or deposited, and the date of sale or disposal.

(7) Retain records required by paragraph (f) of this section for at least 2 years.

(g) Submit the following reports to the Administrator:

(1) A report for each analysis of product composite samples performed during the initial 90 days of operation.

(2) A quarterly report, including the following information concerning activities during each consecutive 3-month period:

(i) Results of analyses of monthly product composite samples.

(ii) A description of any deviation from the operating parameters established during performance testing, the duration of the deviation, and steps taken to correct the deviation.

(iii) Disposition of any product produced during a period of deviation, including whether it was recycled, disposed of as asbestos-containing waste material, or stored temporarily on-site until analyzed for asbestos content.

(iv) The information on waste disposal activities as required in §61.154(f).

(h) Nonasbestos (asbestos-free) output material is not subject to any of the provisions of this subpart. Output materials in which asbestos is detected, or output materials produced when the operating parameters deviated from those established during the start-up performance testing, unless shown by TEM analysis to be asbestos-free, shall be considered to be asbestos-containing waste and shall be handled and disposed of according to §§61.150 and 61.154 or reprocessed while all of the established operating parameters are being met.

[55 FR 48431, Nov. 20, 1990]

§61.156 Cross-reference to other asbestos regulations.

In addition to this subpart, the regulations referenced in Table 1 also apply to asbestos and may be applicable to those sources specified in §§61.142 through 61.151, 61.154, and 61.155 of this subpart. These cross-references are presented for the reader's information and to promote compliance with the cited regulations.

TABLE 1—CROSS-REFERENCE TO OTHER ASBESTOS REGULATIONS

Agency	CFR citation	Comment
EPA	40 CFR part 763, subpart E	Requires schools to inspect for asbestos and implement response actions and submit asbestos management plans to States. Specifies use of accredited inspectors, air sampling methods, and waste disposal procedures.
	40 CFR part 427	Effluent standards for asbestos manufacturing source categories.
	40 CFR part 763, subpart G	Protects public employees performing asbestos abatement work in States not covered by OSHA asbestos standard.
OSHA	29 CFR 1910.1001	Worker protection measures-engineering controls, worker training, labeling, respiratory protection, bagging of waste, permissible exposure level.
	29 CFR 1926.1101	Worker protection measures for all construction work involving asbestos, including demolition and renovation-work practices, worker training, bagging of waste, permissible exposure level.
MSHA	30 CFR part 56, subpart D	Specifies exposure limits, engineering controls, and respiratory protection measures for workers in surface mines.
	30 CFR part 57, subpart D	Specifies exposure limits, engineering controls, and respiratory protection measures for workers in underground mines.
DOT	49 CFR parts 171 and 172	Regulates the transportation of asbestos-containing waste material. Requires waste containment and shipping papers.

[55 FR 48432, Nov. 20, 1990, as amended at 60 FR 31920, June 19, 1995; 68 FR 54793, Sept. 18, 2003; 69 FR 43324, July 20, 2004]

§61.157 Delegation of authority.

(a) In delegating implementation and enforcement authority to a State under section 112(d) of the Act, the authorities contained in paragraph (b) of this section shall be retained by the Administrator and not transferred to a State.

(b) Authorities that will not be delegated to States:

(1) Section 61.149(c)(2)
(2) Section 61.150(a)(4)
(3) Section 61.151(c)
(4) Section 61.152(b)(3)
(5) Section 61.154(d)
(6) Section 61.155(a).

[55 FR 48433, Nov. 20, 1990]

APPENDIX A TO SUBPART M OF PART 61—INTERPRETIVE RULE GOVERNING ROOF REMOVAL OPERATIONS

I. Applicability of the Asbestos NESHAP

1.1. Asbestos-containing material (ACM) is material containing more than one percent asbestos as determined using the methods specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy. The NESHAP classifies ACM as either ‘‘friable’’ or ‘‘nonfriable’’. Friable ACM is ACM that, when dry, can be crumbled, pulverized or reduced to powder by hand pressure. Nonfriable ACM is ACM that, when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure.

1.2. Nonfriable ACM is further classified as either Category I ACM or Category II ACM. Category I ACM and Category II ACM are distinguished from each other by their potential to release fibers when damaged. Category I ACM includes asbestos-containing gaskets, packings, resilient floor coverings, resilient floor covering mastic, and asphalt roofing products containing more than one percent asbestos. Asphalt roofing products which may contain asbestos include built-up roofing; asphalt-containing single ply membrane systems; asphalt shingles; asphalt-containing underlayment felts; asphalt-containing roof coatings and mastics; and asphalt-containing base flashings. ACM roofing products that use other bituminous or resinous binders (such as coal tars or pitches) are also considered to be Category I ACM. Category II ACM includes all other nonfriable ACM, for example, asbestos-cement (A/C) shingles, A/C tiles, and transite boards or panels containing more than one percent asbestos. Generally speaking, Category II ACM is more likely to become friable when damaged than is Category I ACM. The applicability of the NESHAP to Category I and II ACM depends on: (1) the condition of the material at the time of demolition or renovation, (2) the nature of the operation to which the material will be subjected, (3) the amount of ACM involved.

1.3. Asbestos-containing material regulated under the NESHAP is referred to as ‘‘regulated asbestos-containing material’’ (RACM). RACM is defined in §61.141 of the NESHAP and includes: (1) friable asbestos-containing material; (2) Category I nonfriable ACM that has become friable; (3) Category I nonfriable ACM that has been or will be sanded, ground, cut, or abraded; or (4) Category II nonfriable ACM that has already been or is likely to become crumbled, pulverized, or reduced to powder. If the coverage threshold for RACM is met or exceeded in a renovation or demolition operation, then all friable ACM in the operation, and in certain situations, nonfriable ACM in the operation, are subject to the NESHAP.

A. Threshold Amounts of Asbestos-Containing Roofing Material

1.A.1. The NESHAP does not cover roofing projects on single family homes or on residential buildings containing four or fewer dwelling units. 40 CFR 61.141. For other roofing renovation projects, if the total asbestos-containing roof area undergoing renovation is less than 160 ft^2, the NESHAP does not apply, regardless of the removal method to be used, the type of material (Category I or II), or its condition (friable versus nonfriable). 40 CFR 61.145(a)(4). However, EPA would recommend the use of methods that damage asbestos-containing roofing material as little as possible. EPA has determined that where a rotating blade (RB) roof cutter or equipment that similarly damages the roofing material is used to remove Category I nonfriable asbestos-containing roofing material, the removal of 5580 ft^2 of that material will create 160 ft^2 of RACM. For the purposes of this interpretive rule, ‘‘RB roof cutter’’ means an engine-powered roof cutting machine with one or more rotating cutting blades the edges of which are blunt. (Equipment with blades having sharp or tapered edges, and/or which does not use a rotating blade, is used for ‘‘slicing’’ rather than ‘‘cutting’’ the roofing material; such equipment is not included in the term ‘‘RB roof cutter’’.) Therefore, it is EPA's interpretation that when an RB roof cutter or equipment that similarly damages the roofing material is used to remove Category I nonfriable asbestos-containing roofing material, any project that is 5580 ft^2 or greater is subject to the NESHAP; conversely, it is EPA's interpretation that when an RB roof cutter or equipment that similarly damages the roofing material is used to remove Category I nonfriable asbestos-containing roofing material in a roof removal project that is less than 5580 ft^2, the project is not subject to the NESHAP, except that notification is always required for demolitions. EPA further construes the NESHAP to mean that if slicing or other methods that do not sand, grind, cut or abrade will be used on Category I nonfriable ACM, the NESHAP does not apply, regardless of the area of roof to be removed.

1.A.2. For asbestos cement (A/C) shingles (or other Category II roofing material), if the area of the roofing material to be removed is at least 160 ft^2 and the removal methods will crumble, pulverize, reduce to powder, or contaminate with RACM (from other ACM that has been crumbled, pulverized or reduced to powder) 160 ft^2 or more of such roofing material, the removal is subject to the NESHAP. Conversely, if the area of the A/C shingles (or other Category II roofing materials) to be removed is less than 160 ft^2, the removal is not subject to the NESHAP regardless of the removal method used, except that notification is always required for demolitions. 40 CFR 61.145(a). However, EPA would recommend the use of methods that damage asbestos-containing roofing material as little as possible. If A/C shingles (or other Category II roofing materials) are removed without 160 ft^2 or more of such roofing material being crumbled, pulverized, reduced to powder, or contaminated with RACM (from other ACM that has been crumbled, pulverized or reduced to powder), the operation is not subject to the NESHAP, even where the total area of the roofing material to be removed exceeds 160 ft^2; provided, however, that if the renovation includes other operations involving RACM, the roof removal operation is covered if the total area of RACM from all renovation activities exceeds 160 ft^2. *See* the definition of regulated asbestos-containing material (RACM), 40 CFR 61.141.

1.A.3. Only roofing material that meets the definition of ACM can qualify as RACM subject to the NESHAP. Therefore, to determine if a removal operation that meets or exceeds the coverage threshold is subject to the NESHAP, any suspect roofing material (*i.e.* roofing material that may be ACM) should be tested for asbestos. If any such roofing material contains more than one percent asbestos and if the removal operation is covered by the NESHAP, then EPA must be notified and the work practices in §61.145(c) must be followed. In EPA's view, if a removal operation involves at least the threshold level of suspect material, a roofing contractor may choose not to test for asbestos if the contractor follows the notification and work practice requirements of the NESHAP.

B. A/C Shingle Removal (Category II ACM Removal)

1.B.1. A/C shingles, which are Category II nonfriable ACM, become regulated ACM if the material 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. 40 CFR 61.141. However, merely breaking an A/C shingle (or any other category II ACM) that is not friable may not necessarily cause the material to become RACM. A/C shingles are typically nailed to buildings on which they are attached. EPA believes that the extent of breakage that will normally result from carefully removing A/C shingles and lowering the shingles to the ground will not result in crumbling, pulverizing or reducing the shingles to powder. Conversely, the extent of breakage that will normally occur if the A/C shingles are dropped from a building or scraped off of a building with heavy machinery would cause the shingles to become RACM. EPA therefore construes the NESHAP to mean that the removal of A/C shingles that are not friable, using methods that do not crumble, pulverize, or reduce the A/C shingles to powder (such as pry bars, spud bars and shovels to carefully pry the material), is not subject to the NESHAP provided that the A/C shingles are properly handled during and after removal, as discussed in this paragraph and the asbestos NESHAP. This interpretation also applies to other Category II nonfriable asbestos-containing roofing materials.

C. Cutting vs. Slicing and Manual Methods for Removal of Category I ACM

1.C.1. Because of damage to the roofing material, and the potential for fiber release, roof removal operations using rotating blade (RB) roof cutters or other equipment that sand, grind, cut or abrade the roof material are subject to the NESHAP. As EPA interprets the NESHAP, the use of certain manual methods (using equipment such as axes, hatchets, or knives, spud bars, pry bars, and shovels, but not saws) or methods that slice, shear, or punch (using equipment such as a power slicer or power plow) does not constitute "cutting, sanding, grinding or abrading." This is because these methods do not destroy the structural matrix or integrity of the material such that the material is crumbled, pulverized or reduced to powder. Hence, it is EPA's interpretation that when such methods are used, assuming the roof material is not friable, the removal operation is not subject to the regulation.

1.C.2. Power removers or power tear-off machines are typically used to pry the roofing material up from the deck after the roof membrane has been cut. It is EPA's interpretation that when these machines are used to pry roofing material up, their use is not regulated by the NESHAP.

1.C.3. As noted previously, the NESHAP only applies to the removal of asbestos-containing roofing materials. Thus, the NESHAP does not apply to the use of RB cutters to remove non-asbestos built up roofing (BUR). On roofs containing some asbestos-containing and some non-asbestos-containing materials, coverage under the NESHAP depends on the methods used to remove each type of material in addition to other coverage thresholds specified above. For example, it is not uncommon for existing roofs to be made of non-asbestos BUR and base flashings that do contain asbestos. In that situation, EPA construes the

NESHAP to be inapplicable to the removal of the non-asbestos BUR using an RB cutter so long as the RB cutter is not used to cut 5580 ft^2 or more of the asbestos-containing base flashing or other asbestos-containing material into sections. In addition, the use of methods that slice, shear, punch or pry could then be used to remove the asbestos flashings and not trigger coverage under the NESHAP.

II. Notification

2.1. Notification for a demolition is always required under the NESHAP. However, EPA believes that few roof removal jobs constitute ''demolitions'' as defined in the NESHAP (§61.141). In particular, it is EPA's view that the removal of roofing systems (i.e., the roof membrane, insulation, surfacing, coatings, flashings, mastic, shingles, and felt underlayment), when such removal is not a part of a demolition project, constitutes a ''renovation'' under the NESHAP. If the operation is a renovation, and Category I roofing material is being removed using either manual methods or slicing, notification is not required by the NESHAP. If Category II material is not friable and will be removed without crumbling, pulverizing, or reducing it to powder, no notification is required. Also, if the renovation involves less than the threshold area for applicability as discussed above, then no notification is required. However, if a roof removal meets the applicability and threshold requirements under the NESHAP, then EPA (or the delegated agency) must be notified in advance of the removal in accordance with the requirements of §61.145(b), as follows:

- Notification must be given in writing at least 10 working days in advance and must include the information in §61.145(b)(4), except for emergency renovations as discussed below.
- The notice must be updated as necessary, including, for example, when the amount of asbestos-containing roofing material reported changes by 20 percent or more.
- EPA must be notified if the start date of the roof removal changes. If the start date of a roof removal project is changed to an earlier date, EPA must be provided with a written notice of the new start date at least 10 working days in advance. If the start date changes to a later date, EPA must be notified by telephone as soon as possible before the original start date and a written notice must be sent as soon as possible.
- For emergency renovations (as defined in §61.141), where work must begin immediately to avoid safety or public health hazards, equipment damage, or unreasonable financial burden, the notification must be postmarked or delivered to EPA as soon as possible, but no later than the following work day.

III. Emission Control Practices

A. Requirements To Adequately Wet and Discharge No Visible Emission

3.A.1. The principal controls contained in the NESHAP for removal operations include requirements that the affected material be adequately wetted, and that asbestos waste be handled, collected, and disposed of properly. The requirements for disposal of waste materials are discussed separately in section IV below. The emission control requirements discussed in this section III apply only to roof removal operations that are covered by the NESHAP as set forth in Section I above.

3.A.2. For any operation subject to the NESHAP, the regulation (§§61.145(c)(2)(i), (3), (6)(i)) requires that RACM be adequately wet (as defined in §61.141) during the operation that damages or disturbs the asbestos material until collected for disposal.

3.A.3. When using an RB roof cutter (or any other method that sands, grinds, cuts or abrades the roofing material) to remove Category I asbestos-containing roofing material, the emission control requirements of §61.145(c) apply as discussed in Section I above. EPA will consider a roof removal project to be in compliance with the ''adequately wet'' and ''discharge no visible emission'' requirements of the NESHAP if the RB roof cutter is equipped and operated with the following: (1) a blade guard that completely encloses the blade and extends down close to the roof surface; and (2) a device for spraying a fine mist of water inside the blade guard, and which device is in operation during the cutting of the roof.

B. Exemptions From Wetting Requirements

3.B.1. The NESHAP provides that, in certain instances, wetting may not be required during the cutting of Category I asbestos roofing material with an RB roof cutter. If EPA determines in accordance with §61.145(c)(3)(i), that wetting will unavoidably damage the building, equipment inside the building, or will present a safety hazard while stripping the ACM from a facility component that remains in place, the roof removal operation will be exempted from the requirement to wet during cutting. EPA must have sufficient written information on which to base such a decision. Before proceeding with a dry removal, the contractor must have received EPA's written approval. Such exemptions will be made on a case-by-case basis.

3.B.2. It is EPA's view that, in most instances, exemptions from the wetting requirements are not necessary. Where EPA grants an exemption from wetting because of the potential for damage to the building, damage to equipment within the building or a safety hazard, the NESHAP specifies alternative control methods (§61.145(c)(3)(i)(B)).

Alternative control methods include (a) the use of local exhaust ventilation systems that capture the dust, and do not produce visible emissions, or (b) methods that are designed and operated in accordance with the requirements of § 61.152, or (c) other methods that have received the written approval of EPA. EPA will consider an alternative emission control method in compliance with the NESHAP if the method has received written approval from EPA and the method is being implemented consistent with the approved procedures (§ 61.145(c)(3)(ii) or § 61.152(b)(3)).

3.B.3. An exemption from wetting is also allowed when the air or roof surface temperature at the point of wetting is below freezing, as specified in § 61.145(c)(7). If freezing temperatures are indicated as the reason for not wetting, records must be kept of the temperature at the beginning, middle and end of the day on which wetting is not performed and the records of temperature must be retained for at least 2 years. 42 CFR § 61.145(c)(7)(iii). It is EPA's interpretation that in such cases, no written application to, or written approval by the Administrator is needed for using emission control methods listed in § 61.145(c)(3)(i)(B), or alternative emission control methods that have been previously approved by the Administrator. However, such written application or approval is required for alternative emission control methods that have not been previously approved. Any dust and debris collected from cutting must still be kept wet and placed in containers. All of the other requirements for notification and waste disposal would continue to apply as described elsewhere in this notice and the Asbestos NESHAP.

C. Waste Collection and Handling

3.C.1. It is EPA's interpretation that waste resulting from slicing and other methods that do not cut, grind, sand or abrade Category I nonfriable asbestos-containing roofing material is not subject to the NESHAP and can be disposed of as nonasbestos waste. EPA further construes the NESHAP to provide that if Category II roofing material (such as A/C shingles) is removed and disposed of without crumbling, pulverizing, or reducing it to powder, the waste from the removal is not subject to the NESHAP waste disposal requirements. EPA also interprets the NESHAP to be inapplicable to waste resulting from roof removal operations that do not meet or exceed the coverage thresholds described in section I above. Of course, other State, local, or Federal regulations may apply.

3.C.2. It is EPA's interpretation that when an RB roof cutter, or other method that similarly damages the roofing material, is used to cut Category I asbestos containing roofing material, the damaged material from the cut (the sawdust or debris) is considered asbestos containing waste subject to § 61.150 of the NESHAP, provided the coverage thresholds discussed above in section 1 are met or exceeded. This sawdust or debris must be disposed of at a disposal site operated in accordance with the NESHAP. It is also EPA's interpretation of the NESHAP that if the remainder of the roof is free of the sawdust and debris generated by the cutting, or if such sawdust or debris is collected as discussed below in paragraphs 3.C.3, 3.C.4, 3.C.5 and 3.C.6, the remainder of the roof can be disposed of as nonasbestos waste because it is considered to be Category I nonfriable material (as long as the remainder of the roof is in fact nonasbestos material or if it is Category I asbestos material and the removal methods do not further sand, grind, cut or abrade the roof material). EPA further believes that if the roof is not cleaned of such sawdust or debris, *i.e.*, it is contaminated, then it must be treated as asbestos-containing waste material and be handled in accordance with § 61.150.

3.C.3. In order to be in compliance with the NESHAP while using an RB roof cutter (or device that similarly damages the roofing material) to cut Category I asbestos containing roofing material, the dust and debris resulting from the cutting of the roof should be collected as soon as possible after the cutting operation, and kept wet until collected and placed in leak-tight containers. EPA believes that where the blade guard completely encloses the blade and extends down close to the roof surface and is equipped with a device for spraying a fine mist of water inside the blade guard, and the spraying device is in operation during the cutting, most of the dust and debris from cutting will be confined along the cut. The most efficient methods to collect the dust and debris from cutting are to immediately collect or vacuum up the damaged material where it lies along the cut using a filtered vacuum cleaner or debris collector that meets the requirements of 40 CFR 61.152 to clean up as much of the debris as possible, or to gently sweep up the bulk of the debris, and then use a filtered vacuum cleaner that meets the requirements of 40 CFR 61.152 to clean up as much of the remainder of the debris as possible. On smooth surfaced roofs (nonaggregate roofs), sweeping up the debris and then wet wiping the surface may be done in place of using a filtered vacuum cleaner. It is EPA's view that if these decontamination procedures are followed, the remaining roofing material does not have to be collected and disposed of as asbestos waste. Additionally, it is EPA's view that where such decontamination procedures are followed, if the remaining portions of the roof are non-asbestos or Category I nonfriable asbestos material, and if the remaining portions are removed using removal methods that slice, shear, punch or pry, as discussed in section 1.C above, then the remaining portions do not have to be collected and disposed of as asbestos waste and the NESHAP's no visible emissions and adequately wet requirements are not applicable to the removal of the remaining portions. In EPA's interpretation, the failure of a filtered vacuum cleaner or debris collector to collect larger chunks or pieces of damaged roofing material created by the RB roof cutter does not require the remaining roofing material to be handled and disposed of as asbestos waste, provided that such visible chunks or pieces of roofing material are collected (e.g. by gentle sweeping) and disposed of as asbestos waste. Other methods of decontamination may not be adequate, and should be approved by the local delegated agency.

3.C.4. In EPA's interpretation, if the debris from the cutting is not collected immediately, it will be necessary to lightly mist the dust or debris, until it is collected, as discussed above, and placed in containers. The dust or debris should be lightly misted frequently enough to prevent the material from drying, and to prevent airborne emissions, prior to collection as described above. It is EPA's interpretation of the NESHAP that if these procedures are followed, the remaining roofing material does not have to be collected and disposed of as asbestos waste, as long as the remaining roof material is in fact nonasbestos material or if it is Category I asbestos material and the removal methods do not further sand, grind, cut or abrade the roof material.

3.C.5. It is EPA's interpretation that, provided the roofing material is not friable prior to the cutting operation, and provided the roofing material has not been made friable by the cutting operation, the appearance of rough, jagged or damaged edges on the remaining roofing material, due to the use of an RB roof cutter, does not require that such remaining roofing material be handled and disposed of as asbestos waste. In addition, it is also EPA's interpretation that if the sawdust or debris generated by the use of an RB roof cutter has been collected as discussed in paragraphs 3.C.3, 3.C.4 and 3.C.6, the presence of dust along the edge of the remaining roof material does not render such material ''friable'' for purposes of this interpretive rule or the NESHAP, provided the roofing material is not friable prior to the cutting operation, and provided that the remaining roofing material near the cutline has not been made friable by the cutting operation. Where roofing material near the cutline has been made friable by the use of the RB cutter (*i.e.* where such remaining roofing material near the cutline can be crumbled, pulverized or reduced to powder using hand pressure), it is EPA's interpretation that the use of an encapsulant will ensure that such friable material need not be treated or disposed of as asbestos containing waste material. The encapsulant may be applied to the friable material after the roofing material has been collected into stacks for subsequent disposal as nonasbestos waste. It is EPA's view that if the encapsulation procedure set forth in this paragraph is followed in operations where roofing material near the cutline has been rendered friable by the use of an RB roof cutter, and if the decontamination procedures set forth in paragraph 3.C.3 have been followed, the NESHAP's no visible emissions and adequately wet requirements would be met for the removal, handling and disposal of the remaining roofing material.

3.C.6. As one way to comply with the NESHAP, the dust and debris from cutting can be placed in leak-tight containers, such as plastic bags, and the containers labeled using warning labels required by OSHA (29 CFR 1926.58). In addition, the containers must have labels that identify the waste generator (such as the name of the roofing contractor, abatement contractor, and/or building owner or operator) and the location of the site at which the waste was generated.

IV. Waste Disposal

A. Disposal Requirements

4.A.1. Section 61.150(b) requires that, as soon as is practical, all collected dust and debris from cutting as well as any contaminated roofing squares, must be taken to a landfill that is operated in accordance with §61.154 or to an EPA-approved site that converts asbestos waste to nonasbestos material in accordance with §61.155. During the loading and unloading of affected waste, asbestos warning signs must be affixed to the vehicles.

B. Waste Shipment Record

4.B.1. For each load of asbestos waste that is regulated under the NESHAP, a waste shipment record (WSR) must be maintained in accordance with §61.150(d). Information that must be maintained for each waste load includes the following:

- Name, address, and telephone number of the waste generator
- Name and address of the local, State, or EPA regional office responsible for administering the asbestos NESHAP program
- Quantity of waste in cubic meters (or cubic yards)
- Name and telephone number of the disposal site operator
- Name and physical site location of the disposal site
- Date transported
- Name, address, and telephone number of the transporter(s)
- Certification that the contents meet all government regulations for transport by highways.

4.B.2. The waste generator is responsible for ensuring that a copy of the WSR is delivered to the disposal site along with the waste shipment. If a copy of the WSR signed by the disposal site operator is not returned to the waste generator within 35 days, the waste generator must contact the transporter and/or the disposal site to determine the status of the waste shipment. 40 CFR 61.150(d)(3). If the signed WSR is not received within 45 days, the waste generator must report, in writing, to the responsible NESHAP program agency and send along a copy of the WSR. 40 CFR 61.150(d)(4). Copies of WSRs, including those signed by the disposal site operator, must be retained for at least 2 years. 40 CFR 61.150(d)(5).

V. Training

5.1. For those roof removals that are subject to the NESHAP, at least one on-site supervisor trained in the provisions of the NESHAP must be present during the removal of the asbestos roofing material. 40 CFR 61.145(c)(8). In EPA's view, this person can be a job foreman, a hired consultant, or someone who can represent the building owner or contractor responsible for the removal. In addition to the initial training requirement, a refresher training course is required every 2 years. The NESHAP training requirements became effective on November 20, 1991.

5.2. Asbestos training courses developed specifically to address compliance with the NESHAP in roofing work, as well as courses developed for other purposes can satisfy this requirement of the NESHAP, as long as the course covers the areas specified in the regulation. EPA believes that Asbestos Hazard Emergency Response Act (AHERA) training courses will, for example, satisfy the NESHAP training requirements. However, nothing in this interpretive rule or in the NESHAP shall be deemed to require that roofing contractors or roofing workers performing operations covered by the NESHAP must be trained or accredited under AHERA, as amended by the Asbestos School Hazard Abatement Reauthorization Act (ASHARA). Likewise, state or local authorities may independently impose additional training, licensing, or accreditation requirements on roofing contractors performing operations covered by the NESHAP, but such additional training, licensing or accreditation is not called for by this interpretive rule or the federal NESHAP.

5.3. For removal of Category I asbestos containing roofing material where RB roof cutters or equipment that similarly damages the asbestos-containing roofing material are used, the NESHAP training requirements (§61.145(c)(8)) apply as discussed in Section I above. It is EPA's intention that removal of Category I asbestos-containing roofing material using hatchets, axes, knives, and/or the use of spud bars, pry bars and shovels to lift the roofing material, or similar removal methods that slice, punch, or shear the roof membrane are not subject to the training requirements, since these methods do not cause the roof removal to be subject to the NESHAP. Likewise, it is EPA's intention that roof removal operations involving Category II nonfriable ACM are not subject to the training requirements where such operations are not subject to the NESHAP as discussed in section I above.

[59 FR 31158, June 17, 1994, as amended at 60 FR 31920, June 19, 1995]

Subpart N—National Emission Standard for Inorganic Arsenic Emissions From Glass Manufacturing Plants

SOURCE: 51 FR 28025, Aug. 4, 1986, unless otherwise noted.

§61.160 Applicability and designation of source.

(a) The source to which this subpart applies is each glass melting furnace that uses commercial arsenic as a raw material. This subpart does not apply to pot furnaces.

(b) Rebricking is not considered construction or modification for the purposes of §61.05(a).

§61.161 Definitions.

The terms used in this subpart are defined in the Clean Air Act, in §61.02, or in this section as follows:

Arsenic-containing glass type means any glass that is distinguished from other glass solely by the weight percent of arsenic added as a raw material and by the weight percent of arsenic in the glass produced. Any two or more glasses that have the same weight percent of arsenic in the raw materials as well as in the glass produced shall be considered to belong to one arsenic-containing glass type, without regard to the recipe used or any other characteristics of the glass or the method of production.

By-pass the control device means to operate the glass melting furnace without operating the control device to which that furnace's emissions are directed routinely.

Commercial arsenic means any form of arsenic that is produced by extraction

Asbestos-Containing Materials in Schools (AHERA) - 40 CFR Part 763, Subpart E contaminated surface used in the validation study. Record and keep the results of the validation study as an appendix to the SOP. Include in this appendix, the solvent used to make the spiking solution, the PCB concentration of the spiking solution used to contaminate the surfaces in the validation study, and all of the validation study testing parameters and experimental conditions.

PART 763—ASBESTOS

Subparts A–D [Reserved]

Subpart E—Asbestos-Containing Materials in Schools

Subpart F [Reserved]

Subpart G—Asbestos Worker Protection

Subpart H [Reserved]

Subpart I—Prohibition of the Manufacture, Importation, Processing, and Distribution in Commerce of Certain Asbestos-Containing Products; Labeling Requirements

AUTHORITY: 15 U.S.C. 2605, 2607(c), 2643, and 2646.

Subparts A–D [Reserved]

Subpart E—Asbestos-Containing Materials in Schools

SOURCE: 52 FR 41846, Oct. 30, 1987, unless otherwise noted.

§ 763.80 Scope and purpose.

(a) This rule requires local education agencies to identify friable and nonfriable asbestos-containing material (ACM) in public and private elementary and secondary schools by visually inspecting school buildings for such materials, sampling such materials if they are not assumed to be ACM, and having samples analyzed by appropriate techniques referred to in this rule. The rule requires local education agencies to submit management plans to the Governor of their State by October 12, 1988, begin to implement the plans by July 9, 1989, and complete implementation of the plans in a timely fashion. In addition, local education agencies are required to use persons who have been accredited to conduct inspections, reinspections, develop management plans, or perform response actions. The rule also includes recordkeeping requirements. Local education agencies may contractually delegate their duties under this rule, but they remain responsible for the proper performance of those duties.

Local education agencies are encouraged to consult with EPA Regional Asbestos Coordinators, or if applicable, a State's lead agency designated by the State Governor, for assistance in complying with this rule.

(b) Local education agencies must provide for the transportation and disposal of asbestos in accordance with EPA's ''Asbestos Waste Management Guidance.'' For convenience, applicable sections of this guidance are reprinted as Appendix D of this subpart. There are regulations in place, however, that affect transportation and disposal of asbestos waste generated by this rule. The transportation of asbestos waste is covered by the Department of Transportation (49 CFR part 173, subpart J) and disposal is covered by the National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR part 61, subpart M).

§ 763.83 Definitions.

For purposes of this subpart:

Act means the Toxic Substances Control Act (TSCA), 15 U.S.C. 2601, *et seq.*

Accessible when referring to ACM means that the material is subject to disturbance by school building occupants or custodial or maintenance personnel in the course of their normal activities.

Accredited or *accreditation* when referring to a person or laboratory means that such person or laboratory is accredited in accordance with section 206 of Title II of the Act.

Air erosion means the passage of air over friable ACBM which may result in the release of asbestos fibers.

Asbestos means the asbestiform varieties of: Chrysotile (serpentine); crocidolite (riebeckite); amosite (cummingtonitegrunerite); anthophyllite; tremolite; and actinolite.

Asbestos-containing material (ACM) when referring to school buildings means any material or product which contains more than 1 percent asbestos.

Asbestos-containing building material (ACBM) means surfacing ACM, thermal system insulation ACM, or miscellaneous ACM that is found in or on interior structural members or other parts of a school building.

Asbestos debris means pieces of ACBM that can be identified by color, texture, or composition, or means dust, if the dust is determined by an accredited inspector to be ACM.

Damaged friable miscellaneous ACM means friable miscellaneous ACM which has deteriorated or sustained physical injury such that the internal structure (cohesion) of the material is inadequate or, if applicable, which has delaminated such that its bond to the substrate (adhesion) is inadequate or which for any other reason lacks fiber cohesion or adhesion qualities. Such damage or deterioration may be illustrated by the separation of ACM into layers; separation of ACM from the substrate; flaking, blistering, or crumbling of the ACM surface; water damage; significant or repeated water stains, scrapes, gouges, mars or other signs of physical injury on the ACM. Asbestos debris originating from the ACBM in question may also indicate damage.

Damaged friable surfacing ACM means friable surfacing ACM which has deteriorated or sustained physical injury such that the internal structure (cohesion) of the material is inadequate or which has delaminated such that its bond to the substrate (adhesion) is inadequate, or which, for any other reason, lacks fiber cohesion or adhesion qualities. Such damage or deterioration may be illustrated by the separation of ACM into layers; separation of ACM from the substrate; flaking, blistering, or crumbling of the ACM surface; water damage; significant or repeated water stains, scrapes, gouges, mars or other signs of physical injury on the ACM. Asbestos debris originating from the ACBM in question may also indicate damage.

Damaged or significantly damaged thermal system insulation ACM means thermal system insulation ACM on pipes, boilers, tanks, ducts, and other thermal system insulation equipment where the insulation has lost its structural integrity, or its covering, in whole or in part, is crushed, water-stained, gouged, punctured, missing, or not intact such that it is not able to contain fibers. Damage may be further illustrated by occasional punctures, gouges or other signs of physical injury to ACM; occasional water damage on the protective coverings/jackets; or exposed ACM ends or joints. Asbestos debris originating from the ACBM in question may also indicate damage.

Encapsulation means the treatment of ACBM with a material that surrounds or embeds asbestos fibers in an adhesive matrix to prevent the release of fibers, as the encapsulant creates a membrane over the surface (bridging encapsulant) or penetrates the material and binds its components together (penetrating encapsulant).

Enclosure means an airtight, impermeable, permanent barrier around ACBM to prevent the release of asbestos fibers into the air.

Fiber release episode means any uncontrolled or unintentional disturbance of ACBM resulting in visible emission.

Friable when referring to material in a school building means that the material, when dry, may be crumbled, pulverized, or reduced to powder by hand pressure, and includes previously nonfriable material after such previously nonfriable material becomes damaged to the extent that when dry it may be crumbled, pulverized, or reduced to powder by hand pressure.

Functional space means a room, group of rooms, or homogeneous area (including crawl spaces or the space between a dropped ceiling and the floor or roof deck above), such as classroom(s), a cafeteria, gymnasium, hallway(s), designated by a person accredited to prepare management plans, design abatement projects, or conduct response actions.

High-efficiency particulate air (HEPA) refers to a filtering system capable of trapping and retaining at least 99.97 percent of all monodispersed particles 0.3 µm in diameter or larger.

Homogeneous area means an area of surfacing material, thermal system insulation material, or miscellaneous material that is uniform in color and texture.

Local education agency means:

(1) Any local educational agency as defined in section 198 of the Elementary and Secondary Education Act of 1965 (20 U.S.C. 3381).

(2) The owner of any nonpublic, nonprofit elementary, or secondary school building.

(3) The governing authority of any school operated under the defense dependent's education system provided for under the Defense Dependents' Education Act of 1978 (20 U.S.C. 921, et seq.).

Miscellaneous ACM means miscellaneous material that is ACM in a school building.

Miscellaneous material means interior building material on structural components, structural members or fixtures, such as floor and ceiling tiles, and does not include surfacing material or thermal system insulation.

Nonfriable means material in a school building which when dry may not be crumbled, pulverized, or reduced to powder by hand pressure.

Operations and maintenance program means a program of work practices to maintain friable ACBM in good condition, ensure clean up of asbestos fibers previously released, and prevent further release by minimizing and controlling friable ACBM disturbance or damage.

Potential damage means circumstances in which:

(1) Friable ACBM is in an area regularly used by building occupants, including maintenance personnel, in the course of their normal activities.

(2) There are indications that there is a reasonable likelihood that the material or its covering will become damaged, deteriorated, or delaminated due to factors such as changes in building use, changes in operations and maintenance practices, changes in occupancy, or recurrent damage.

Potential significant damage means circumstances in which:

(1) Friable ACBM is in an area regularly used by building occupants, including maintenance personnel, in the course of their normal activities.

(2) There are indications that there is a reasonable likelihood that the material or its covering will become significantly damaged, deteriorated, or delaminated due to factors such as changes in building use, changes in operations and maintenance practices, changes in occupancy, or recurrent damage.

(3) The material is subject to major or continuing disturbance, due to factors including, but not limited to, accessibility or, under certain circumstances, vibration or air erosion.

Preventive measures means actions taken to reduce disturbance of ACBM or otherwise eliminate the reasonable likelihood of the material's becoming damaged or significantly damaged.

Removal means the taking out or the stripping of substantially all ACBM from a damaged area, a functional space, or a homogeneous area in a school building.

Repair means returning damaged ACBM to an undamaged condition or to an intact state so as to prevent fiber release.

Response action means a method, including removal, encapsulation, enclosure, repair, operations and maintenance, that protects human health and the environment from friable ACBM.

Routine maintenance area means an area, such as a boiler room or mechanical room, that is not normally frequented by students and in which maintenance employees or contract workers regularly conduct maintenance activities.

School means any elementary or secondary school as defined in section 198 of the Elementary and Secondary Education Act of 1965 (20 U.S.C. 2854).

School building means:

(1) Any structure suitable for use as a classroom, including a school facility such as a laboratory, library, school eating facility, or facility used for the preparation of food.

(2) Any gymnasium or other facility which is specially designed for athletic or recreational activities for an academic course in physical education.

(3) Any other facility used for the instruction or housing of students or for the administration of educational or research programs.

(4) Any maintenance, storage, or utility facility, including any hallway, essential to the operation of any facility described in this definition of ''school building'' under paragraphs (1), (2), or (3).

(5) Any portico or covered exterior hallway or walkway.

(6) Any exterior portion of a mechanical system used to condition interior space.

Significantly damaged friable miscellaneous ACM means damaged friable miscellaneous ACM where the damage is extensive and severe.

Significantly damaged friable surfacing ACM means damaged friable surfacing ACM in a functional space where the damage is extensive and severe.

State means a State, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the Northern Marianas, the Trust Territory of the Pacific Islands, and the Virgin Islands.

Surfacing ACM means surfacing material that is ACM.

Surfacing material means material in a school building that is sprayed-on, troweled-on, or otherwise applied to surfaces, such as acoustical plaster on ceilings and fireproofing materials on structural members, or other materials on surfaces for acoustical, fireproofing, or other purposes.

Thermal system insulation means material in a school building applied to pipes, fittings, boilers, breeching, tanks, ducts, or other interior structural components to prevent heat loss or gain, or water condensation, or for other purposes.

Thermal system insulation ACM means thermal system insulation that is ACM.

Vibration means the periodic motion of friable ACBM which may result in the release of asbestos fibers.

§ 763.84 General local education agency responsibilities.

Each local education agency shall:

(a) Ensure that the activities of any persons who perform inspections, reinspections, and periodic surveillance, develop and update management plans, and develop and implement response actions, including operations and maintenance, are carried out in accordance with subpart E of this part.

(b) Ensure that all custodial and maintenance employees are properly trained as required by this subpart E and other applicable Federal and/or

State regulations (e.g., the Occupational Safety and Health Administration asbestos standard for construction, the EPA worker protection rule, or applicable State regulations).

(c) Ensure that workers and building occupants, or their legal guardians, are informed at least once each school year about inspections, response actions, and post-response action activities, including periodic reinspection and surveillance activities that are planned or in progress.

(d) Ensure that short-term workers (e.g., telephone repair workers, utility workers, or exterminators) who may come in contact with asbestos in a school are provided information regarding the locations of ACBM and suspected ACBM assumed to be ACM.

(e) Ensure that warning labels are posted in accordance with § 763.95.

(f) Ensure that management plans are available for inspection and notification of such availability has been provided as specified in the management plan under § 763.93(g).

(g)(1) Designate a person to ensure that requirements under this section are properly implemented.

(2) Ensure that the designated person receives adequate training to perform duties assigned under this section. Such training shall provide, as necessary, basic knowledge of:

(i) Health effects of asbestos.

(ii) Detection, identification, and assessment of ACM.

(iii) Options for controlling ACBM.

(iv) Asbestos management programs.

(v) Relevant Federal and State regulations concerning asbestos, including those in this subpart E and those of the Occupational Safety and Health Administration, U.S. Department of Labor, the U.S. Department of Transportation and the U.S. Environmental Protection Agency.

(h) Consider whether any conflict of interest may arise from the interrelationship among accredited personnel and whether that should influence the selection of accredited personnel to perform activities under this subpart.

§ 763.85 Inspection and reinspections.

(a) *Inspection*. (1) Except as provided in paragraph (a)(2) of this section, before October 12, 1988, local education agencies shall inspect each school building that they lease, own, or otherwise use as a school building to identify all locations of friable and nonfriable ACBM.

(2) Any building leased or acquired on or after October 12, 1988, that is to be used as a school building shall be inspected as described under paragraphs (a) (3) and (4) of this section prior to use as a school building. In the event that emergency use of an uninspected building as a school building is necessitated, such buildings shall be inspected within 30 days after commencement of such use.

(3) Each inspection shall be made by an accredited inspector.

(4) For each area of a school building, except as excluded under § 763.99, each person performing an inspection shall:

(i) Visually inspect the area to identify the locations of all suspected ACBM.

(ii) Touch all suspected ACBM to determine whether they are friable.

(iii) Identify all homogeneous areas of friable suspected ACBM and all homogeneous areas of nonfriable suspected ACBM.

(iv) Assume that some or all of the homogeneous areas are ACM, and, for each homogeneous area that is not assumed to be ACM, collect and submit for analysis bulk samples under §§ 763.86 and 763.87.

(v) Assess, under § 763.88, friable material in areas where samples are collected, friable material in areas that are assumed to be ACBM, and friable ACBM identified during a previous inspection.

(vi) Record the following and submit to the person designated under § 763.84 a copy of such record for inclusion in the management plan within 30 days of the inspection:

(A) An inspection report with the date of the inspection signed by each accredited person making the inspection, State of accreditation, and if applicable, his or her accreditation number.

(B) An inventory of the locations of the homogeneous areas where samples are collected, exact location where each bulk sample is collected, dates that samples are collected, homogeneous areas where friable suspected ACBM is assumed to be ACM, and homogeneous areas where nonfriable suspected ACBM is assumed to be ACM.

(C) A description of the manner used to determine sampling locations, the name and signature of each accredited inspector who collected the samples, State of accreditation, and, if applicable, his or her accreditation number.

(D) A list of whether the homogeneous areas identified under paragraph (a)(4)(vi)(B) of this section, are surfacing material, thermal system insulation, or miscellaneous material.

(E) Assessments made of friable material, the name and signature of each accredited inspector making the assessment, State of accreditation, and if applicable, his or her accreditation number.

(b) *Reinspection.* (1) At least once every 3 years after a management plan is in effect, each local education agency shall conduct a reinspection of all friable and nonfriable known or assumed ACBM in each school building that they lease, own, or otherwise use as a school building.

(2) Each inspection shall be made by an accredited inspector.

(3) For each area of a school building, each person performing a reinspection shall:

(i) Visually reinspect, and reassess, under § 763.88, the condition of all friable known or assumed ACBM.

(ii) Visually inspect material that was previously considered nonfriable ACBM and touch the material to determine whether it has become friable since the last inspection or reinspection.

(iii) Identify any homogeneous areas with material that has become friable since the last inspection or reinspection.

(iv) For each homogeneous area of newly friable material that is already assumed to be ACBM, bulk samples may be collected and submitted for analysis in accordance with §§ 763.86 and 763.87.

(v) Assess, under § 763.88, the condition of the newly friable material in areas where samples are collected, and newly friable materials in areas that are assumed to be ACBM.

(vi) Reassess, under § 763.88, the condition of friable known or assumed ACBM previously identified.

(vii) Record the following and submit to the person designated under § 763.84 a copy of such record for inclusion in the management plan within 30 days of the reinspection:

(A) The date of the reinspection, the name and signature of the person making the reinspection, State of accreditation, and if applicable, his or her accreditation number, and any changes in the condition of known or assumed ACBM.

(B) The exact locations where samples are collected during the reinspection, a description of the manner used to determine sampling locations, the name and signature of each accredited inspector who collected the samples, State of accreditation, and, if applicable, his or her accreditation number.

(C) Any assessments or reassessments made of friable material, the name and signature of the accredited inspector making the assessments, State of accreditation, and if applicable, his or her accreditation number.

(c) *General.* Thermal system insulation that has retained its structural integrity and that has an undamaged protective jacket or wrap that prevents fiber release shall be treated as nonfriable and therefore is subject only to periodic surveillance and preventive measures as necessary.

§ 763.86 Sampling.

(a) *Surfacing material.* An accredited inspector shall collect, in a statistically random manner that is representative of the homogeneous area, bulk samples from each homogeneous area of friable surfacing material that is not assumed to be ACM, and shall collect the samples as follows:

(1) At least three bulk samples shall be collected from each homogeneous area that is 1,000 ft^2 or less, except as provided in § 763.87(c)(2).

(2) At least five bulk samples shall be collected from each homogeneous area that is greater than 1,000 ft^2 but less than or equal to 5,000 ft^2, except as provided in § 763.87(c)(2).

(3) At least seven bulk samples shall be collected from each homogeneous

area that is greater than 5,000 ft^2, except as provided in § 763.87(c)(2).

(b) *Thermal system insulation.* (1) Except as provided in paragraphs (b) (2) through (4) of this section and § 763.87(c), an accredited inspector shall collect, in a randomly distributed manner, at least three bulk samples from each homogeneous area of thermal system insulation that is not assumed to be ACM.

(2) Collect at least one bulk sample from each homogeneous area of patched thermal system insulation that is not assumed to be ACM if the patched section is less than 6 linear or square feet.

(3) In a manner sufficient to determine whether the material is ACM or not ACM, collect bulk samples from each insulated mechanical system that is not assumed to be ACM where cement or plaster is used on fittings such as tees, elbows, or valves, except as provided under § 763.87(c)(2).

(4) Bulk samples are not required to be collected from any homogeneous area where the accredited inspector has determined that the thermal system insulation is fiberglass, foam glass, rubber, or other non-ACBM.

(c) *Miscellaneous material.* In a manner sufficient to determine whether material is ACM or not ACM, an accredited inspector shall collect bulk samples from each homogeneous area of friable miscellaneous material that is not assumed to be ACM.

(d) *Nonfriable suspected ACBM.* If any homogeneous area of nonfriable suspected ACBM is not assumed to be ACM, then an accredited inspector shall collect, in a manner sufficient to determine whether the material is ACM or not ACM, bulk samples from the homogeneous area of nonfriable suspected ACBM that is not assumed to be ACM.

§ 763.87 Analysis.

(a) Local education agencies shall have bulk samples, collected under § 763.86 and submitted for analysis, analyzed for asbestos using laboratories accredited by the National Bureau of Standards (NBS). Local education agencies shall use laboratories which have received interim accreditation for polarized light microscopy (PLM) analysis under the EPA Interim Asbestos Bulk Sample Analysis Quality Assurance Program until the NBS PLM laboratory accreditation program for PLM is operational.

(b) Bulk samples shall not be composited for analysis and shall be analyzed for asbestos content by PLM, using the ‘‘Interim Method for the Determination of Asbestos in Bulk Insulation Samples’’ found at appendix E to subpart E of this part.

(c)(1) A homogeneous area is considered not to contain ACM only if the results of all samples required to be collected from the area show asbestos in amounts of 1 percent or less.

(2) A homogeneous area shall be determined to contain ACM based on a finding that the results of at least one sample collected from that area shows that asbestos is present in an amount greater than 1 percent.

(d) The name and address of each laboratory performing an analysis, the date of analysis, and the name and signature of the person performing the analysis shall be submitted to the person designated under § 763.84 for inclusion into the management plan within 30 days of the analysis.

[52 FR 41846, Oct. 30, 1987, as amended at 60 FR 31922, June 19, 1995]

§ 763.88 Assessment.

(a)(1) For each inspection and reinspection conducted under § 763.85 (a) and (c) and previous inspections specified under § 763.99, the local education agency shall have an accredited inspector provide a written assessment of all friable known or assumed ACBM in the school building.

(2) Each accredited inspector providing a written assessment shall sign and date the assessment, provide his or her State of accreditation, and if applicable, accreditation number, and submit a copy of the assessment to the person designated under § 763.84 for inclusion in the management plan within 30 days of the assessment.

(b) The inspector shall classify and give reasons in the written assessment for classifying the ACBM and suspected ACBM assumed to be ACM in the school building into one of the following categories:

(1) Damaged or significantly damaged thermal system insulation ACM.

(2) Damaged friable surfacing ACM.

(3) Significantly damaged friable surfacing ACM.

(4) Damaged or significantly damaged friable miscellaneous ACM.

(5) ACBM with potential for damage.

(6) ACBM with potential for significant damage.

(7) Any remaining friable ACBM or friable suspected ACBM.

(c) Assessment may include the following considerations:

(1) Location and the amount of the material, both in total quantity and as a percentage of the functional space.

(2) Condition of the material, specifying:

(i) Type of damage or significant damage (e.g., flaking, blistering, water damage, or other signs of physical damage).

(ii) Severity of damage (e.g., major flaking, severely torn jackets, as opposed to occasional flaking, minor tears to jackets).

(iii) Extent or spread of damage over large areas or large percentages of the homogeneous area.

(3) Whether the material is accessible.

(4) The material's potential for disturbance.

(5) Known or suspected causes of damage or significant damage (e.g., air erosion, vandalism, vibration, water).

(6) Preventive measures which might eliminate the reasonable likelihood of undamaged ACM from becoming significantly damaged.

(d) The local education agency shall select a person accredited to develop management plans to review the results of each inspection, reinspection, and assessment for the school building and to conduct any other necessary activities in order to recommend in writing to the local education agency appropriate response actions. The accredited person shall sign and date the recommendation, provide his or her State of accreditation, and, if applicable, provide his or her accreditation number, and submit a copy of the recommendation to the person designated under §763.84 for inclusion in the management plan.

§ 763.90 Response actions.

(a) The local education agency shall select and implement in a timely manner the appropriate response actions in this section consistent with the assessment conducted in §763.88. The response actions selected shall be sufficient to protect human health and the environment. The local education agency may then select, from the response actions which protect human health and the environment, that action which is the least burdensome method. Nothing in this section shall be construed to prohibit removal of ACBM from a school building at any time, should removal be the preferred response action of the local education agency.

(b) If damaged or significantly damaged thermal system insulation ACM is present in a building, the local education agency shall:

(1) At least repair the damaged area.

(2) Remove the damaged material if it is not feasible, due to technological factors, to repair the damage.

(3) Maintain all thermal system insulation ACM and its covering in an intact state and undamaged condition.

(c)(1) If damaged friable surfacing ACM or damaged friable miscellaneous ACM is present in a building, the local education agency shall select from among the following response actions: encapsulation, enclosure, removal, or repair of the damaged material.

(2) In selecting the response action from among those which meet the definitional standards in §763.83, the local education agency shall determine which of these response actions protects human health and the environment. For purposes of determining which of these response actions are the least burdensome, the local education agency may then consider local circumstances, including occupancy and use patterns within the school building, and its economic concerns, including short- and long-term costs.

(d) If significantly damaged friable surfacing ACM or significantly damaged friable miscellaneous ACM is present in a building the local education agency shall:

(1) Immediately isolate the functional space and restrict access, unless

isolation is not necessary to protect human health and the environment.

(2) Remove the material in the functional space or, depending upon whether enclosure or encapsulation would be sufficient to protect human health and the environment, enclose or encapsulate.

(e) If any friable surfacing ACM, thermal system insulation ACM, or friable miscellaneous ACM that has potential for damage is present in a building, the local education agency shall at least implement an operations and maintenance (O&M) program, as described under § 763.91.

(f) If any friable surfacing ACM, thermal system insulation ACM, or friable miscellaneous ACM that has potential for significant damage is present in a building, the local education agency shall:

(1) Implement an O&M program, as described under § 763.91.

(2) Institute preventive measures appropriate to eliminate the reasonable likelihood that the ACM or its covering will become significantly damaged, deteriorated, or delaminated.

(3) Remove the material as soon as possible if appropriate preventive measures cannot be effectively implemented, or unless other response actions are determined to protect human health and the environment. Immediately isolate the area and restrict access if necessary to avoid an imminent and substantial endangerment to human health or the environment.

(g) Response actions including removal, encapsulation, enclosure, or repair, other than small-scale, short-duration repairs, shall be designed and conducted by persons accredited to design and conduct response actions.

(h) The requirements of this subpart E in no way supersede the worker protection and work practice requirements under 29 CFR 1926.58 (Occupational Safety and Health Administration (OSHA) asbestos worker protection standards for construction), 40 CFR part 763, subpart G (EPA asbestos worker protection standards for public employees), and 40 CFR part 61, subpart M (National Emission Standards for Hazardous Air Pollutants—Asbestos).

(i) Completion of response actions. (1) At the conclusion of any action to remove, encapsulate, or enclose ACBM or material assumed to be ACBM, a person designated by the local education agency shall visually inspect each functional space where such action was conducted to determine whether the action has been properly completed.

(2)(i) A person designated by the local education agency shall collect air samples using aggressive sampling as described in appendix A to this subpart E to monitor air for clearance after each removal, encapsulation, and enclosure project involving ACBM, except for projects that are of small-scale, short-duration.

(ii) Local education agencies shall have air samples collected under this section analyzed for asbestos using laboratories accredited by the National Bureau of Standards to conduct such analysis using transmission electron microscopy (TEM) or, under circumstances permitted in this section, laboratories enrolled in the American Industrial Hygiene Association Proficiency Analytical Testing Program for phase contrast microscopy (PCM).

(iii) Until the National Bureau of Standards TEM laboratory accreditation program is operational, local educational agencies shall use laboratories that use the protocol described in appendix A to subpart E of this part.

(3) Except as provided in paragraphs (i)(4), and (i)(5), of this section, an action to remove, encapsulate, or enclose ACBM shall be considered complete when the average concentration of asbestos of five air samples collected within the affected functional space and analyzed by the TEM method in appendix A of this subpart E, is not statistically significantly different, as determined by the Z-test calculation found in appendix A of this subpart E, from the average asbestos concentration of five air samples collected at the same time outside the affected functional space and analyzed in the same manner, and the average asbestos concentration of the three field blanks described in appendix A of this subpart E is below the filter background level, as defined in appendix A of this subpart E, of 70 structures per square millimeter (70 s/mm^2).

(4) An action may also be considered complete if the volume of air drawn for each of the five samples collected within the affected functional space is equal to or greater than 1,199 L of air for a 25 mm filter or equal to or greater than 2,799 L of air for a 37 mm filter, and the average concentration of asbestos as analyzed by the TEM method in appendix A of this subpart E, for the five air samples does not exceed the filter background level, as defined in appendix A, of 70 structures per square millimeter (70 s/mm^2). If the average concentration of asbestos of the five air samples within the affected functional space exceeds 70 s/mm^2, or if the volume of air in each of the samples is less than 1,199 L of air for a 25 mm filter or less than 2,799 L of air for a 37 mm filter, the action shall be considered complete only when the requirements of paragraph (i)(3) or (i)(5), of this section are met.

(5) At any time, a local education agency may analyze air monitoring samples collected for clearance purposes by phase contrast microscopy (PCM) to confirm completion of removal, encapsulation, or enclosure of ACBM that is greater than small-scale, short-duration and less than or equal to 160 square feet or 260 linear feet. The action shall be considered complete when the results of samples collected in the affected functional space and analyzed by phase contrast microscopy using the National Institute for Occupational Safety and Health (NIOSH) Method 7400 entitled ''Fibers'' published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987, show that the concentration of fibers for each of the five samples is less than or equal to a limit of quantitation for PCM (0.01 fibers per cubic centimeter (0.01 f/cm^3) of air). The method is available for public inspection at the Non-Confidential Information Center (NCIC) (7407), Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency, Room B–607 NEM, 401 M St., SW., Washington, DC 20460, between the hours of 12 p.m. and 4 p.m. weekdays excluding legal holidays or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.* This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. The method is incorporated as it exists on the effective date of this rule, and a notice of any change to the method will be published in the FEDERAL REGISTER.

(6) To determine the amount of ACBM affected under paragraph (i)(5) of this section, the local education agency shall add the total square or linear footage of ACBM within the containment barriers used to isolate the functional space for the action to remove, encapsulate, or enclose the ACBM. Contiguous portions of material subject to such action conducted concurrently or at approximately the same time within the same school building shall not be separated to qualify under paragraph (i)(5), of this section.

[52 FR 41846, Oct. 30, 1987, as amended at 53 FR 12525, Apr. 15, 1988; 60 FR 31922, June 19, 1995; 60 FR 34465, July 3, 1995; 69 FR 18803, Apr. 9, 2004]

§ 763.91 Operations and maintenance.

(a) *Applicability.* The local education agency shall implement an operations, maintenance, and repair (O&M) program under this section whenever any friable ACBM is present or assumed to be present in a building that it leases, owns, or otherwise uses as a school building. Any material identified as nonfriable ACBM or nonfriable assumed ACBM must be treated as friable ACBM for purposes of this section when the material is about to become friable as a result of activities performed in the school building.

(b) *Worker protection.* Local education agencies must comply with either the OSHA Asbestos Construction Standard at 29 CFR 1926.1101, or the Asbestos Worker Protection Rule at 40 CFR 763.120, whichever is applicable.

(c) *Cleaning*—(1) *Initial cleaning.* Unless the building has been cleaned using equivalent methods within the previous 6 months, all areas of a school building where friable ACBM, damaged or significantly damaged thermal system insulation ACM, or friable suspected ACBM assumed to be ACM are present shall be cleaned at least once after the completion of the inspection required by § 763.85(a) and before the initiation of any response action, other than O&M activities or repair, according to the following procedures:

(i) HEPA-vacuum or steam-clean all carpets.

(ii) HEPA-vacuum or wet-clean all other floors and all other horizontal surfaces.

(iii) Dispose of all debris, filters, mopheads, and cloths in sealed, leak-tight containers.

(2) *Additional cleaning.* The accredited management planner shall make a written recommendation to the local education agency whether additional cleaning is needed, and if so, the methods and frequency of such cleaning.

(d) *Operations and maintenance activities.* The local education agency shall ensure that the procedures described below to protect building occupants shall be followed for any operations and maintenance activities disturbing friable ACBM:

(1) Restrict entry into the area by persons other than those necessary to perform the maintenance project, either by physically isolating the area or by scheduling.

(2) Post signs to prevent entry by unauthorized persons.

(3) Shut off or temporarily modify the air-handling system and restrict other sources of air movement.

(4) Use work practices or other controls, such as, wet methods, protective clothing, HEPA-vacuums, mini-enclosures, glove bags, as necessary to inhibit the spread of any released fibers.

(5) Clean all fixtures or other components in the immediate work area.

(6) Place the asbestos debris and other cleaning materials in a sealed, leak-tight container.

(e) *Maintenance activities other than small-scale, short-duration.* The response action for any maintenance activities disturbing friable ACBM, other than small-scale, short-duration maintenance activities, shall be designed by persons accredited to design response actions and conducted by persons accredited to conduct response actions.

(f) *Fiber release episodes*—(1) *Minor fiber release episode.* The local education agency shall ensure that the procedures described below are followed in the event of a minor fiber release episode (i.e., the falling or dislodging of 3 square or linear feet or less of friable ACBM): 5

(i) Thoroughly saturate the debris using wet methods.

(ii) Clean the area, as described in paragraph (e) of this section.

(iii) Place the asbestos debris in a sealed, leak-tight container.

(iv) Repair the area of damaged ACM with materials such as asbestos-free spackling, plaster, cement, or insulation, or seal with latex paint or an encapsulant, or immediately have the appropriate response action implemented as required by § 763.90.

(2) *Major fiber release episode.* The local education agency shall ensure that the procedures described below are followed in the event of a major fiber release episode (i.e., the falling or dislodging of more than 3 square or linear feet of friable ACBM):

(i) Restrict entry into the area and post signs to prevent entry into the area by persons other than those necessary to perform the response action.

(ii) Shut off or temporarily modify the air-handling system to prevent the distribution of fibers to other areas in the building.

(iii) The response action for any major fiber release episode must be designed by persons accredited to design response actions and conducted by persons accredited to conduct response actions.

[52 FR 41846, Oct. 30, 1987, as amended at 65 FR 69216, Nov. 15, 2000]

§ 763.92 Training and periodic surveillance.

(a) *Training.* (1) The local education agency shall ensure, prior to the implementation of the O&M provisions of the management plan, that all members of its maintenance and custodial staff (custodians, electricians, heating/air conditioning engineers, plumbers, etc.) who may work in a building that contains ACBM receive awareness training of at least 2 hours, whether or not they are required to work with ACBM. New custodial and maintenance employees shall be trained within 60 days after commencement of employment. Training shall include, but not be limited to:

(i) Information regarding asbestos and its various uses and forms.

(ii) Information on the health effects associated with asbestos exposure.

(iii) Locations of ACBM identified throughout each school building in which they work.

(iv) Recognition of damage, deterioration, and delamination of ACBM.

(v) Name and telephone number of the person designated to carry out general local education agency responsibilities under § 763.84 and the availability and location of the management plan.

(2) The local education agency shall ensure that all members of its maintenance and custodial staff who conduct any activities that will result in the disturbance of ACBM shall receive training described in paragraph (a)(1) of this section and 14 hours of additional training. Additional training shall include, but not be limited to:

(i) Descriptions of the proper methods of handling ACBM.

(ii) Information on the use of respiratory protection as contained in the EPA/NIOSH *Guide to Respiratory Protection for the Asbestos Abatement Industry*, September 1986 (EPA 560/OPPTS–86–001), available from the Director, Environmental Assistance Division (7408), Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency, Room E–543B, 1200 Pennsylvania Ave., NW., Washington, DC 20460, Telephone: (202) 554–1404, TDD: (202) 544–0551 and other personal protection measures.

(iii) The provisions of this section and § 763.91, Appendices A, C, and D of this subpart E of this part, EPA regulations contained in 40 CFR part 763, subpart G, and in 40 CFR part 61, subpart M, and OSHA regulations contained in 29 CFR 1926.58.

(iv) Hands-on training in the use of respiratory protection, other personal protection measures, and good work practices.

(3) Local education agency maintenance and custodial staff who have attended EPA-approved asbestos training or received equivalent training for O&M and periodic surveillance activities involving asbestos shall be considered trained for the purposes of this section.

(b) *Periodic surveillance.* (1) At least once every 6 months after a management plan is in effect, each local education agency shall conduct periodic surveillance in each building that it leases, owns, or otherwise uses as a school building that contains ACBM or is assumed to contain ACBM.

(2) Each person performing periodic surveillance shall:

(i) Visually inspect all areas that are identified in the management plan as ACBM or assumed ACBM.

(ii) Record the date of the surveillance, his or her name, and any changes in the condition of the materials.

(iii) Submit to the person designated to carry out general local education agency responsibilities under § 763.84 a copy of such record for inclusion in the management plan.

[52 FR 41846, Oct. 30, 1987, as amended at 60 FR 34465, July 3, 1995; 65 FR 69216, Nov. 15, 2000]

§ 763.93 Management plans.

(a)(1) On or before October 12, 1988, each local education agency shall develop an asbestos management plan for each school, including all buildings that they lease, own, or otherwise use as school buildings, and submit the plan to an Agency designated by the Governor of the State in which the local education agency is located. The plan may be submitted in stages that cover a portion of the school buildings under the authority of the local education agency.

(2) If a building to be used as part of a school is leased or otherwise acquired after October 12, 1988, the local education agency shall include the new building in the management plan for the school prior to its use as a school building. The revised portions of the management plan shall be submitted to the Agency designated by the Governor.

(3) If a local education agency begins to use a building as a school after October 12, 1988, the local education agency shall submit a management plan for the school to the Agency designated by

the Governor prior to its use as a school.

(b) On or before October 17, 1987, the Governor of each State shall notify local education agencies in the State regarding where to submit their management plans. States may establish administrative procedures for reviewing management plans. If the Governor does not disapprove a management plan within 90 days after receipt of the plan, the local education agency shall implement the plan.

(c) Each local education agency must begin implementation of its management plan on or before July 9, 1989, and complete implementation in a timely fashion.

(d) Each local education agency shall maintain and update its management plan to keep it current with ongoing operations and maintenance, periodic surveillance, inspection, reinspection, and response action activities. All provisions required to be included in the management plan under this section shall be retained as part of the management plan, as well as any information that has been revised to bring the plan up-to-date.

(e) The management plan shall be developed by an accredited management planner and shall include:

(1) A list of the name and address of each school building and whether the school building contains friable ACBM, nonfriable ACBM, and friable and nonfriable suspected ACBM assumed to be ACM.

(2) For each inspection conducted before the December 14, 1987:

(i) The date of the inspection.

(ii) A blueprint, diagram, or written description of each school building that identifies clearly each location and approximate square or linear footage of any homogeneous or sampling area where material was sampled for ACM, and, if possible, the exact locations where bulk samples were collected, and the dates of collection.

(iii) A copy of the analyses of any bulk samples, dates of analyses, and a copy of any other laboratory reports pertaining to the analyses.

(iv) A description of any response actions or preventive measures taken to reduce asbestos exposure, including if possible, the names and addresses of all contractors involved, start and completion dates of the work, and results of any air samples analyzed during and upon completion of the work.

(v) A description of assessments, required to be made under § 763.88, of material that was identified before December 14, 1987, as friable ACBM or friable suspected ACBM assumed to be ACM, and the name and signature, State of accreditation, and if applicable, accreditation number of each accredited person making the assessments.

(3) For each inspection and reinspection conducted under § 763.85:

(i) The date of the inspection or reinspection and the name and signature, State of accreditation and, if applicable, the accreditation number of each accredited inspector performing the inspection or reinspection.

(ii) A blueprint, diagram, or written description of each school building that identifies clearly each location and approximate square or linear footage of homogeneous areas where material was sampled for ACM, the exact location where each bulk sample was collected, date of collection, homogeneous areas where friable suspected ACBM is assumed to be ACM, and where nonfriable suspected ACBM is assumed to be ACM.

(iii) A description of the manner used to determine sampling locations, and the name and signature of each accredited inspector collecting samples, the State of accreditation, and if applicable, his or her accreditation number.

(iv) A copy of the analyses of any bulk samples collected and analyzed, the name and address of any laboratory that analyzed bulk samples, a statement that the laboratory meets the applicable requirements of § 763.87(a) the date of analysis, and the name and signature of the person performing the analysis.

(v) A description of assessments, required to be made under § 763.88, of all ACBM and suspected ACBM assumed to be ACM, and the name, signature, State of accreditation, and if applicable, accreditation number of each accredited person making the assessments.

(4) The name, address, and telephone number of the person designated under § 763.84 to ensure that the duties of the

local education agency are carried out, and the course name, and dates and hours of training taken by that person to carry out the duties.

(5) The recommendations made to the local education agency regarding response actions, under § 763.88(d), the name, signature, State of accreditation of each person making the recommendations, and if applicable, his or her accreditation number.

(6) A detailed description of preventive measures and response actions to be taken, including methods to be used, for any friable ACBM, the locations where such measures and action will be taken, reasons for selecting the response action or preventive measure, and a schedule for beginning and completing each preventive measure and response action.

(7) With respect to the person or persons who inspected for ACBM and who will design or carry out response actions, except for operations and maintenance, with respect to the ACBM, one of the following statements:

(i) If the State has adopted a contractor accreditation program under section 206(b) of Title II of the Act, a statement that the person(s) is accredited under such plan.

(ii) A statement that the local education agency used (or will use) persons who have been accredited by another State which has adopted a contractor accreditation plan under section 206(b) of Title II of the Act or is accredited by an EPA-approved course under section 206(c) of Title II of the Act.

(8) A detailed description in the form of a blueprint, diagram, or in writing of any ACBM or suspected ACBM assumed to be ACM which remains in the school once response actions are undertaken pursuant to § 763.90. This description shall be updated as response actions are completed.

(9) A plan for reinspection under § 763.85, a plan for operations and maintenance activities under § 763.91, and a plan for periodic surveillance under § 763.92, a description of the recommendation made by the management planner regarding additional cleaning under § 763.91(c)(2) as part of an operations and maintenance program, and the response of the local education agency to that recommendation.

(10) A description of steps taken to inform workers and building occupants, or their legal guardians, about inspections, reinspections, response actions, and post-response action activities, including periodic reinspection and surveillance activities that are planned or in progress.

(11) An evaluation of the resources needed to complete response actions successfully and carry out reinspection, operations and maintenance activities, periodic surveillance and training.

(12) With respect to each consultant who contributed to the management plan, the name of the consultant and one of the following statements:

(i) If the State has adopted a contractor accreditation plan under section 206(b) of Title II of the Act, a statement that the consultant is accredited under such plan.

(ii) A statement that the contractor is accredited by another State which has adopted a contractor accreditation plan under section 206(b) of Title II of the Act, or is accredited by an EPA-approved course developed under section 206(c) of Title II of the Act.

(f) A local education agency may require each management plan to contain a statement signed by an accredited management plan developer that such person has prepared or assisted in the preparation of such plan or has reviewed such plan, and that such plan is in compliance with this subpart E. Such statement may not be signed by a person who, in addition to preparing or assisting in preparing the management plan, also implements (or will implement) the management plan.

(g)(1) Upon submission of a management plan to the Governor for review, a local education agency shall keep a copy of the plan in its administrative office. The management plans shall be available, without cost or restriction, for inspection by representatives of EPA and the State, the public, including teachers, other school personnel and their representatives, and parents. The local education agency may charge a reasonable cost to make copies of management plans.

(2) Each local education agency shall maintain in its administrative office a complete, updated copy of a management plan for each school under its administrative control or direction. The management plans shall be available, during normal business hours, without cost or restriction, for inspection by representatives of EPA and the State, the public, including teachers, other school personnel and their representatives, and parents. The local education agency may charge a reasonable cost to make copies of management plans.

(3) Each school shall maintain in its administrative office a complete, updated copy of the management plan for that school. Management plans shall be available for inspection, without cost or restriction, to workers before work begins in any area of a school building. The school shall make management plans available for inspection to representatives of EPA and the State, the public, including parents, teachers, and other school personnel and their representatives within 5 working days after receiving a request for inspection. The school may charge a reasonable cost to make copies of the management plan.

(4) Upon submission of its management plan to the Governor and at least once each school year, the local education agency shall notify in writing parent, teacher, and employee organizations of the availability of management plans and shall include in the management plan a description of the steps taken to notify such organizations, and a dated copy of the notification. In the absence of any such organizations for parents, teachers, or employees, the local education agency shall provide written notice to that relevant group of the availability of management plans and shall include in the management plan a description of the steps taken to notify such groups, and a dated copy of the notification.

(h) Records required under §763.94 shall be made by local education agencies and maintained as part of the management plan.

(i) Each management plan must contain a true and correct statement, signed by the individual designated by the local education agency under §763.84, which certifies that the general, local education agency responsibilities, as stipulated by §763.84, have been met or will be met.

§763.94 Recordkeeping.

(a) Records required under this section shall be maintained in a centralized location in the administrative office of both the school and the local education agency as part of the management plan. For each homogeneous area where all ACBM has been removed, the local education agency shall ensure that such records are retained for 3 years after the next reinspection required under §763.85(b)(1), or for an equivalent period.

(b) For each preventive measure and response action taken for friable and nonfriable ACBM and friable and nonfriable suspected ACBM assumed to be ACM, the local education agency shall provide:

(1) A detailed written description of the measure or action, including methods used, the location where the measure or action was taken, reasons for selecting the measure or action, start and completion dates of the work, names and addresses of all contractors involved, and if applicable, their State of accreditation, and accreditation numbers, and if ACBM is removed, the name and location of storage or disposal site of the ACM.

(2) The name and signature of any person collecting any air sample required to be collected at the completion of certain response actions specified by §763.90(i), the locations where samples were collected, date of collection, the name and address of the laboratory analyzing the samples, the date of analysis, the results of the analysis, the method of analysis, the name and signature of the person performing the analysis, and a statement that the laboratory meets the applicable requirements of §763.90(i)(2)(ii).

(c) For each person required to be trained under §763.92(a) (1) and (2), the local education agency shall provide the person's name and job title, the date that training was completed by that person, the location of the training, and the number of hours completed in such training.

(d) For each time that periodic surveillance under §763.92(b) is performed, the local education agency shall record the name of each person performing the surveillance, the date of the surveillance, and any changes in the conditions of the materials.

(e) For each time that cleaning under § 763.91(c) is performed, the local education agency shall record the name of each person performing the cleaning, the date of such cleaning, the locations cleaned, and the methods used to perform such cleaning.

(f) For each time that operations and maintenance activities under § 763.91(d) are performed, the local education agency shall record the name of each person performing the activity, the start and completion dates of the activity, the locations where such activity occurred, a description of the activity including preventive measures used, and if ACBM is removed, the name and location of storage or disposal site of the ACM.

(g) For each time that major asbestos activity under § 763.91(e) is performed, the local education agency shall provide the name and signature, State of accreditation, and if applicable, the accreditation number of each person performing the activity, the start and completion dates of the activity, the locations where such activity occurred, a description of the activity including preventive measures used, and if ACBM is removed, the name and location of storage or disposal site of the ACM.

(h) For each fiber release episode under § 763.91(f), the local education agency shall provide the date and location of the episode, the method of repair, preventive measures or response action taken, the name of each person performing the work, and if ACBM is removed, the name and location of storage or disposal site of the ACM.

(Approved by the Office of Management and Budget under control number 2070–0091)

§ 763.95 Warning labels.

(a) The local education agency shall attach a warning label immediately adjacent to any friable and nonfriable ACBM and suspected ACBM assumed to be ACM located in routine maintenance areas (such as boiler rooms) at each school building. This shall include:

(1) Friable ACBM that was responded to by a means other than removal.

(2) ACBM for which no response action was carried out.

(b) All labels shall be prominently displayed in readily visible locations and shall remain posted until the ACBM that is labeled is removed.

(c) The warning label shall read, in print which is readily visible because of large size or bright color, as follows:

CAUTION: ASBESTOS. HAZARDOUS. DO NOT DISTURB WITHOUT PROPER TRAINING AND EQUIPMENT.

§ 763.97 Compliance and enforcement.

(a) *Compliance with Title II of the Act.* (1) Section 207(a) of Title II of the Act (15 U.S.C. 2647) makes it unlawful for any local education agency to:

(i) Fail to conduct inspections pursuant to section 203(b) of Title II of the Act, including failure to follow procedures and failure to use accredited personnel and laboratories.

(ii) Knowingly submit false information to the Governor regarding any inspection pursuant to regulations under section 203(i) of Title II of the Act.

(iii) Fail to develop a management plan pursuant to regulations under section 203(i) of Title II of the Act.

(2) Section 207(a) of Title II of the Act (15 U.S.C. 2647) also provides that any local education agency which violates any provision of section 207 shall be liable for a civil penalty of not more than $5,000 for each day during which the violation continues. For the purposes of this subpart, a ‘‘violation’’ means a failure to comply with respect to a single school building.

(b) *Compliance with Title I of the Act.* (1) Section 15(1)(D) of Title I of the Act (15 U.S.C. 2614) makes it unlawful for any person to fail or refuse to comply with any requirement of Title II or any rule promulgated or order issued under Title II. Therefore, any person who violates any requirement of this subpart is in violation of section 15 of Title I of the Act.

(2) Section 15(3) of Title I of the Act (15 U.S.C. 2614) makes it unlawful for any person to fail or refuse to establish or maintain records, submit reports, notices or other information, or permit access to or copying of records, as required by this Act or a rule thereunder.

(3) Section 15(4) (15 U.S.C. 2614) of Title I of the Act makes it unlawful for any person to fail or refuse to permit entry or inspection as required by section 11 of Title I of the Act.

(4) Section 16(a) of Title I of the Act (15 U.S.C. 2615) provides that any person who violates any provision of section 15 of Title I of the Act shall be liable to the United States for a civil penalty in an amount not to exceed $25,000 for each such violation. Each day such a violation continues shall, for purposes of this paragraph, constitute a separate violation of section 15. A local education agency is not liable for any civil penalty under Title I of the Act for failing or refusing to comply with any rule promulgated or order issued under Title II of the Act.

(c) *Criminal penalties.* If any violation committed by any person (including a local education agency) is knowing or willful, criminal penalties may be assessed under section 16(b) of Title I of the Act.

(d) *Injunctive relief.* The Agency may obtain injunctive relief under section 208(b) of Title II of the Act to respond to a hazard which poses an imminent and substantial endangerment to human health or the environment or section 17 (15 U.S.C. 2616) of Title I of the Act to restrain any violation of section 15 of Title I of the Act or to compel the taking of any action required by or under Title I of the Act.

(e) *Citizen complaints.* Any citizen who wishes to file a complaint pursuant to section 207(d) of Title II of the Act should direct the complaint to the Governor of the State or the EPA Asbestos Ombudsman, 1200 Pennsylvania Ave., NW., Washington, DC 20460. The citizen complaint should be in writing and identified as a citizen complaint pursuant to section 207(d) of Title II of TSCA. The EPA Asbestos Ombudsman or the Governor shall investigate and respond to the complaint within a reasonable period of time if the allegations provide a reasonable basis to believe that a violation of the Act has occurred.

(f) *Inspections.* EPA may conduct inspections and review management plans under section 11 of Title I of the Act (15 U.S.C. 2610) to ensure compliance.

§763.98 Waiver; delegation to State.

(a) *General.* (1) Upon request from a state Governor and after notice and comment and an opportunity for a public hearing in accordance with paragraphs (b) and (c) of this section, EPA may waive some or all of the requirements of this subpart E if the state has established and is implementing or intends to implement a program of asbestos inspection and management that contains requirements that are at least as stringent as the requirements of this subpart. In addition, if the state chooses to receive electronic documents, the state program must include, at a minimum, the requirements of 40 CFR part 3—(Electronic reporting).

(2) A waiver from any requirement of this subpart E shall apply only to the specific provision for which a waiver has been granted under this section. All requirements of this subpart E shall apply until a waiver is granted under this section.

(b) *Request.* Each request by a Governor to waive any requirement of this subpart E shall be sent with three complete copies of the request to the Regional Administrator for the EPA Region in which the State is located and shall include:

(1) A copy of the State provisions or proposed provisions relating to its program of asbestos inspection and management in schools for which the request is made.

(2)(i) The name of the State agency that is or will be responsible for administering and enforcing the requirements for which a waiver is requested, the names and job titles of responsible officials in that agency, and phone numbers where the officials can be contacted.

(ii) In the event that more than one agency is or will be responsible for administering and enforcing the requirements for which a waiver is requested, a description of the functions to be performed by each agency, how the program will be coordinated by the lead agency to ensure consistency and effective administration in the asbestos inspection and management program within the State, the names and job titles of responsible officials in the agencies, and phone numbers where the officials can be contacted. The lead agency will serve as the central contact point for the EPA.

(3) Detailed reasons, supporting papers, and the rationale for concluding that the state's asbestos inspection and management program provisions for which the request is made are at least as stringent as the requirements of Subpart E of this part, and that, if the state chooses to receive electronic documents, the state program includes, at a minimum, the requirements of 40 CFR part 3—(Electronic reporting).

(4) A discussion of any special situations, problems, and needs pertaining to the waiver request accompanied by an explanation of how the State intends to handle them.

(5) A statement of the resources that the State intends to devote to the administration and enforcement of the provisions relating to the waiver request.

(6) Copies of any specific or enabling State laws (enacted and pending enactment) and regulations (promulgated and pending promulgation) relating to the request, including provisions for assessing criminal and/or civil penalties.

(7) Assurance from the Governor, the Attorney General, or the legal counsel of the lead agency that the lead agency or other cooperating agencies have the legal authority necessary to carry out the requirements relating to the request.

(c) *General notice—hearing.* (1) Within 30 days after receipt of a request for a waiver, EPA will determine the completeness of the request. If EPA does not request further information within the 30-day period, the request will be deemed complete.

(2) Within 30 days after EPA determines that a request is complete, EPA will issue for publication in the FEDERAL REGISTER a notice that announces receipt of the request, describes the information submitted under paragraph (b) of this section, and solicits written comment from interested members of the public. Comments must be submitted within 60 days.

(3) If, during the comment period, EPA receives a written objection to a Governor's request and a request for a public hearing detailing specific objections to the granting of a waiver, EPA will schedule a public hearing to be held in the affected State after the close of the comment period and will announce the public hearing date in the FEDERAL REGISTER before the date of the hearing. Each comment shall include the name and address of the person submitting the comment.

(d) *Criteria.* EPA may waive some or all of the requirements of subpart E of this part if:

(1) The State's lead agency and other cooperating agencies have the legal authority necessary to carry out the provisions of asbestos inspection and management in schools relating to the waiver request.

(2) The State's program of asbestos inspection and management in schools relating to the waiver request and implementation of the program are or will be at least as stringent as the requirements of this subpart E.

(3) The state has an enforcement mechanism to allow it to implement the program described in the waiver request and any electronic reporting requirements are at least as stringent as 40 CFR part 3—(Electronic reporting).

(4) The lead agency and any cooperating agencies have or will have qualified personnel to carry out the provisions relating to the waiver request.

(5) The State will devote adequate resources to the administration and enforcement of the asbestos inspection and management provisions relating to the waiver request.

(6) When specified by EPA, the State gives satisfactory assurances that necessary steps, including specific actions it proposes to take and a time schedule for their accomplishment, will be taken within a reasonable time to conform with applicable criteria under paragraphs (d) (2) through (4) of this section.

(e) *Decision.* EPA will issue for publication in the FEDERAL REGISTER a notice announcing its decision to grant or deny, in whole or in part, a Governor's request for a waiver from some or all of the requirements of this subpart E within 30 days after the close of the comment period or within 30 days following a public hearing, whichever is applicable. The notice will include the Agency's reasons and rationale for granting or denying the Governor's request. The 30-day period may be extended if mutually agreed upon by EPA and the State.

(f) *Modifications.* When any substantial change is made in the administration or enforcement of a State program for which a waiver was granted under this section, a responsible official in the lead agency shall submit such changes to EPA.

(g) *Reports.* The lead agency in each State that has been granted a waiver by EPA from any requirement of subpart E of this part shall submit a report to the Regional Administrator for the Region in which the State is located at least once every 12 months to include the following information:

(1) A summary of the State's implementation and enforcement activities during the last reporting period relating to provisions waived under this section, including enforcement actions taken.

(2) Any changes in the administration or enforcement of the State program implemented during the last reporting period.

(3) Other reports as may be required by EPA to carry out effective oversight of any requirement of this subpart E that was waived under this section.

(h) *Oversight.* EPA may periodically evaluate the adequacy of a State's implementation and enforcement of and resources devoted to carrying out requirements relating to the waiver. This evaluation may include, but is not limited to, site visits to local education agencies without prior notice to the State.

(i) *Informal conference.* (1) EPA may request that an informal conference be held between appropriate State and EPA officials when EPA has reason to believe that a State has failed to:

(i) Substantially comply with the terms of any provision that was waived under this section.

(ii) Meet the criteria under paragraph (d) of this section, including the failure to carry out enforcement activities or act on violations of the State program.

(2) EPA will:

(i) Specify to the State those aspects of the State's program believed to be inadequate.

(ii) Specify to the State the facts that underlie the belief of inadequacy.

(3) If EPA finds, on the basis of information submitted by the State at the conference, that deficiencies did not exist or were corrected by the State, no further action is required.

(4) Where EPA finds that deficiencies in the State program exist, a plan to correct the deficiencies shall be negotiated between the State and EPA. The plan shall detail the deficiencies found in the State program, specify the steps the State has taken or will take to remedy the deficiencies, and establish a schedule for each remedial action to be initiated.

(j) *Rescission.* (1) If the State fails to meet with EPA or fails to correct deficiencies raised at the informal conference, EPA will deliver to the Governor of the State and a responsible official in the lead agency a written notice of its intent to rescind, in whole or part, the waiver.

(2) EPA will issue for publication in the FEDERAL REGISTER a notice that announces the rescission of the waiver, describes those aspects of the State's program determined to be inadequate, and specifies the facts that underlie the findings of inadequacy.

[52 FR 41846, Oct. 30, 1987, as amended at 70 FR 59889, Oct. 13, 2005]

§ 763.99 Exclusions.

(a) A local education agency shall not be required to perform an inspection under § 763.85(a) in any sampling area as defined in 40 CFR 763.103 or homogeneous area of a school building where:

(1) An accredited inspector has determined that, based on sampling records, friable ACBM was identified in that homogeneous or sampling area during an inspection conducted before December 14, 1987. The inspector shall sign and date a statement to that effect with his or her State of accreditation and if applicable, accreditation number and, within 30 days after such determination, submit a copy of the statement to the person designated under § 763.84 for inclusion in the management plan. However, an accredited inspector shall assess the friable ACBM under § 763.88.

(2) An accredited inspector has determined that, based on sampling records,

nonfriable ACBM was identified in that homogeneous or sampling area during an inspection conducted before December 14, 1987. The inspector shall sign and date a statement to that effect with his or her State of accreditation and if applicable, accreditation number and, within 30 days after such determination, submit a copy of the statement to the person designated under § 763.84 for inclusion in the management plan. However, an accredited inspector shall identify whether material that was nonfriable has become friable since that previous inspection and shall assess the newly-friable ACBM under § 763.88.

(3) Based on sampling records and inspection records, an accredited inspector has determined that no ACBM is present in the homogeneous or sampling area and the records show that the area was sampled, before December 14, 1987 in substantial compliance with § 763.85(a), which for purposes of this section means in a random manner and with a sufficient number of samples to reasonably ensure that the area is not ACBM.

(i) The accredited inspector shall sign and date a statement, with his or her State of accreditation and if applicable, accreditation number that the homogeneous or sampling area determined not to be ACBM was sampled in substantial compliance with § 763.85(a).

(ii) Within 30 days after the inspector's determination, the local education agency shall submit a copy of the inspector's statement to the EPA Regional Office and shall include the statement in the management plan for that school.

(4) The lead agency responsible for asbestos inspection in a State that has been granted a waiver from § 763.85(a) has determined that, based on sampling records and inspection records, no ACBM is present in the homogeneous or sampling area and the records show that the area was sampled before December 14, 1987, in substantial compliance with § 763.85(a). Such determination shall be included in the management plan for that school.

(5) An accredited inspector has determined that, based on records of an inspection conducted before December 14, 1987, suspected ACBM identified in that homogeneous or sampling area is assumed to be ACM. The inspector shall sign and date a statement to that effect, with his or her State of accreditation and if applicable, accreditation number and, within 30 days of such determination, submit a copy of the statement to the person designated under § 763.84 for inclusion in the management plan. However, an accredited inspector shall identify whether material that was nonfriable suspected ACBM assumed to be ACM has become friable since the previous inspection and shall assess the newly friable material and previously identified friable suspected ACBM assumed to be ACM under § 763.88.

(6) Based on inspection records and contractor and clearance records, an accredited inspector has determined that no ACBM is present in the homogeneous or sampling area where asbestos removal operations have been conducted before December 14, 1987, and shall sign and date a statement to that effect and include his or her State of accreditation and, if applicable, accreditation number. The local education agency shall submit a copy of the statement to the EPA Regional Office and shall include the statement in the management plan for that school.

(7) An architect or project engineer responsible for the construction of a new school building built after October 12, 1988, or an accredited inspector signs a statement that no ACBM was specified as a building material in any construction document for the building, or, to the best of his or her knowledge, no ACBM was used as a building material in the building. The local education agency shall submit a copy of the signed statement of the architect, project engineer, or accredited inspector to the EPA Regional Office and shall include the statement in the management plan for that school.

(b) The exclusion, under paragraphs (a) (1) through (4) of this section, from conducting the inspection under § 763.85(a) shall apply only to homogeneous or sampling areas of a school building that were inspected and sampled before October 17, 1987. The local education agency shall conduct an inspection under § 763.85(a) of all areas inspected before October 17, 1987, that were not sampled or were not assumed to be ACM.

(c) If ACBM is subsequently found in a homogeneous or sampling area of a local education agency that had been identified as receiving an exclusion by an accredited inspector under paragraphs (a) (3), (4), (5) of this section, or an architect, project engineer or accredited inspector under paragraph (a)(7) of this section, the local education agency shall have 180 days following the date of identification of ACBM to comply with this subpart E.

APPENDIX A TO SUBPART E OF PART 763—INTERIM TRANSMISSION ELECTRON MICROSCOPY ANALYTICAL METHODS—MANDATORY AND NON-MANDATORY—AND MANDATORY SECTION TO DETERMINE COMPLETION OF RESPONSE ACTIONS

I. Introduction

The following appendix contains three units. The first unit is the mandatory transmission electron microscopy (TEM) method which all laboratories must follow; it is the minimum requirement for analysis of air samples for asbestos by TEM. The mandatory method contains the essential elements of the TEM method. The second unit contains the complete non-mandatory method. The non-mandatory method supplements the mandatory method by including additional steps to improve the analysis. EPA recommends that the non-mandatory method be employed for analyzing air filters; however, the laboratory may choose to employ the mandatory method. The non-mandatory method contains the same minimum requirements as are outlined in the mandatory method. Hence, laboratories may choose either of the two methods for analyzing air samples by TEM.

The final unit of this Appendix A to subpart E defines the steps which must be taken to determine completion of response actions. This unit is mandatory.

II. Mandatory Transmission Electron Microscopy Method

A. Definitions of Terms

1. *Analytical sensitivity*—Airborne asbestos concentration represented by each fiber counted under the electron microscope. It is determined by the air volume collected and the proportion of the filter examined. This method requires that the analytical sensitivity be no greater than 0.005 structures/cm^3.

2. *Asbestiform*—A specific type of mineral fibrosity in which the fibers and fibrils possess high tensile strength and flexibility.

3. *Aspect ratio*—A ratio of the length to the width of a particle. Minimum aspect ratio as defined by this method is equal to or greater than 5:1.

4. *Bundle*—A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

5. *Clean area*—A controlled environment which is maintained and monitored to assure a low probability of asbestos contamination to materials in that space. Clean areas used in this method have HEPA filtered air under positive pressure and are capable of sustained operation with an open laboratory blank which on subsequent analysis has an average of less than 18 structures/mm^2 in an area of 0.057 mm^2 (nominally 10 200-mesh grid openings) and a maximum of 53 structures/mm^2 for any single preparation for that same area.

6. *Cluster*—A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two intersections.

7. *ED*—Electron diffraction.

8. *EDXA*—Energy dispersive X-ray analysis.

9. *Fiber*—A structure greater than or equal to 0.5 µm in length with an aspect ratio (length to width) of 5:1 or greater and having substantially parallel sides.

10. *Grid*—An open structure for mounting on the sample to aid in its examination in the TEM. The term is used here to denote a 200-mesh copper lattice approximately 3 mm in diameter.

11. *Intersection*—Nonparallel touching or crossing of fibers, with the projection having an aspect ratio of 5:1 or greater.

12. *Laboratory sample coordinator*—That person responsible for the conduct of sample handling and the certification of the testing procedures.

13. *Filter background level*—The concentration of structures per square millimeter of filter that is considered indistinguishable from the concentration measured on a blank (filters through which no air has been drawn). For this method the filter background level is defined as 70 structures/mm^2.

14. *Matrix*—Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

15. *NSD*—No structure detected.

16. *Operator*—A person responsible for the TEM instrumental analysis of the sample.

17. *PCM*—Phase contrast microscopy.

18. *SAED*—Selected area electron diffraction.

19. *SEM*—Scanning electron microscope.

20. *STEM*—Scanning transmission electron microscope.

21. *Structure*—a microscopic bundle, cluster, fiber, or matrix which may contain asbestos.

22. *S/cm³*—Structures per cubic centimeter.

23. *S/mm²*—Structures per square millimeter.

24. *TEM*—Transmission electron microscope.

B. Sampling

1. The sampling agency must have written quality control procedures and documents which verify compliance.

2. Sampling operations must be performed by qualified individuals completely independent of the abatement contractor to avoid possible conflict of interest (References 1, 2, 3, and 5 of Unit II.J.).

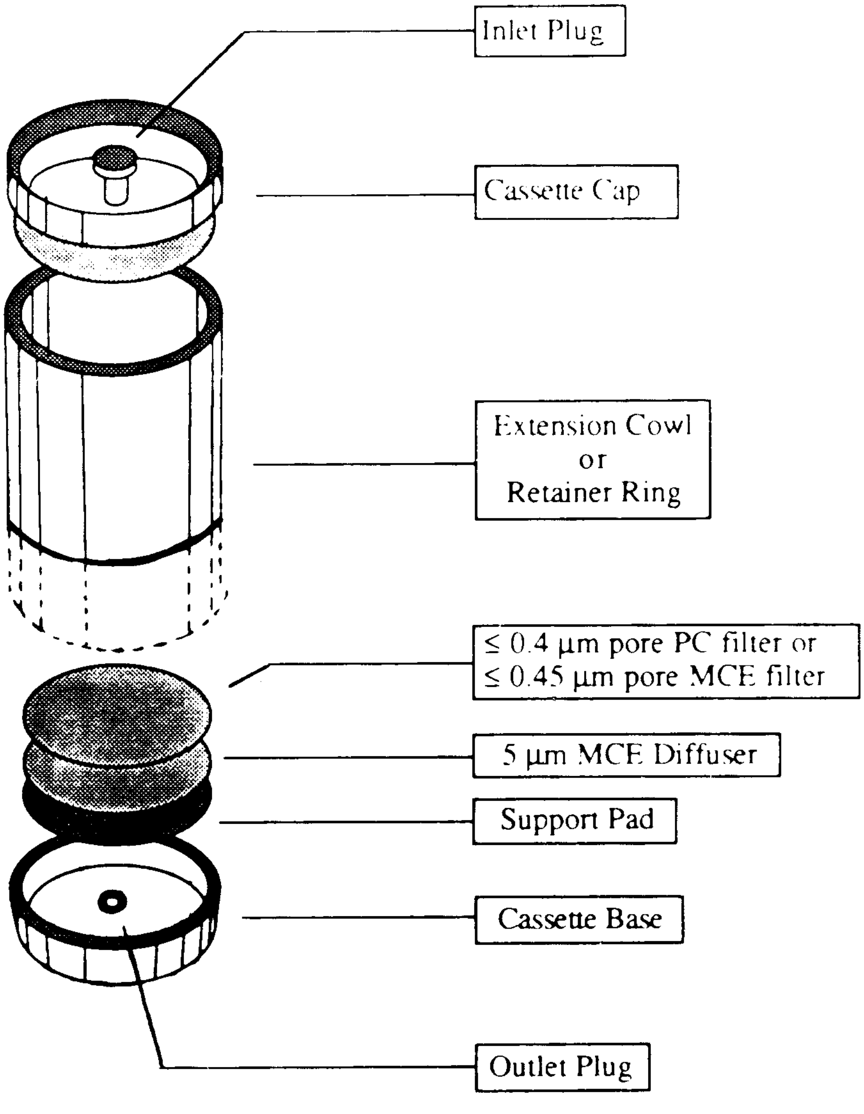
3. Sampling for airborne asbestos following an abatement action must use commercially available cassettes.

4. Prescreen the loaded cassette collection filters to assure that they do not contain concentrations of asbestos which may interfere with the analysis of the sample. A filter blank average of less than 18 s/mm² in an area of 0.057 mm² (nominally 10 200-mesh grid openings) and a single preparation with a maximum of 53 s/mm² for that same area is acceptable for this method.

5. Use sample collection filters which are either polycarbonate having a pore size less than or equal to 0.4 µm or mixed cellulose ester having a pore size less than or equal to 0.45 µm.

6. Place these filters in series with a 5.0 µm backup filter (to serve as a diffuser) and a support pad. See the following Figure 1:

FIGURE I--SAMPLING CASSETTE CONFIGURATION



7. Reloading of used cassettes is not permitted.

8. Orient the cassette downward at approximately 45 degrees from the horizontal.

9. Maintain a log of all pertinent sampling information.

10. Calibrate sampling pumps and their flow indicators over the range of their intended use with a recognized standard. Assemble the sampling system with a representative filter (not the filter which will be used in sampling) before and after the sampling operation.

11. Record all calibration information.

12. Ensure that the mechanical vibrations from the pump will be minimized to prevent transferral of vibration to the cassette.

13. Ensure that a continuous smooth flow of negative pressure is delivered by the pump by damping out any pump action fluctuations if necessary.

14. The final plastic barrier around the abatement area remains in place for the sampling period.

15. After the area has passed a thorough visual inspection, use aggressive sampling conditions to dislodge any remaining dust. (See suggested protocol in Unit III.B.7.d.)

16. Select an appropriate flow rate equal to or greater than 1 liter per minute (L/min) or less than 10 L/min for 25 mm cassettes. Larger filters may be operated at proportionally higher flow rates.

17. A minimum of 13 samples are to be collected for each testing site consisting of the following:

a. A minimum of five samples per abatement area.

b. A minimum of five samples per ambient area positioned at locations representative of the air entering the abatement site.

c. Two field blanks are to be taken by removing the cap for not more than 30 seconds and replacing it at the time of sampling before sampling is initiated at the following places:

i. Near the entrance to each abatement area.

ii. At one of the ambient sites. (DO NOT leave the field blanks open during the sampling period.)

d. A sealed blank is to be carried with each sample set. This representative cassette is not to be opened in the field.

18. Perform a leak check of the sampling system at each indoor and outdoor sampling site by activating the pump with the closed sampling cassette in line. Any flow indicates a leak which must be eliminated before initiating the sampling operation.

19. The following Table I specifies volume ranges to be used:

TABLE 1--NUMBER OF 200 MESH EM GRID OPENINGS (0.0057 MM^2) THAT NEED TO BE ANALYZED TO MAINTAIN SENSITIVITY OF 0.005 STRUCTURES/CC BASED ON VOLUME AND EFFECTIVE FILTER AREA

Effective Filter Area 385 sq mm

	Volume (liters)	# of grid openings
	560	*24*
	600	23
	700	19
	800	17
	900	15
	1,000	14
	1,100	12
Recommended Volume Range	**1,200**	**11**
	1,300	**10**
	1,400	**10**
	1,500	**9**
	1,600	**8**
	1,700	**8**
	1,800	**8**
	1,900	7
	2,000	7
	2,100	6
	2,200	6
	2,300	6
	2,400	6
	2,500	5
	2,600	5
	2,700	5
	2,800	5
	2,900	5
	3,000	5
	3,100	4
	3,200	4
	3,300	4
	3,400	4
	3,500	4
	3,600	4
	3,700	4
	3,800	4

Effective Filter Area 855 sq mm

Volume (liters)	# of grid openings	
1,250	*24*	
1,300	23	
1,400	21	
1,600	19	
1,800	17	
2,000	15	
2,200	14	
2,400	13	
2,600	12	
2,800	**11**	Recommended Volume Range
3,000	**10**	
3,200	**9**	
3,400	**9**	
3,600	**8**	
3,800	**8**	
4,000	**8**	
4,200	7	
4,400	7	
4,600	7	
4,800	6	
5,000	6	
5,200	6	
5,400	6	
5,600	5	
5,800	5	
6,000	5	
6,200	5	
6,400	5	
6,600	5	
6,800	4	
7,000	4	
7,200	4	
7,400	4	
7,600	4	

Note minimum volumes required:
25 mm : 560 liters
37 mm : 1250 liters

Filter diameter of 25 mm = effective area of 385 sq mm
Filter diameter of 37 mm = effective area of 855 sq mm

20. Ensure that the sampler is turned upright before interrupting the pump flow.

21. Check that all samples are clearly labeled and that all pertinent information has been enclosed before transfer of the samples to the laboratory.

22. Ensure that the samples are stored in a secure and representative location.

23. Do not change containers if portions of these filters are taken for other purposes.

24. A summary of Sample Data Quality Objectives is shown in the following Table II:

TABLE II--SUMMARY OF SAMPLING AGENCY DATA QUALITY OBJECTIVES

This table summarizes the data quality objectives from the performance of this method in terms of precision, accuracy, completeness, representativeness, and comparability. These objectives are assured by the periodic control checks and reference checks listed here and described in the text of the method.

Unit Operation	QC Check	Frequency	Conformance Expectation
Sampling materials	Sealed blank	1 per I/O site	95%
Sample procedures	Field blanks	2 per I/O site	95%
	Pump calibration	Before and after each field series	90%
Sample custody	Review of chain-of-custody record	Each sample	95% complete
Sample shipment	Review of sending report	Each sample	95% complete

C. Sample Shipment

Ship bulk samples to the analytical laboratory in a separate container from air samples.

D. Sample Receiving

1. Designate one individual as sample coordinator at the laboratory. While that individual will normally be available to receive samples, the coordinator may train and supervise others in receiving procedures for those times when he/she is not available.

2. Bulk samples and air samples delivered to the analytical laboratory in the same container shall be rejected.

E. Sample Preparation

1. All sample preparation and analysis shall be performed by a laboratory independent of the abatement contractor.

2. Wet-wipe the exterior of the cassettes to minimize contamination possibilities before taking them into the clean room facility.

3. Perform sample preparation in a well-equipped clean facility.

NOTE: The clean area is required to have the following minimum characteristics. The area or hood must be capable of maintaining a positive pressure with make-up air being HEPA-filtered. The cumulative analytical blank concentration must average less than 18 s/mm^2 in an area of 0.057 mm^2 (nominally 10 200-mesh grid openings) and a single preparation with a maximum of 53 s/mm^2 for that same area.

4. Preparation areas for air samples must not only be separated from preparation areas for bulk samples, but they must be prepared in separate rooms.

5. Direct preparation techniques are required. The object is to produce an intact film containing the particulates of the filter surface which is sufficiently clear for TEM analysis.

a. TEM Grid Opening Area measurement must be done as follows:

i. The filter portion being used for sample preparation must have the surface collapsed using an acetone vapor technique.

ii. Measure 20 grid openings on each of 20 random 200-mesh copper grids by placing a grid on a glass and examining it under the PCM. Use a calibrated graticule to measure the average field diameters. From the data, calculate the field area for an average grid opening.

iii. Measurements can also be made on the TEM at a properly calibrated low magnification or on an optical microscope at a magnification of approximately 400X by using an eyepiece fitted with a scale that has been calibrated against a stage micrometer. Optical microscopy utilizing manual or automated procedures may be used providing instrument calibration can be verified.

b. TEM specimen preparation from polycarbonate (PC) filters. Procedures as described in Unit III.G. or other equivalent methods may be used.

c. TEM specimen preparation from mixed cellulose ester (MCE) filters.

i. Filter portion being used for sample preparation must have the surface collapsed using an acetone vapor technique or the Burdette procedure (Ref. 7 of Unit II.J.)

ii. Plasma etching of the collapsed filter is required. The microscope slide to which the collapsed filter pieces are attached is placed in a plasma asher. Because plasma ashers vary greatly in their performance, both from unit to unit and between different positions in the asher chamber, it is difficult to specify the conditions that should be used. Insufficient etching will result in a failure to expose embedded filters, and too much etching may result in loss of particulate from the surface. As an interim measure, it is recommended that the time for ashing of a known weight of a collapsed filter be established and that the etching rate be calculated in terms of micrometers per second. The actual etching time used for the particulate asher and operating conditions will then be set such that a 1–2 µm (10 percent) layer of collapsed surface will be removed.

iii. Procedures as described in Unit III. or other equivalent methods may be used to prepare samples.

F. TEM Method

1. An 80–120 kV TEM capable of performing electron diffraction with a fluorescent screen inscribed with calibrated gradations is required. If the TEM is equipped with EDXA it must either have a STEM attachment or be capable of producing a spot less than 250 nm in diameter at crossover. The microscope shall be calibrated routinely for magnification and camera constant.

2. *Determination of Camera Constant and ED Pattern Analysis.* The camera length of the TEM in ED operating mode must be calibrated before ED patterns on unknown samples are observed. This can be achieved by using a carbon-coated grid on which a thin film of gold has been sputtered or evaporated. A thin film of gold is evaporated on the specimen TEM grid to obtain zone-axis ED patterns superimposed with a ring pattern from the polycrystalline gold film. In practice, it is desirable to optimize the thickness of the gold film so that only one or two sharp rings are obtained on the superimposed ED pattern. Thicker gold film would normally give multiple gold rings, but it will tend to mask weaker diffraction spots from the unknown fibrous particulate. Since the unknown d-spacings of most interest in asbestos analysis are those which lie closest to the transmitted beam, multiple gold rings are unnecessary on zone-axis ED patterns. An average camera constant using multiple gold rings can be determined. The camera constant is one-half the diameter of the rings times the interplanar spacing of the ring being measured.

3. *Magnification Calibration.* The magnification calibration must be done at the fluorescent screen. The TEM must be calibrated at the grid opening magnification (if used) and also at the magnification used for fiber counting. This is performed with a cross grating replica (e.g., one containing 2,160 lines/mm). Define a field of view on the fluorescent screen either by markings or physical boundaries. The field of view must be measurable or previously inscribed with a scale or concentric circles (all scales should be metric). A logbook must be maintained, and the dates of calibration and the values obtained must be recorded. The frequency of calibration depends on the past history of the particular microscope. After any maintenance of the microscope that involved adjustment of the power supplied to the lenses or the high-voltage system or the mechanical disassembly of the electron optical column apart from filament exchange, the magnification must be recalibrated. Before the TEM calibration is performed, the analyst must ensure that the cross grating replica is placed at the same distance from the objective lens as the specimens are. For instruments that incorporate a eucentric tilting specimen stage, all specimens and the cross grating replica must be placed at the eucentric position.

4. While not required on every microscope in the laboratory, the laboratory must have either one microscope equipped with energy dispersive X-ray analysis or access to an equivalent system on a TEM in another laboratory.

5. Microscope settings: 80–120 kV, grid assessment 250–1,000X, then 15,000–20,000X screen magnification for analysis.

6. Approximately one-half (0.5) of the predetermined sample area to be analyzed shall be performed on one sample grid preparation and the remaining half on a second sample grid preparation.

7. Individual grid openings with greater than 5 percent openings (holes) or covered with greater than 25 percent particulate matter or obviously having nonuniform loading must not be analyzed.

8. Reject the grid if:

a. Less than 50 percent of the grid openings covered by the replica are intact.

b. The replica is doubled or folded.

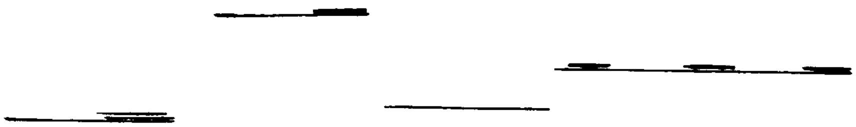
c. The replica is too dark because of incomplete dissolution of the filter.

9. *Recording Rules.*

a. Any continuous grouping of particles in which an asbestos fiber with an aspect ratio greater than or equal to 5:1 and a length greater than or equal to 0.5 µm is detected shall be recorded on the count sheet. These will be designated asbestos structures and will be classified as fibers, bundles, clusters, or matrices. Record as individual fibers any contiguous grouping having 0, 1, or 2 definable intersections. Groupings having more than 2 intersections are to be described as cluster or matrix. An intersection is a nonparallel touching or crossing of fibers, with the projection having an aspect ratio of 5:1 or greater. See the following Figure 2:

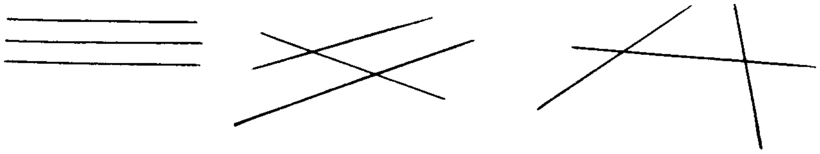
FIGURE 2--COUNTING GUIDELINES USED IN
DETERMINING ASBESTOS STRUCTURES

Count as 1 fiber; 1 Structure; no intersections.



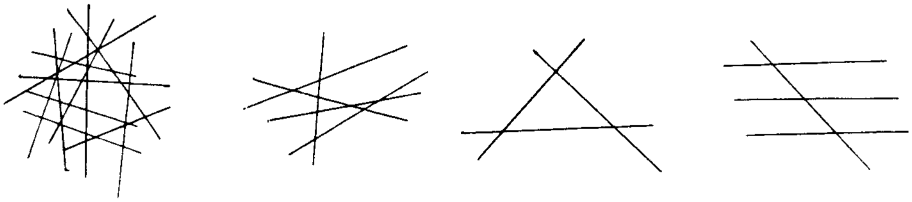
Count as 2 fibers if space between fibers is greater than width of 1 fiber diameter or number of intersections is equal to or less than 1.

Count as 3 structures if space between fibers is greater than width of 1 fiber diameter or if the number of intersections is equal to or less than 2.

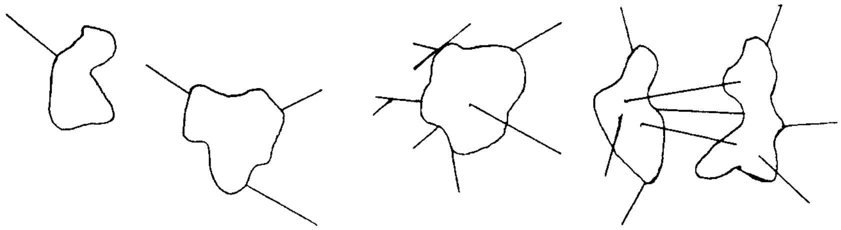


Count bundles as 1 structure; 3 or more parallel fibrils less than 1 fiber diameter separation.

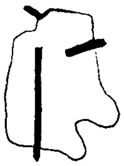
Count clusters as 1 structure; fibers having greater than or equal to 3 intersections.



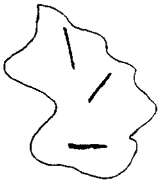
Count matrix as 1 structure.



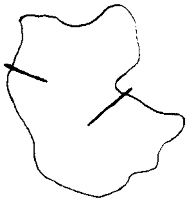
DO NOT COUNT AS STRUCTURES:



Fiber protrusion
<5:1 Aspect Ratio



No fiber protusion



Fiber protrusion
<0.5 micrometer

— <0.5 micrometer in length
▬ <5:1 Aspect Ratio

i. *Fiber.* A structure having a minimum length greater than or equal to 0.5 µm and an aspect ratio (length to width) of 5:1 or greater and substantially parallel sides. Note the appearance of the end of the fiber, i.e., whether it is flat, rounded or dovetailed.

ii. *Bundle.* A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

iii. *Cluster.* A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two intersections.

iv. *Matrix.* Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

b. Separate categories will be maintained for fibers less than 5 µm and for fibers equal to or greater than 5 µm in length.

c. Record NSD when no structures are detected in the field.

d. Visual identification of electron diffraction (ED) patterns is required for each asbestos structure counted which would cause the analysis to exceed the 70 s/mm^2 concentration. (Generally this means the first four fibers identified as asbestos must exhibit an identifiable diffraction pattern for chrysotile or amphibole.)

e. The micrograph number of the recorded diffraction patterns must be reported to the client and maintained in the laboratory's quality assurance records. In the event that examination of the pattern by a qualified individual indicates that the pattern has been misidentified visually, the client shall be contacted.

f. Energy Dispersive X-ray Analysis (EDXA) is required of all amphiboles which would cause the analysis results to exceed the 70 s/mm^2 concentration. (Generally speaking, the first 4 amphiboles would require EDXA.)

g. If the number of fibers in the nonasbestos class would cause the analysis to exceed the 70 s/mm^2 concentration, the fact that they are not asbestos must be confirmed by EDXA or measurement of a zone axis diffraction pattern.

h. Fibers classified as chrysotile must be identified by diffraction or X-ray analysis and recorded on a count sheet. X-ray analysis alone can be used only after 70 s/mm^2 have been exceeded for a particular sample.

i. Fibers classified as amphiboles must be identified by X-ray analysis and electron diffraction and recorded on the count sheet. (X-ray analysis alone can be used only after 70 s/mm^2 have been exceeded for a particular sample.)

j. If a diffraction pattern was recorded on film, record the micrograph number on the count sheet.

k. If an electron diffraction was attempted but no pattern was observed, record N on the count sheet.

l. If an EDXA spectrum was attempted but not observed, record N on the count sheet.

m. If an X-ray analysis spectrum is stored, record the file and disk number on the count sheet.

10. Classification Rules.

a. *Fiber.* A structure having a minimum length greater than or equal to 0.5 µm and an aspect ratio (length to width) of 5:1 or greater and substantially parallel sides. Note the appearance of the end of the fiber, i.e., whether it is flat, rounded or dovetailed.

b. *Bundle.* A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

c. *Cluster.* A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two intersections.

d. *Matrix.* Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

11. After finishing with a grid, remove it from the microscope, and replace it in the appropriate grid holder. Sample grids must be stored for a minimum of 1 year from the date of the analysis; the sample cassette must be retained for a minimum of 30 days by the laboratory or returned at the client's request.

G. Sample Analytical Sequence

1. Under the present sampling requirements a minimum of 13 samples is to be collected for the clearance testing of an abatement site. These include five abatement area samples, five ambient samples, two field blanks, and one sealed blank.

2. Carry out visual inspection of work site prior to air monitoring.

3. Collect a minimum of 5 air samples inside the work site and 5 samples outside the work site. The indoor and outdoor samples shall be taken during the same time period.

4. Remaining steps in the analytical sequence are contained in Unit IV of this Appendix.

H. Reporting

1. The following information must be reported to the client for each sample analyzed:

a. Concentration in structures per square millimeter and structures per cubic centimeter.

b. Analytical sensitivity used for the analysis.

c. Number of asbestos structures.

d. Area analyzed.

e. Volume of air sampled (which must be initially supplied to lab by client).

f. Copy of the count sheet must be included with the report.

g. Signature of laboratory official to indicate that the laboratory met specifications of the method.

h. Report form must contain official laboratory identification (e.g., letterhead).

i. Type of asbestos.

I. Quality Control/Quality Assurance Procedures (Data Quality Indicators)

Monitoring the environment for airborne asbestos requires the use of sensitive sampling and analysis procedures. Because the test is sensitive, it may be influenced by a variety of factors. These include the supplies used in the sampling operation, the performance of the sampling, the preparation of the grid from the filter and the actual examination of this grid in the microscope. Each of these unit operations must produce a product of defined quality if the analytical result is to be a reliable and meaningful test result. Accordingly, a series of control checks and reference standards are to be performed along with the sample analysis as indicators that the materials used are adequate and the operations are within acceptable limits. In this way, the quality of the data is defined and the results are of known value. These checks and tests also provide timely and specific warning of any problems which might develop within the sampling and analysis operations. A description of these quality control/quality assurance procedures is summarized in the following Table III:

TABLE III--SUMMARY OF LABORATORY DATA QUALITY OBJECTIVES

Unit Operation	QC Check	Frequency	Conformance Expectation
Sample receiving	Review of receiving report	Each sample	95% complete
Sample custody	Review of chain-of-custody record	Each sample	95% complete
Sample preparation	Supplies and reagents	On receipt	Meet specs. or reject
	Grid opening size	20 openings/20 grids/lot of 1000 or 1 opening/sample	100%
	Special clean area monitoring	After cleaning or service	Meet specs or reclean
	Laboratory blank	1 per prep series or 10%	Meet specs. or reanalyze series
	Plasma etch blank	1 per 20 samples	75%
	Multiple preps (3 per sample)	Each sample	One with cover of 15 complete grid sqs.
Sample analysis	System check	Each day	Each day
	Alignment check	Each day	Each day
	Magnification calibration with low and high standards	Each month or after service	95%
	ED calibration by gold standard	Weekly	95%
	EDS calibration by copper line	Daily	95%
Performance check	Laboratory blank (measure of cleanliness)	Prep 1 per series or 10% read 1 per 25 samples	Meet specs or reanalyze series
	Replicate counting (measure of precision)	1 per 100 samples	1.5 x Poisson Std. Dev.
	Duplicate analysis (measure of reproducibility)	1 per 100 samples	2 x Poisson Std. Dev.
	Known samples of typical materials (working standards)	Training and for comparison with unknowns	100%
	Analysis of NBS SRM 1876 and/or RM 8410 (measure of accuracy and comparability)	1 per analyst per year	1.5 x Poisson Std. Dev.
	Data entry review (data validation and measure of completeness)	Each sample	95%
	Record and verify ID electron diffraction pattern of structure	1 per 5 samples	80% accuracy
Calculations and data reduction	Hand calculation of automated data reduction procedure or independent recalculation of hand-calculated data	1 per 100 samples	85%

1. When the samples arrive at the laboratory, check the samples and documentation for completeness and requirements before initiating the analysis.

2. Check all laboratory reagents and supplies for acceptable asbestos background levels.

3. Conduct all sample preparation in a clean room environment monitored by laboratory blanks. Testing with blanks must also be done after cleaning or servicing the room.

4. Prepare multiple grids of each sample.

5. Provide laboratory blanks with each sample batch. Maintain a cumulative average of these results. If there are more than 53 fibers/mm^2 per 10 200-mesh grid openings, the system must be checked for possible sources of contamination.

6. Perform a system check on the transmission electron microscope daily.

7. Make periodic performance checks of magnification, electron diffraction and energy dispersive X-ray systems as set forth in Table III under Unit II.I.

8. Ensure qualified operator performance by evaluation of replicate analysis and standard sample comparisons as set forth in Table III under Unit II.I.

9. Validate all data entries.

10. Recalculate a percentage of all computations and automatic data reduction steps as specified in Table III under Unit II.I.

11. Record an electron diffraction pattern of one asbestos structure from every five samples that contain asbestos. Verify the identification of the pattern by measurement or comparison of the pattern with patterns collected from standards under the same conditions. The records must also demonstrate that the identification of the pattern has been verified by a qualified individual and that the operator who made the identification is maintaining at least an 80 percent correct visual identification based on his measured patterns.

12. Appropriate logs or records must be maintained by the analytical laboratory verifying that it is in compliance with the mandatory quality assurance procedures.

J. References

For additional background information on this method, the following references should be consulted.

1. ‘‘Guidance for Controlling Asbestos-Containing Materials in Buildings,’’ EPA 560/5–85–024, June 1985.

2. ‘‘Measuring Airborne Asbestos Following an Abatement Action,’’ USEPA, Office of Pollution Prevention and Toxics, EPA 600/4–85–049, 1985.

3. Small, John and E. Steel. Asbestos Standards: Materials and Analytical Methods. N.B.S. Special Publication 619, 1982.

4. Campbell, W.J., R.L. Blake, L.L. Brown, E.E. Cather, and J.J. Sjoberg. Selected Silicate Minerals and Their Asbestiform Varieties. Information Circular 8751, U.S. Bureau of Mines, 1977.

5. Quality Assurance Handbook for Air Pollution Measurement System. Ambient Air Methods, EPA 600/4–77–027a, USEPA, Office of Research and Development, 1977.

6. Method 2A: Direct Measurement of Gas Volume through Pipes and Small Ducts. 40 CFR Part 60 Appendix A.

7. Burdette, G.J., Health & Safety Exec. Research & Lab. Services Div., London, ‘‘Proposed Analytical Method for Determination of Asbestos in Air.’’

8. Chatfield, E.J., Chatfield Tech. Cons., Ltd., Clark, T., PEI Assoc., ‘‘Standard Operating Procedure for Determination of Airborne Asbestos Fibers by Transmission Electron Microscopy Using Polycarbonate Membrane Filters,’’ WERL SOP 87–1, March 5, 1987.

9. NIOSH Method 7402 for Asbestos Fibers, 12–11–86 Draft.

10. Yamate, G., Agarwall, S.C., Gibbons, R.D., IIT Research Institute, ‘‘Methodology for the Measurement of Airborne Asbestos by Electron Microscopy,’’ Draft report, USEPA Contract 68–02–3266, July 1984.

11. ‘‘Guidance to the Preparation of Quality Assurance Project Plans,’’ USEPA, Office of Pollution Prevention and Toxics, 1984.

III. Nonmandatory Transmission Electron Microscopy Method

A. Definitions of Terms

1. *Analytical sensitivity*—Airborne asbestos concentration represented by each fiber counted under the electron microscope. It is determined by the air volume collected and the proportion of the filter examined. This method requires that the analytical sensitivity be no greater than 0.005 s/cm^3.

2. *Asbestiform*—A specific type of mineral fibrosity in which the fibers and fibrils possess high tensile strength and flexibility.

3. *Aspect ratio*—A ratio of the length to the width of a particle. Minimum aspect ratio as defined by this method is equal to or greater than 5:1.

4. *Bundle*—A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

5. *Clean area*—A controlled environment which is maintained and monitored to assure a low probability of asbestos contamination to materials in that space. Clean areas used in this method have HEPA filtered air under positive pressure and are capable of sustained operation with an open laboratory blank which on subsequent analysis has an average of less than 18 structures/mm^2 in an area of 0.057 mm^2 (nominally 10 200 mesh grid openings) and a maximum of 53 structures/mm^2 for no more than one single preparation for that same area.

6. *Cluster*—A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two intersections.

7. *ED*—Electron diffraction.

8. *EDXA*—Energy dispersive X-ray analysis.

9. *Fiber*—A structure greater than or equal to 0.5 µm in length with an aspect ratio (length to width) of 5:1 or greater and having substantially parallel sides.

10. *Grid*—An open structure for mounting on the sample to aid in its examination in the TEM. The term is used here to denote a 200-mesh copper lattice approximately 3 mm in diameter.

11. *Intersection*—Nonparallel touching or crossing of fibers, with the projection having an aspect ratio of 5:1 or greater.

12. *Laboratory sample coordinator*—That person responsible for the conduct of sample handling and the certification of the testing procedures.

13. *Filter background level*—The concentration of structures per square millimeter of filter that is considered indistinguishable from the concentration measured on blanks (filters through which no air has been drawn). For this method the filter background level is defined as 70 structures/mm^2.

14. *Matrix*—Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

15. *NSD*—No structure detected.

16. *Operator*—A person responsible for the TEM instrumental analysis of the sample.

17. *PCM*—Phase contrast microscopy.

18. *SAED*—Selected area electron diffraction.

19. *SEM*—Scanning electron microscope.

20. *STEM*—Scanning transmission electron microscope.

21. *Structure*—a microscopic bundle, cluster, fiber, or matrix which may contain asbestos.

22. *S/cm^3*—Structures per cubic centimeter.

23. *S/mm^2*—Structures per square millimeter.

24. *TEM*—Transmission electron microscope.

B. Sampling

1. Sampling operations must be performed by qualified individuals completely independent of the abatement contractor to avoid possible conflict of interest (See References 1, 2, and 5 of Unit III.L.) Special precautions should be taken to avoid contamination of the sample. For example, materials that have not been prescreened for their asbestos background content should not be used; also, sample handling procedures which do not take cross contamination possibilities into account should not be used.

2. Material and supply checks for asbestos contamination should be made on all critical supplies, reagents, and procedures before their use in a monitoring study.

3. Quality control and quality assurance steps are needed to identify problem areas and isolate the cause of the contamination (see Reference 5 of Unit III.L.). Control checks shall be permanently recorded to document the quality of the information produced. The sampling firm must have written quality control procedures and documents which verify compliance. Independent audits by a qualified consultant or firm should be performed once a year. All documentation of compliance should be retained indefinitely to provide a guarantee of quality. A summary of Sample Data Quality Objectives is shown in Table II of Unit II.B.

4. Sampling materials.

a. Sample for airborne asbestos following an abatement action using commercially available cassettes.

b. Use either a cowling or a filter-retaining middle piece. Conductive material may reduce the potential for particulates to adhere to the walls of the cowl.

c. Cassettes must be verified as ‘‘clean’’ prior to use in the field. If packaged filters are used for loading or preloaded cassettes are purchased from the manufacturer or a distributor, the manufacturer’s name and lot number should be entered on all field data sheets provided to the laboratory, and are required to be listed on all reports from the laboratory.

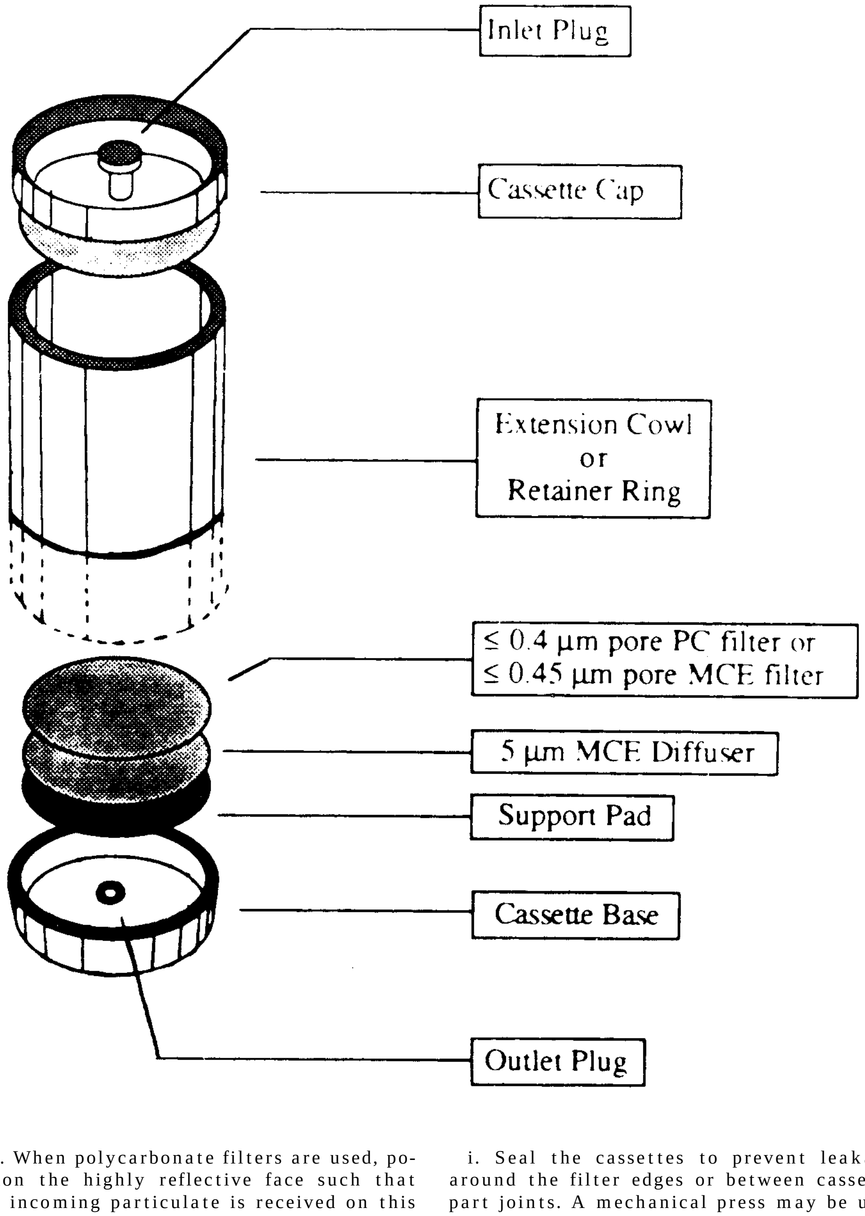
d. Assemble the cassettes in a clean facility (See definition of clean area under Unit III.A.).

e. Reloading of used cassettes is not permitted.

f. Use sample collection filters which are either polycarbonate having a pore size of less than or equal to 0.4 µm or mixed cellulose ester having a pore size of less than or equal to 0.45 µm.

g. Place these filters in series with a backup filter with a pore size of 5.0 µm (to serve as a diffuser) and a support pad. See the following Figure 1:

FIGURE I--SAMPLING CASSETTE CONFIGURATION



h. When polycarbonate filters are used, position the highly reflective face such that the incoming particulate is received on this surface.

i. Seal the cassettes to prevent leakage around the filter edges or between cassette part joints. A mechanical press may be useful to achieve a reproducible leak-free seal.

Shrink fit gel-bands may be used for this purpose and are available from filter manufacturers and their authorized distributors.

j. Use wrinkle-free loaded cassettes in the sampling operation.

5. Pump setup.

a. Calibrate the sampling pump over the range of flow rates and loads anticipated for the monitoring period with this flow measuring device in series. Perform this calibration using guidance from EPA Method 2A each time the unit is sent to the field (See Reference 6 of Unit III.L.).

b. Configure the sampling system to preclude pump vibrations from being transmitted to the cassette by using a sampling stand separate from the pump station and making connections with flexible tubing.

c. Maintain continuous smooth flow conditions by damping out any pump action fluctuations if necessary.

d. Check the sampling system for leaks with the end cap still in place and the pump operating before initiating sample collection. Trace and stop the source of any flow indicated by the flowmeter under these conditions.

e. Select an appropriate flow rate equal to or greater than 1 L/min or less than 10 L/min for 25 mm cassettes. Larger filters may be operated at proportionally higher flow rates.

f. Orient the cassette downward at approximately 45 degrees from the horizontal.

g. Maintain a log of all pertinent sampling information, such as pump identification number, calibration data, sample location, date, sample identification number, flow rates at the beginning, middle, and end, start and stop times, and other useful information or comments. Use of a sampling log form is recommended. See the following Figure 2:

FIGURE 2--SAMPLING LOG FORM

Sample Number	Location of Sample	Pump I.D.	Start Time	Middle Time	End Time	Flow Rate

Inspector: ____________________ Date: ____________

h. Initiate a chain of custody procedure at the start of each sampling, if this is requested by the client.

i. Maintain a close check of all aspects of the sampling operation on a regular basis.

j. Continue sampling until at least the minimum volume is collected, as specified in the following Table I:

TABLE 1--NUMBER OF 200 MESH EM GRID OPENINGS ($0.0057\ MM^2$) THAT NEED TO BE ANALYZED TO MAINTAIN SENSITIVITY OF 0.005 STRUCTURES/CC BASED ON VOLUME AND EFFECTIVE FILTER AREA

	Effective Filter Area 385 sq mm	
	Volume (liters)	# of grid openings
	560	*24*
	600	23
	700	19
	800	17
	900	15
	1,000	14
	1,100	12
Recommended Volume Range	**1,200**	**11**
	1,300	**10**
	1,400	**10**
	1,500	**9**
	1,600	**8**
	1,700	**8**
	1,800	**8**
	1,900	7
	2,000	7
	2,100	6
	2,200	6
	2,300	6
	2,400	6
	2,500	5
	2,600	5
	2,700	5
	2,800	5
	2,900	5
	3,000	5
	3,100	4
	3,200	4
	3,300	4
	3,400	4
	3,500	4
	3,600	4
	3,700	4
	3,800	4

Effective Filter Area 855 sq mm		
Volume (liters)	# of grid openings	
1,250	*24*	
1,300	23	
1,400	21	
1,600	19	
1,800	17	
2,000	15	
2,200	14	
2,400	13	
2,600	12	
2,800	**11**	Recommended Volume Range
3,000	**10**	
3,200	**9**	
3,400	**9**	
3,600	**8**	
3,800	**8**	
4,000	**8**	
4,200	7	
4,400	7	
4,600	7	
4,800	6	
5,000	6	
5,200	6	
5,400	6	
5,600	5	
5,800	5	
6,000	5	
6,200	5	
6,400	5	
6,600	5	
6,800	4	
7,000	4	
7,200	4	
7,400	4	
7,600	4	

Note minimum volumes required:
25 mm : 560 liters
37 mm : 1250 liters

Filter diameter of 25 mm = effective area of 385 sq mm
Filter diameter of 37 mm = effective area of 855 sq mm

k. At the conclusion of sampling, turn the cassette upward before stopping the flow to minimize possible particle loss. If the sampling is resumed, restart the flow before reorienting the cassette downward. Note the condition of the filter at the conclusion of sampling.

l. Double check to see that all information has been recorded on the data collection forms and that the cassette is securely closed and appropriately identified using a waterproof label. Protect cassettes in individual clean resealed polyethylene bags. Bags are to be used for storing cassette caps when they are removed for sampling purposes. Caps and plugs should only be removed or replaced using clean hands or clean disposable plastic gloves.

m. Do not change containers if portions of these filters are taken for other purposes.

6. Minimum sample number per site. A minimum of 13 samples are to be collected for each testing consisting of the following:

a. A minimum of five samples per abatement area.

b. A minimum of five samples per ambient area positioned at locations representative of the air entering the abatement site.

c. Two field blanks are to be taken by removing the cap for not more than 30 sec and replacing it at the time of sampling before sampling is initiated at the following places:

i. Near the entrance to each ambient area.

ii. At one of the ambient sites.

(NOTE: Do not leave the blank open during the sampling period.)

d. A sealed blank is to be carried with each sample set. This representative cassette is not to be opened in the field.

7. Abatement area sampling.

a. Conduct final clearance sampling only after the primary containment barriers have been removed; the abatement area has been thoroughly dried; and, it has passed visual inspection tests by qualified personnel. (See Reference 1 of Unit III.L.)

b. Containment barriers over windows, doors, and air passageways must remain in place until the TEM clearance sampling and analysis is completed and results meet clearance test criteria. The final plastic barrier remains in place for the sampling period.

c. Select sampling sites in the abatement area on a random basis to provide unbiased and representative samples.

d. After the area has passed a thorough visual inspection, use aggressive sampling conditions to dislodge any remaining dust.

i. Equipment used in aggressive sampling such as a leaf blower and/or fan should be properly cleaned and decontaminated before use.

ii. Air filtration units shall remain on during the air monitoring period.

iii. Prior to air monitoring, floors, ceiling and walls shall be swept with the exhaust of a minimum one (1) horsepower leaf blower.

iv. Stationary fans are placed in locations which will not interfere with air monitoring equipment. Fan air is directed toward the ceiling. One fan shall be used for each 10,000 ft^3 of worksite.

v. Monitoring of an abatement work area with high-volume pumps and the use of circulating fans will require electrical power. Electrical outlets in the abatement area may be used if available. If no such outlets are available, the equipment must be supplied with electricity by the use of extension cords and strip plug units. All electrical power supply equipment of this type must be approved Underwriter Laboratory equipment that has not been modified. All wiring must be grounded. Ground fault interrupters should be used. Extreme care must be taken to clean up any residual water and ensure that electrical equipment does not become wet while operational.

vi. Low volume pumps may be carefully wrapped in 6-mil polyethylene to insulate the pump from the air. High volume pumps cannot be sealed in this manner since the heat of the motor may melt the plastic. The pump exhausts should be kept free.

vii. If recleaning is necessary, removal of this equipment from the work area must be handled with care. It is not possible to completely decontaminate the pump motor and parts since these areas cannot be wetted. To minimize any problems in this area, all equipment such as fans and pumps should be carefully wet wiped prior to removal from the abatement area. Wrapping and sealing low volume pumps in 6-mil polyethylene will provide easier decontamination of this equipment. Use of clean water and disposable wipes should be available for this purpose.

e. Pump flow rate equal to or greater than 1 L/min or less than 10 L/min may be used for 25 mm cassettes. The larger cassette diameters may have comparably increased flow.

f. Sample a volume of air sufficient to ensure the minimum quantitation limits. (See Table I of Unit III.B.5.j.)

8. Ambient sampling.

a. Position ambient samplers at locations representative of the air entering the abatement site. If makeup air entering the abatement site is drawn from another area of the building which is outside of the abatement area, place the pumps in the building, pumps should be placed out of doors located near the building and away from any obstructions that may influence wind patterns. If construction is in progress immediately outside the enclosure, it may be necessary to select another ambient site. Samples should be representative of any air entering the work site.

b. Locate the ambient samplers at least 3 ft apart and protect them from adverse weather conditions.

c. Sample same volume of air as samples taken inside the abatement site.

C. Sample Shipment

1. Ship bulk samples in a separate container from air samples. Bulk samples and air samples delivered to the analytical laboratory in the same container shall be rejected.

2. Select a rigid shipping container and pack the cassettes upright in a noncontaminating nonfibrous medium such as a bubble pack. The use of resealable polyethylene bags may help to prevent jostling of individual cassettes.

3. Avoid using expanded polystyrene because of its static charge potential. Also avoid using particle-based packaging materials because of possible contamination.

4. Include a shipping bill and a detailed listing of samples shipped, their descriptions

and all identifying numbers or marks, sampling data, shipper's name, and contact information. For each sample set, designate which are the ambient samples, which are the abatement area samples, which are the field blanks, and which is the sealed blank if sequential analysis is to be performed.

5. Hand-carry samples to the laboratory in an upright position if possible; otherwise choose that mode of transportation least likely to jar the samples in transit.

6. Address the package to the laboratory sample coordinator by name when known and alert him or her of the package description, shipment mode, and anticipated arrival as part of the chain of custody and sample tracking procedures. This will also help the laboratory schedule timely analysis for the samples when they are received.

D. Quality Control/Quality Assurance Procedures (Data Quality Indicators)

Monitoring the environment for airborne asbestos requires the use of sensitive sampling and analysis procedures. Because the test is sensitive, it may be influenced by a variety of factors. These include the supplies used in the sampling operation, the performance of the sampling, the preparation of the grid from the filter and the actual examination of this grid in the microscope. Each of these unit operations must produce a product of defined quality if the analytical result is to be a reliable and meaningful test result. Accordingly, a series of control checks and reference standards is performed along with the sample analysis as indicators that the materials used are adequate and the operations are within acceptable limits. In this way, the quality of the data is defined, and the results are of known value. These checks and tests also provide timely and specific warning of any problems which might develop within the sampling and analysis operations. A description of these quality control/quality assurance procedures is summarized in the text below.

1. Prescreen the loaded cassette collection filters to assure that they do not contain concentrations of asbestos which may interfere with the analysis of the sample. A filter blank average of less than 18 s/mm^2 in an area of 0.057 mm^2 (nominally 10 200-mesh grid openings) and a maximum of 53 s/mm^2 for that same area for any single preparation is acceptable for this method.

2. Calibrate sampling pumps and their flow indicators over the range of their intended use with a recognized standard. Assemble the sampling system with a representative filter—not the filter which will be used in sampling—before and after the sampling operation.

3. Record all calibration information with the data to be used on a standard sampling form.

4. Ensure that the samples are stored in a secure and representative location.

5. Ensure that mechanical calibrations from the pump will be minimized to prevent transferral of vibration to the cassette.

6. Ensure that a continuous smooth flow of negative pressure is delivered by the pump by installing a damping chamber if necessary.

7. Open a loaded cassette momentarily at one of the indoor sampling sites when sampling is initiated. This sample will serve as an indoor field blank.

8. Open a loaded cassette momentarily at one of the outdoor sampling sites when sampling is initiated. This sample will serve as an outdoor field blank.

9. Carry a sealed blank into the field with each sample series. Do not open this cassette in the field.

10. Perform a leak check of the sampling system at each indoor and outdoor sampling site by activating the pump with the closed sampling cassette in line. Any flow indicates a leak which must be eliminated before initiating the sampling operation.

11. Ensure that the sampler is turned upright before interrupting the pump flow.

12. Check that all samples are clearly labeled and that all pertinent information has been enclosed before transfer of the samples to the laboratory.

E. Sample Receiving

1. Designate one individual as sample coordinator at the laboratory. While that individual will normally be available to receive samples, the coordinator may train and supervise others in receiving procedures for those times when he/she is not available.

2. Adhere to the following procedures to ensure both the continued chain-of-custody and the accountability of all samples passing through the laboratory:

a. Note the condition of the shipping package and data written on it upon receipt.

b. Retain all bills of lading or shipping slips to document the shipper and delivery time.

c. Examine the chain-of-custody seal, if any, and the package for its integrity.

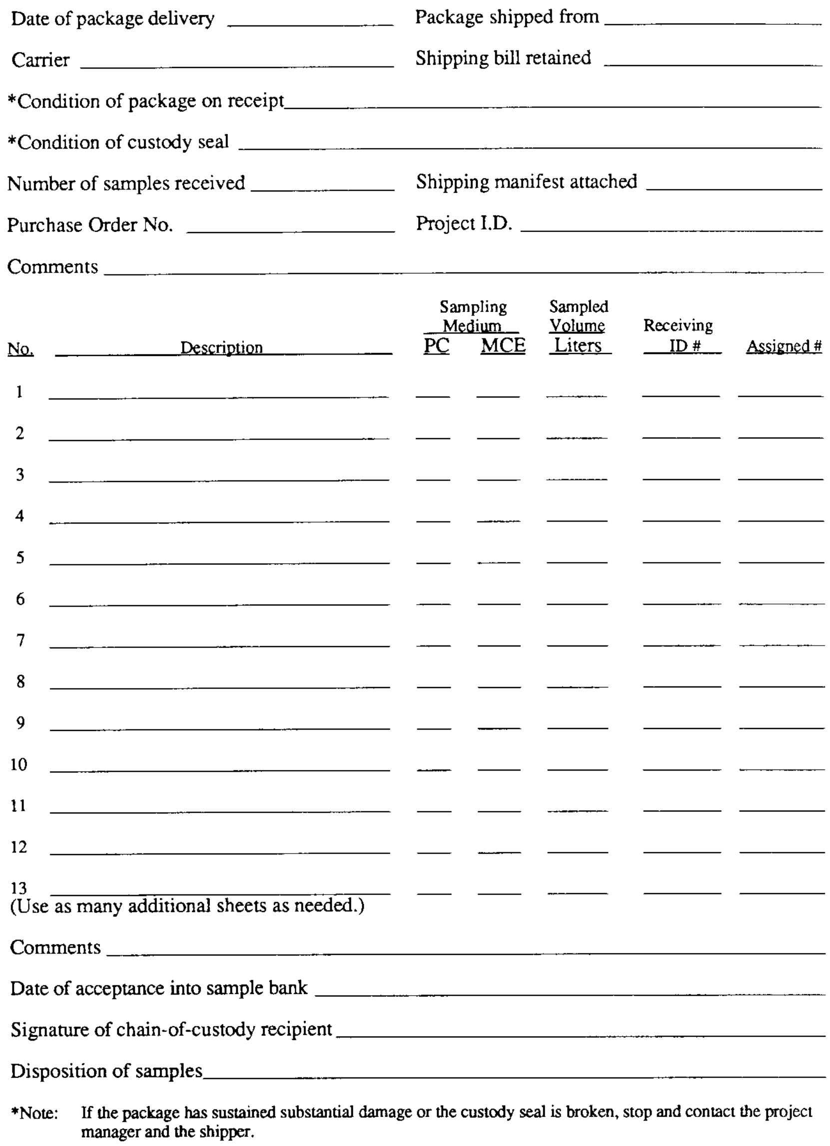
d. If there has been a break in the seal or substantive damage to the package, the sample coordinator shall immediately notify the shipper and a responsible laboratory manager before any action is taken to unpack the shipment.

e. Packages with significant damage shall be accepted only by the responsible laboratory manager after discussions with the client.

3. Unwrap the shipment in a clean, uncluttered facility. The sample coordinator or his or her designee will record the contents, including a description of each item and all identifying numbers or marks. A

Sample Receiving Form to document this information is attached for use when necessary. (See the following Figure 3.)

FIGURE 3--SAMPLE RECEIVING FORM



Date of package delivery ____________ Package shipped from ____________

Carrier ____________ Shipping bill retained ____________

*Condition of package on receipt____________

*Condition of custody seal ____________

Number of samples received ____________ Shipping manifest attached ____________

Purchase Order No. ____________ Project I.D. ____________

Comments ____________

No.	Description	Sampling Medium PC	Sampling Medium MCE	Sampled Volume Liters	Receiving ID #	Assigned #
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						

(Use as many additional sheets as needed.)

Comments ____________

Date of acceptance into sample bank ____________

Signature of chain-of-custody recipient____________

Disposition of samples____________

*Note: If the package has sustained substantial damage or the custody seal is broken, stop and contact the project manager and the shipper.

NOTE: The person breaking the chain-of-custody seal and itemizing the contents assumes responsibility for the shipment and signs documents accordingly.

4. Assign a laboratory number and schedule an analysis sequence.

5. Manage all chain-of-custody samples within the laboratory such that their integrity can be ensured and documented.

F. Sample Preparation

1. Personnel not affiliated with the Abatement Contractor shall be used to prepare samples and conduct TEM analysis. Wet-wipe the exterior of the cassettes to minimize contamination possibilities before taking them to the clean sample preparation facility.

2. Perform sample preparation in a well-equipped clean facility.

NOTE: The clean area is required to have the following minimum characteristics. The area or hood must be capable of maintaining a positive pressure with make-up air being HEPA filtered. The cumulative analytical blank concentration must average less than 18 s/mm^2 in an area of 0.057 s/mm^2 (nominally 10 200-mesh grid openings) with no more than one single preparation to exceed 53 s/mm^2 for that same area.

3. Preparation areas for air samples must be separated from preparation areas for bulk samples. Personnel must not prepare air samples if they have previously been preparing bulk samples without performing appropriate personal hygiene procedures, i.e., clothing change, showering, etc.

4. *Preparation.* Direct preparation techniques are required. The objective is to produce an intact carbon film containing the particulates from the filter surface which is sufficiently clear for TEM analysis. Currently recommended direct preparation procedures for polycarbonate (PC) and mixed cellulose ester (MCE) filters are described in Unit III.F.7. and 8. Sample preparation is a subject requiring additional research. Variation on those steps which do not substantively change the procedure, which improve filter clearing or which reduce contamination problems in a laboratory are permitted.

a. Use only TEM grids that have had grid opening areas measured according to directions in Unit III.J.

b. Remove the inlet and outlet plugs prior to opening the cassette to minimize any pressure differential that may be present.

c. Examples of techniques used to prepare polycarbonate filters are described in Unit III.F.7.

d. Examples of techniques used to prepare mixed cellulose ester filters are described in Unit III.F.8.

e. Prepare multiple grids for each sample.

f. Store the three grids to be measured in appropriately labeled grid holders or polyethylene capsules.

5. Equipment.

a. Clean area.

b. Tweezers. Fine-point tweezers for handling of filters and TEM grids.

c. Scalpel Holder and Curved No. 10 Surgical Blades.

d. Microscope slides.

e. Double-coated adhesive tape.

f. Gummed page reinforcements.

g. Micro-pipet with disposal tips 10 to 100 µL variable volume.

h. Vacuum coating unit with facilities for evaporation of carbon. Use of a liquid nitrogen cold trap above the diffusion pump will minimize the possibility of contamination of the filter surface by oil from the pumping system. The vacuum-coating unit can also be used for deposition of a thin film of gold.

i. *Carbon rod electrodes.* Spectrochemically pure carbon rods are required for use in the vacuum evaporator for carbon coating of filters.

j. *Carbon rod sharpener.* This is used to sharpen carbon rods to a neck. The use of necked carbon rods (or equivalent) allows the carbon to be applied to the filters with a minimum of heating.

k. *Low-temperature plasma asher.* This is used to etch the surface of collapsed mixed cellulose ester (MCE) filters. The asher should be supplied with oxygen, and should be modified as necessary to provide a throttle or bleed valve to control the speed of the vacuum to minimize disturbance of the filter. Some early models of ashers admit air too rapidly, which may disturb particulates on the surface of the filter during the etching step.

l. *Glass petri dishes, 10 cm in diameter, 1 cm high.* For prevention of excessive evaporation of solvent when these are in use, a good seal must be provided between the base and the lid. The seal can be improved by grinding the base and lid together with an abrasive grinding material.

m. Stainless steel mesh.

n. Lens tissue.

o. Copper 200-mesh TEM grids, 3 mm in diameter, or equivalent.

p. Gold 200-mesh TEM grids, 3 mm in diameter, or equivalent.

q. Condensation washer.

r. Carbon-coated, 200-mesh TEM grids, or equivalent.

s. Analytical balance, 0.1 mg sensitivity.

t. Filter paper, 9 cm in diameter.

u. Oven or slide warmer. Must be capable of maintaining a temperature of 65–70 °C.

v. Polyurethane foam, 6 mm thickness.

w. Gold wire for evaporation.

6. Reagents.

a. *General.* A supply of ultra-clean, fiber-free water must be available for washing of all components used in the analysis. Water that has been distilled in glass or filtered or deionized water is satisfactory for this purpose. Reagents must be fiber-free.

b. Polycarbonate preparation method—chloroform.

c. Mixed Cellulose Ester (MCE) preparation method—acetone or the Burdette procedure (Ref. 7 of Unit III.L.).

7. TEM specimen preparation from polycarbonate filters.

a. *Specimen preparation laboratory*. It is most important to ensure that contamination of TEM specimens by extraneous asbestos fibers is minimized during preparation.

b. Cleaning of sample cassettes. Upon receipt at the analytical laboratory and before they are taken into the clean facility or laminar flow hood, the sample cassettes must be cleaned of any contamination adhering to the outside surfaces.

c. Preparation of the carbon evaporator. If the polycarbonate filter has already been carbon-coated prior to receipt, the carbon coating step will be omitted, unless the analyst believes the carbon film is too thin. If there is a need to apply more carbon, the filter will be treated in the same way as an uncoated filter. Carbon coating must be performed with a high-vacuum coating unit. Units that are based on evaporation of carbon filaments in a vacuum generated only by an oil rotary pump have not been evaluated for this application, and must not be used. The carbon rods should be sharpened by a carbon rod sharpener to necks of about 4 mm long and 1 mm in diameter. The rods are installed in the evaporator in such a manner that the points are approximately 10 to 12 cm from the surface of a microscope slide held in the rotating and tilting device.

d. Selection of filter area for carbon coating. Before preparation of the filters, a 75 mm×50 mm microscope slide is washed and dried. This slide is used to support strips of filter during the carbon evaporation. Two parallel strips of double-sided adhesive tape are applied along the length of the slide. Polycarbonate filters are easily stretched during handling, and cutting of areas for further preparation must be performed with great care. The filter and the MCE backing filter are removed together from the cassette and placed on a cleaned glass microscope slide. The filter can be cut with a curved scalpel blade by rocking the blade from the point placed in contact with the filter. The process can be repeated to cut a strip approximately 3 mm wide across the diameter of the filter. The strip of polycarbonate filter is separated from the corresponding strip of backing filter and carefully placed so that it bridges the gap between the adhesive tape strips on the microscope slide. The filter strip can be held with fine-point tweezers and supported underneath by the scalpel blade during placement on the microscope slide. The analyst can place several such strips on the same microscope slide, taking care to rinse and wet-wipe the scalpel blade and tweezers before handling a new sample. The filter strips should be identified by etching the glass slide or marking the slide using a marker insoluble in water and solvents. After the filter strip has been cut from each filter, the residual parts of the filter must be returned to the cassette and held in position by reassembly of the cassette. The cassette will then be archived for a period of 30 days or returned to the client upon request.

e. Carbon coating of filter strips. The glass slide holding the filter strips is placed on the rotation-tilting device, and the evaporator chamber is evacuated. The evaporation must be performed in very short bursts, separated by some seconds to allow the electrodes to cool. If evaporation is too rapid, the strips of polycarbonate filter will begin to curl, which will lead to cross-linking of the surface material and make it relatively insoluble in chloroform. An experienced analyst can judge the thickness of carbon film to be applied, and some test should be made first on unused filters. If the film is too thin, large particles will be lost from the TEM specimen, and there will be few complete and undamaged grid openings on the specimen. If the coating is too thick, the filter will tend to curl when exposed to chloroform vapor and the carbon film may not adhere to the support mesh. Too thick a carbon film will also lead to a TEM image that is lacking in contrast, and the ability to obtain ED patterns will be compromised. The carbon film should be as thin as possible and remain intact on most of the grid openings of the TEM specimen intact.

f. Preparation of the Jaffe washer. The precise design of the Jaffe washer is not considered important, so any one of the published designs may be used. A washer consisting of a simple stainless steel bridge is recommended. Several pieces of lens tissue approximately 1.0 cm×0.5 cm are placed on the stainless steel bridge, and the washer is filled with chloroform to a level where the meniscus contacts the underside of the mesh, which results in saturation of the lens tissue. See References 8 and 10 of Unit III.L.

g. Placing of specimens into the Jaffe washer. The TEM grids are first placed on a piece of lens tissue so that individual grids can be picked up with tweezers. Using a curved scalpel blade, the analyst excises three 3 mm square pieces of the carbon-coated polycarbonate filter from the filter strip. The three squares are selected from the center of the strip and from two points between the outer periphery of the active surface and the center. The piece of filter is placed on a TEM specimen grid with the shiny side of the TEM grid facing upwards, and the whole assembly is placed boldly onto the saturated lens tissue in the Jaffe washer. If carbon-coated grids are used, the filter should be placed carbon-coated side down. The three excised squares of filters are placed on the same piece of lens tissue. Any number of separate pieces of lens tissue may be placed in the same Jaffe washer. The lid is then placed on the Jaffe washer, and the system is allowed to stand for several hours, preferably overnight.

h. *Condensation washing.* It has been found that many polycarbonate filters will not dissolve completely in the Jaffe washer, even after being exposed to chloroform for as long as 3 days. This problem becomes more serious if the surface of the filter was overheated during the carbon evaporation. The presence of undissolved filter medium on the TEM preparation leads to partial or complete obscuration of areas of the sample, and fibers that may be present in these areas of the specimen will be overlooked; this will lead to a low result. Undissolved filter medium also compromises the ability to obtain ED patterns. Before they are counted, TEM grids must be examined critically to determine whether they are adequately cleared of residual filter medium. It has been found that condensation washing of the grids after the initial Jaffe washer treatment, with chloroform as the solvent, clears all residual filter medium in a period of approximately 1 hour. In practice, the piece of lens tissue supporting the specimen grids is transferred to the cold finger of the condensation washer, and the washer is operated for about 1 hour. If the specimens are cleared satisfactorily by the Jaffe washer alone, the condensation washer step may be unnecessary.

8. TEM specimen preparation from MCE filters.

a. This method of preparing TEM specimens from MCE filters is similar to that specified in NIOSH Method 7402. See References 7, 8, and 9 of Unit III.L.

b. Upon receipt at the analytical laboratory, the sample cassettes must be cleaned of any contamination adhering to the outside surfaces before entering the clean sample preparation area.

c. Remove a section from any quadrant of the sample and blank filters.

d. Place the section on a clean microscope slide. Affix the filter section to the slide with a gummed paged reinforcement or other suitable means. Label the slide with a water and solvent-proof marking pen.

e. Place the slide in a petri dish which contains several paper filters soaked with 2 to 3 mL acetone. Cover the dish. Wait 2 to 4 minutes for the sample filter to fuse and clear.

f. Plasma etching of the collapsed filter is required.

i. The microscope slide to which the collapsed filter pieces are attached is placed in a plasma asher. Because plasma ashers vary greatly in their performance, both from unit to unit and between different positions in the asher chamber, it is difficult to specify the conditions that should be used. This is one area of the method that requires further evaluation. Insufficient etching will result in a failure to expose embedded filters, and too much etching may result in loss of particulate from the surface. As an interim measure, it is recommended that the time for ashing of a known weight of a collapsed filter be established and that the etching rate be calculated in terms of micrometers per second. The actual etching time used for a particular asher and operating conditions will then be set such that a 1–2 µm (10 percent) layer of collapsed surface will be removed.

ii. Place the slide containing the collapsed filters into a low-temperature plasma asher, and etch the filter.

g. Transfer the slide to a rotating stage inside the bell jar of a vacuum evaporator. Evaporate a 1 mm×5 mm section of graphite rod onto the cleared filter. Remove the slide to a clean, dry, covered petri dish.

h. Prepare a second petri dish as a Jaffe washer with the wicking substrate prepared from filter or lens paper placed on top of a 6 mm thick disk of clean spongy polyurethane foam. Cut a V-notch on the edge of the foam and filter paper. Use the V-notch as a reservoir for adding solvent. The wicking substrate should be thin enough to fit into the petri dish without touching the lid.

i. Place carbon-coated TEM grids face up on the filter or lens paper. Label the grids by marking with a pencil on the filter paper or by putting registration marks on the petri dish lid and marking with a waterproof marker on the dish lid. In a fume hood, fill the dish with acetone until the wicking substrate is saturated. The level of acetone should be just high enough to saturate the filter paper without creating puddles.

j. Remove about a quarter section of the carbon-coated filter samples from the glass slides using a surgical knife and tweezers. Carefully place the section of the filter, carbon side down, on the appropriately labeled grid in the acetone-saturated petri dish. When all filter sections have been transferred, slowly add more solvent to the wedge-shaped trough to bring the acetone level up to the highest possible level without disturbing the sample preparations. Cover the petri dish. Elevate one side of the petri dish by placing a slide under it. This allows drops of condensed solvent vapors to form near the edge rather than in the center where they would drip onto the grid preparation.

G. TEM Method

1. *Instrumentation.*

a. Use an 80–120 kV TEM capable of performing electron diffraction with a fluorescent screen inscribed with calibrated gradations. If the TEM is equipped with EDXA it must either have a STEM attachment or be capable of producing a spot less than 250 nm in diameter at crossover. The microscope shall be calibrated routinely (see Unit III.J.) for magnification and camera constant.

b. While not required on every microscope in the laboratory, the laboratory must have either one microscope equipped with energy dispersive X-ray analysis or access to an equivalent system on a TEM in another laboratory. This must be an Energy Dispersive X-ray Detector mounted on TEM column and associated hardware/software to collect, save, and read out spectral information. Calibration of Multi-Channel Analyzer shall be checked regularly for A1 at 1.48 KeV and Cu at 8.04 KeV, as well as the manufacturer's procedures.

i. Standard replica grating may be used to determine magnification (e.g., 2160 lines/mm).

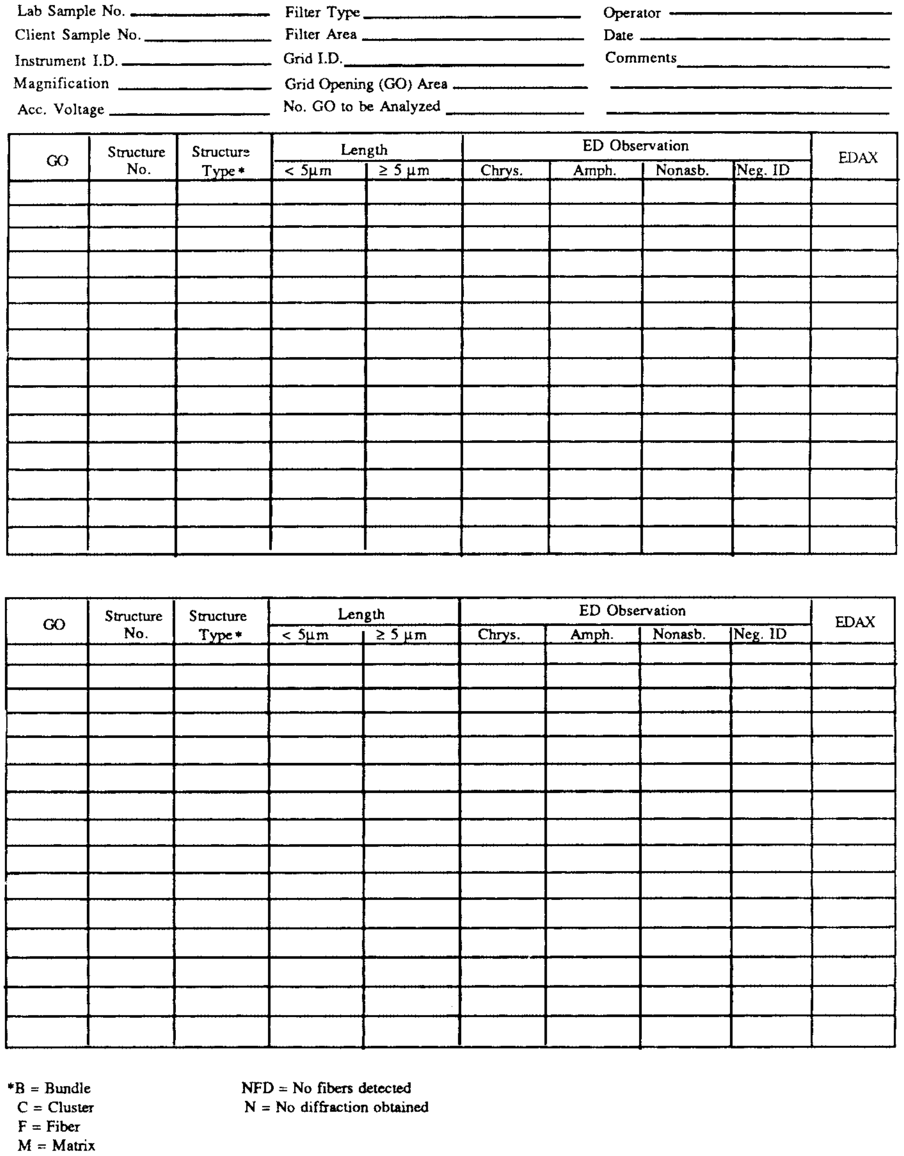
ii. Gold standard may be used to determine camera constant.

c. Use a specimen holder with single tilt and/or double tilt capabilities.

2. Procedure.

a. Start a new Count Sheet for each sample to be analyzed. Record on count sheet: analyst's initials and date; lab sample number; client sample number microscope identification; magnification for analysis; number of predetermined grid openings to be analyzed; and grid identification. See the following Figure 4:

FIGURE 4--COUNT SHEET



Lab Sample No. ____________
Client Sample No. ____________
Instrument I.D. ____________
Magnification ____________
Acc. Voltage ____________
Filter Type ____________
Filter Area ____________
Grid I.D. ____________
Grid Opening (GO) Area ____________
No. GO to be Analyzed ____________
Operator ____________
Date ____________
Comments ____________

GO	Structure No.	Structure Type*	Length		ED Observation				EDAX
			< 5µm	≥ 5 µm	Chrys.	Amph.	Nonasb.	Neg. ID	

GO	Structure No.	Structure Type*	Length		ED Observation				EDAX
			< 5µm	≥ 5 µm	Chrys.	Amph.	Nonasb.	Neg. ID	

*B = Bundle
C = Cluster
F = Fiber
M = Matrix

NFD = No fibers detected
N = No diffraction obtained

b. Check that the microscope is properly aligned and calibrated according to the manufacturer's specifications and instructions.

c. Microscope settings: 80–120 kV, grid assessment 250–1000X, then 15,000–20,000X screen magnification for analysis.

d. Approximately one-half (0.5) of the predetermined sample area to be analyzed shall be performed on one sample grid preparation and the remaining half on a second sample grid preparation.

e. Determine the suitability of the grid.

i. Individual grid openings with greater than 5 percent openings (holes) or covered with greater than 25 percent particulate matter or obviously having nonuniform loading shall not be analyzed.

ii. Examine the grid at low magnification (<1000X) to determine its suitability for detailed study at higher magnifications.

iii. Reject the grid if:

(1) Less than 50 percent of the grid openings covered by the replica are intact.

(2) It is doubled or folded.

(3) It is too dark because of incomplete dissolution of the filter.

iv. If the grid is rejected, load the next sample grid.

v. If the grid is acceptable, continue on to Step 6 if mapping is to be used; otherwise proceed to Step 7.

f. Grid Map (Optional).

i. Set the TEM to the low magnification mode.

ii. Use flat edge or finder grids for mapping.

iii. Index the grid openings (fields) to be counted by marking the acceptable fields for one-half (0.5) of the area needed for analysis on each of the two grids to be analyzed. These may be marked just before examining each grid opening (field), if desired.

iv. Draw in any details which will allow the grid to be properly oriented if it is reloaded into the microscope and a particular field is to be reliably identified.

g. Scan the grid.

i. Select a field to start the examination.

ii. Choose the appropriate magnification (15,000 to 20,000X screen magnification).

iii. Scan the grid as follows.

(1) At the selected magnification, make a series of parallel traverses across the field. On reaching the end of one traverse, move the image one window and reverse the traverse.

NOTE: A slight overlap should be used so as not to miss any part of the grid opening (field).

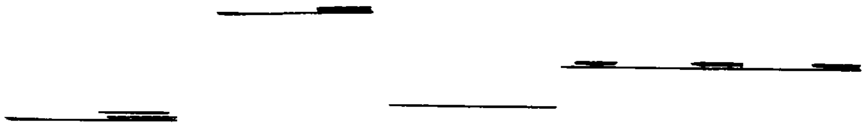
(2) Make parallel traverses until the entire grid opening (field) has been scanned.

h. Identify each structure for appearance and size.

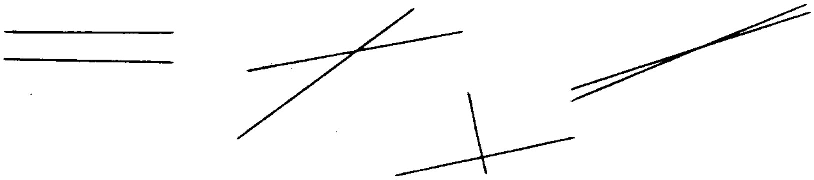
i. Appearance and size: Any continuous grouping of particles in which an asbestos fiber within aspect ratio greater than or equal to 5:1 and a length greater than or equal to 0.5 µm is detected shall be recorded on the count sheet. These will be designated asbestos structures and will be classified as fibers, bundles, clusters, or matrices. Record as individual fibers any contiguous grouping having 0, 1, or 2 definable intersections. Groupings having more than 2 intersections are to be described as cluster or matrix. See the following Figure 5:

FIGURE 5--COUNTING GUIDELINES USED IN
DETERMINING ASBESTOS STRUCTURES

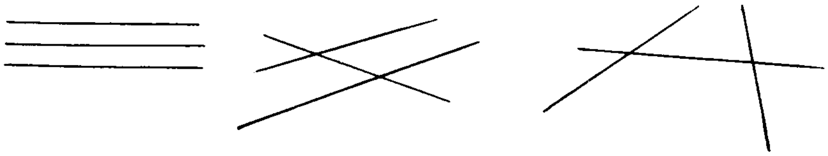
Count as 1 fiber; 1 Structure; no intersections.



Count as 2 fibers if space between fibers is greater than width of 1 fiber diameter or number of intersections is equal to or less than 1.

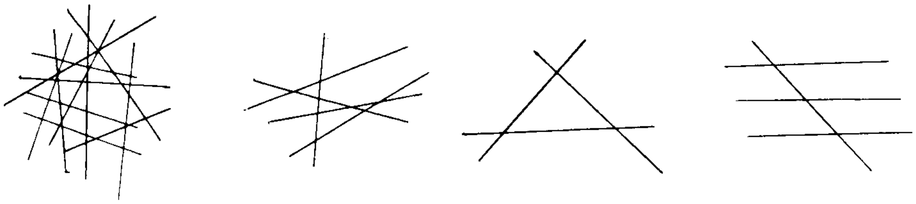


Count as 3 structures if space between fibers is greater than width of 1 fiber diameter or if the number of intersections is equal to or less than 2.

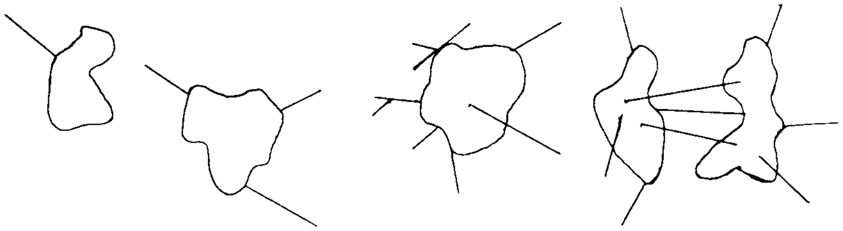


Count bundles as 1 structure; 3 or more parallel fibrils less than 1 fiber diameter separation.

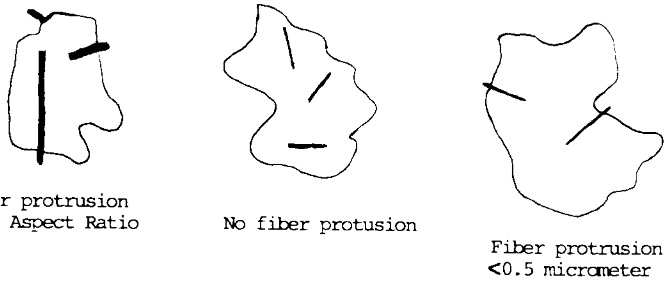
Count clusters as 1 structure; fibers having greater than or equal to 3 intersections.



Count matrix as 1 structure.



DO NOT COUNT AS STRUCTURES:



Fiber protrusion <5:1 Aspect Ratio

No fiber protusion

Fiber protrusion <0.5 micrometer

— <0.5 micrometer in length

▬ <5:1 Aspect Ratio

An intersection is a non-parallel touching or crossing of fibers, with the projection having an aspect ratio of 5:1 or greater. Combinations such as a matrix and cluster, matrix and bundle, or bundle and cluster are categorized by the dominant fiber quality—cluster, bundle, and matrix, respectively. Separate categories will be maintained for fibers less than 5 µm and for fibers greater than or equal to 5 µm in length. Not required, but useful, may be to record the fiber length in 1 µm intervals. (Identify each structure morphologically and analyze it as it enters the ''window''.)

(1) *Fiber.* A structure having a minimum length greater than 0.5 µm and an aspect ratio (length to width) of 5:1 or greater and substantially parallel sides. Note the appearance of the end of the fiber, i.e., whether it is flat, rounded or dovetailed, no intersections.

(2) *Bundle.* A structure composed of 3 or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

(3) *Cluster.* A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group; groupings must have more than 2 intersections.

(4) *Matrix.* Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

(5) *NSD.* Record NSD when no structures are detected in the field.

(6) *Intersection.* Non-parallel touching or crossing of fibers, with the projection having an aspect ratio 5:1 or greater.

ii. Structure Measurement.

(1) Recognize the structure that is to be sized.

(2) Memorize its location in the ''window'' relative to the sides, inscribed square and to other particulates in the field so this exact location can be found again when scanning is resumed.

(3) Measure the structure using the scale on the screen.

(4) Record the length category and structure type classification on the count sheet after the field number and fiber number.

(5) Return the fiber to its original location in the window and scan the rest of the field for other fibers; if the direction of travel is not remembered, return to the right side of the field and begin the traverse again.

i. Visual identification of Electron Diffraction (ED) patterns is required for each asbestos structure counted which would cause the analysis to exceed the 70 s/mm^2 concentration. (Generally this means the first four fibers identified as asbestos must exhibit an identifiable diffraction pattern for chrysotile or amphibole.)

i. Center the structure, focus, and obtain an ED pattern. (See Microscope Instruction Manual for more detailed instructions.)

ii. From a visual examination of the ED pattern, obtained with a short camera length, classify the observed structure as belonging to one of the following classifications: chrysotile, amphibole, or nonasbestos.

(1) Chrysotile: The chrysotile asbestos pattern has characteristic streaks on the layer lines other than the central line and some streaking also on the central line. There will be spots of normal sharpness on the central layer line and on alternate lines (2nd, 4th, etc.). The repeat distance between layer lines is 0.53 nm and the center doublet is at 0.73 nm. The pattern should display (002), (110), (130) diffraction maxima; distances and geometry should match a chrysotile pattern and be measured semiquantitatively.

(2) Amphibole Group [includes grunerite (amosite), crocidolite, anthophyllite, tremolite, and actinolite]: Amphibole asbestos fiber patterns show layer lines formed by very closely spaced dots, and the repeat distance between layer lines is also about 0.53 nm. Streaking in layer lines is occasionally present due to crystal structure defects.

(3) Nonasbestos: Incomplete or unobtainable ED patterns, a nonasbestos EDXA, or a nonasbestos morphology.

iii. The micrograph number of the recorded diffraction patterns must be reported to the client and maintained in the laboratory's quality assurance records. The records must also demonstrate that the identification of the pattern has been verified by a qualified individual and that the operator who made the identification is maintaining at least an 80 percent correct visual identification based on his measured patterns. In the event that examination of the pattern by the qualified individual indicates that the pattern had been misidentified visually, the client shall be contacted. If the pattern is a suspected chrysotile, take a photograph of the diffraction pattern at 0 degrees tilt. If the structure is suspected to be amphibole, the sample may have to be tilted to obtain a simple geometric array of spots.

j. Energy Dispersive X-Ray Analysis (EDXA).

i. Required of all amphiboles which would cause the analysis results to exceed the 70 s/mm^2 concentration. (Generally speaking, the first 4 amphiboles would require EDXA.)

ii. Can be used alone to confirm chrysotile after the 70 s/mm^2 concentration has been exceeded.

iii. Can be used alone to confirm all nonasbestos.

iv. Compare spectrum profiles with profiles obtained from asbestos standards. The closest match identifies and categorizes the structure.

v. If the EDXA is used for confirmation, record the properly labeled spectrum on a computer disk, or if a hard copy, file with analysis data.

vi. If the number of fibers in the nonasbestos class would cause the analysis to exceed the 70 s/mm^2 concentration, their identities must be confirmed by EDXA or measurement of a zone axis diffraction pattern to establish that the particles are nonasbestos.

k. Stopping Rules.

i. If more than 50 asbestiform structures are counted in a particular grid opening, the analysis may be terminated.

ii. After having counted 50 asbestiform structures in a minimum of 4 grid openings, the analysis may be terminated. The grid opening in which the 50th fiber was counted must be completed.

iii. For blank samples, the analysis is always continued until 10 grid openings have been analyzed.

iv. In all other samples the analysis shall be continued until an analytical sensitivity of 0.005 s/cm^3 is reached.

l. Recording Rules. The count sheet should contain the following information:

i. Field (grid opening): List field number.

ii. Record ''NSD'' if no structures are detected.

iii. Structure information.

(1) If fibers, bundles, clusters, and/or matrices are found, list them in consecutive numerical order, starting over with each field.

(2) Length. Record length category of asbestos fibers examined. Indicate if less than 5 µm or greater than or equal to 5 µm.

(3) Structure Type. Positive identification of asbestos fibers is required by the method. At least one diffraction pattern of each fiber type from every five samples must be recorded and compared with a standard diffraction pattern. For each asbestos fiber reported, both a morphological descriptor and an identification descriptor shall be specified on the count sheet.

(4) Fibers classified as chrysotile must be identified by diffraction and/or X-ray analysis and recorded on the count sheet. X-ray analysis alone can be used as sole identification only after 70s/mm^2 have been exceeded for a particular sample.

(5) Fibers classified as amphiboles must be identified by X-ray analysis and electron diffraction and recorded on the count sheet. (X-ray analysis alone can be used as sole identification only after 70s/mm^2 have been exceeded for a particular sample.)

(6) If a diffraction pattern was recorded on film, the micrograph number must be indicated on the count sheet.

(7) If an electron diffraction was attempted and an appropriate spectra is not observed, N should be recorded on the count sheet.

(8) If an X-ray analysis is attempted but not observed, N should be recorded on the count sheet.

(9) If an X-ray analysis spectrum is stored, the file and disk number must be recorded on the count sheet.

m. Classification Rules.

i. *Fiber.* A structure having a minimum length greater than or equal to 0.5 µm and an aspect ratio (length to width) of 5:1 or greater and substantially parallel sides. Note the appearance of the end of the fiber, i.e., whether it is flat, rounded or dovetailed.

ii. *Bundle.* A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

iii. *Cluster.* A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two intersections.

iv. *Matrix.* Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

v. *NSD.* Record NSD when no structures are detected in the field.

n. After all necessary analyses of a particle structure have been completed, return the goniometer stage to 0 degrees, and return the structure to its original location by recall of the original location.

o. Continue scanning until all the structures are identified, classified and sized in the field.

p. Select additional fields (grid openings) at low magnification; scan at a chosen magnification (15,000 to 20,000X screen magnification); and analyze until the stopping rule becomes applicable.

q. Carefully record all data as they are being collected, and check for accuracy.

r. After finishing with a grid, remove it from the microscope, and replace it in the appropriate grid hold. Sample grids must be stored for a minimum of 1 year from the date of the analysis; the sample cassette must be retained for a minimum of 30 days by the laboratory or returned at the client's request.

H. Sample Analytical Sequence

1. Carry out visual inspection of work site prior to air monitoring.

2. Collect a minimum of five air samples inside the work site and five samples outside the work site. The indoor and outdoor samples shall be taken during the same time period.

3. Analyze the abatement area samples according to this protocol. The analysis must meet the 0.005 s/cm^3 analytical sensitivity.

4. Remaining steps in the analytical sequence are contained in Unit IV. of this Appendix.

I. Reporting

The following information must be reported to the client. See the following Table II:

TABLE II--EXAMPLE LABORATORY LETTERHEAD

Laboratory I.D.	Client I.D.	FILTER MEDIA DATA				Analyzed Area, mm^2	Sample Volume, cc
		Type	Diameter, mm	Effective Area, mm^2	Pore Size, µm		

INDIVIDUAL ANALYTICAL RESULTS

Laboratory I.D.	Client I.D.	# Asbestos Structures	Analytical Sensitivity, s/cc	CONCENTRATION	
				Structures/mm^2	Structures/cc

The analysis was carried out to the approved TEM method. This laboratory is in compliance with the quality specified by the method.

Authorized Signature

1. Concentration in structures per square millimeter and structures per cubic centimeter.
2. Analytical sensitivity used for the analysis.
3. Number of asbestos structures.
4. Area analyzed.
5. Volume of air samples (which was initially provided by client).
6. Average grid size opening.
7. Number of grids analyzed.
8. Copy of the count sheet must be included with the report.

9. Signature of laboratory official to indicate that the laboratory met specifications of the AHERA method.
10. Report form must contain official laboratory identification (e.g., letterhead).
11. Type of asbestos.

J. Calibration Methodology

NOTE: Appropriate implementation of the method requires a person knowledgeable in electron diffraction and mineral identification by ED and EDXA. Those inexperienced laboratories wishing to develop capabilities may acquire necessary knowledge through analysis of appropriate standards and by following detailed methods as described in References 8 and 10 of Unit III.L.

1. *Equipment Calibration*. In this method, calibration is required for the air-sampling equipment and the transmission electron microscope (TEM).

a. *TEM Magnification*. The magnification at the fluorescent screen of the TEM must be calibrated at the grid opening magnification (if used) and also at the magnification used for fiber counting. This is performed with a cross grating replica. A logbook must be maintained, and the dates of calibration depend on the past history of the particular microscope; no frequency is specified. After any maintenance of the microscope that involved adjustment of the power supplied to the lenses or the high-voltage system or the mechanical disassembly of the electron optical column apart from filament exchange, the magnification must be recalibrated. Before the TEM calibration is performed, the analyst must ensure that the cross grating replica is placed at the same distance from the objective lens as the specimens are. For instruments that incorporate an eucentric tilting specimen stage, all speciments and the cross grating replica must be placed at the eucentric position.

b. Determination of the TEM magnification on the fluorescent screen.

i. Define a field of view on the fluorescent screen either by markings or physical boundaries. The field of view must be measurable or previously inscribed with a scale or concentric circles (all scales should be metric).

ii. Insert a diffraction grating replica (for example a grating containing 2,160 lines/mm) into the specimen holder and place into the microscope. Orient the replica so that the grating lines fall perpendicular to the scale on the TEM fluorescent screen. Ensure that the goniometer stage tilt is 0 degrees.

iii. Adjust microscope magnification to 10,000X or 20,000X. Measure the distance (mm) between two widely separated lines on the grating replica. Note the number of spaces between the lines. Take care to measure between the same relative positions on the lines (e.g., between left edges of lines).

NOTE: The more spaces included in the measurement, the more accurate the final calculation. On most microscopes, however, the magnification is substantially constant only within the central 8–10 cm diameter region of the fluorescent screen.

iv. Calculate the true magnification (M) on the fluorescent screen:

$$M=XG/Y$$

where:

X=total distance (mm) between the designated grating lines;
G=calibration constant of the grating replica (lines/mm):
Y=number of grating replica spaces counted along X.

c. Calibration of the EDXA System. Initially, the EDXA system must be calibrated by using two reference elements to calibrate the energy scale of the instrument. When this has been completed in accordance with the manufacturer's instructions, calibration in terms of the different types of asbestos can proceed. The EDXA detectors vary in both solid angle of detection and in window thickness. Therefore, at a particular accelerating voltage in use on the TEM, the count rate obtained from specific dimensions of fiber will vary both in absolute X-ray count rate and in the relative X-ray peak heights for different elements. Only a few minerals are relevant for asbestos abatement work, and in this procedure the calibration is specified in terms of a ‘‘fingerprint’’ technique. The EDXA spectra must be recorded from individual fibers of the relevant minerals, and identifications are made on the basis of semiquantitative comparisons with these reference spectra.

d. Calibration of Grid Openings.

i. Measure 20 grid openings on each of 20 random 200-mesh copper grids by placing a grid on a glass slide and examining it under the PCM. Use a calibrated graticule to measure the average field diameter and use this number to calculate the field area for an average grid opening. Grids are to be randomly selected from batches up to 1,000.

NOTE: A grid opening is considered as one field.

ii. The mean grid opening area must be measured for the type of specimen grids in use. This can be accomplished on the TEM at a properly calibrated low magnification or on an optical microscope at a magnification of approximately 400X by using an eyepiece fitted with a scale that has been calibrated against a stage micrometer. Optical microscopy utilizing manual or automated procedures may be used providing instrument calibration can be verified.

e. Determination of Camera Constant and ED Pattern Analysis.

i. The camera length of the TEM in ED operating mode must be calibrated before ED patterns on unknown samples are observed. This can be achieved by using a carbon-coated grid on which a thin film of gold has been sputtered or evaporated. A thin film of gold is evaporated on the specimen TEM grid to obtain zone-axis ED patterns superimposed with a ring pattern from the polycrystalline gold film.

ii. In practice, it is desirable to optimize the thickness of the gold film so that only one or two sharp rings are obtained on the superimposed ED pattern. Thicker gold film would normally give multiple gold rings, but it will tend to mask weaker diffraction spots from the unknown fibrous particulates. Since the unknown d-spacings of most interest in asbestos analysis are those which lie closest to the transmitted beam, multiple gold rings are unnecessary on zone-axis ED patterns. An average camera constant using multiple gold rings can be determined. The camera constant is one-half the diameter, D, of the rings times the interplanar spacing, d, of the ring being measured.

K. Quality Control/Quality Assurance Procedures (Data Quality Indicators)

Monitoring the environment for airborne asbestos requires the use of sensitive sampling and analysis procedures. Because the test is sensitive, it may be influenced by a variety of factors. These include the supplies used in the sampling operation, the performance of the sampling, the preparation of the grid from the filter and the actual examination of this grid in the microscope. Each of these unit operations must produce a product of defined quality if the analytical result is to be a reliable and meaningful test result. Accordingly, a series of control checks and reference standards is performed along with the sample analysis as indicators that the materials used are adequate and the operations are within acceptable limits. In this way, the quality of the data is defined and the results are of known value. These checks and tests also provide timely and specific warning of any problems which might develop within the sampling and analysis operations. A description of these quality control/quality assurance procedures is summarized in the following Table III:

TABLE III--SUMMARY OF LABORATORY
DATA QUALITY OBJECTIVES

Unit Operation	QC Check	Frequency	Conformance Expectation
Sample receiving	Review of receiving report	Each sample	95% complete
Sample custody	Review of chain-of-custody record	Each sample	95% complete
Sample preparation	Supplies and reagents	On receipt	Meet specs. or reject
	Grid opening size	20 openings/20 grids/lot of 1000 or 1 opening/sample	100%
	Special clean area monitoring	After cleaning or service	Meet specs or reclean
	Laboratory blank	1 per prep series or 10%	Meet specs. or reanalyze series
	Plasma etch blank	1 per 20 samples	75%
	Multiple preps (3 per sample)	Each sample	One with cover of 15 complete grid sqs.
Sample analysis	System check	Each day	Each day
	Alignment check	Each day	Each day
	Magnification calibration with low and high standards	Each month or after service	95%
	ED calibration by gold standard	Weekly	95%
	EDS calibration by copper line	Daily	95%
Performance check	Laboratory blank (measure of cleanliness)	Prep 1 per series or 10% read 1 per 25 samples	Meet specs or reanalyze series
	Replicate counting (measure of precision)	1 per 100 samples	1.5 x Poisson Std. Dev.
	Duplicate analysis (measure of reproducibility)	1 per 100 samples	2 x Poisson Std. Dev.
	Known samples of typical materials (working standards)	Training and for comparison with unknowns	100%
	Analysis of NBS SRM 1876 and/or RM 8410 (measure of accuracy and comparability)	1 per analyst per year	1.5 x Poisson Std. Dev.
	Data entry review (data validation and measure of completeness)	Each sample	95%
	Record and verify ID electron diffraction pattern of structure	1 per 5 samples	80% accuracy
Calculations and data reduction	Hand calculation of automated data reduction procedure or independent recalculation of hand-calculated data	1 per 100 samples	85%

1. When the samples arrive at the laboratory, check the samples and documentation for completeness and requirements before initiating the analysis.

2. Check all laboratory reagents and supplies for acceptable asbestos background levels.

3. Conduct all sample preparation in a clean room environment monitored by laboratory blanks and special testing after cleaning or servicing the room.

4. Prepare multiple grids of each sample.

5. Provide laboratory blanks with each sample batch. Maintain a cumulative average of these results. If this average is greater than 53 f/mm^2 per 10 200-mesh grid openings, check the system for possible sources of contamination.

6. Check for recovery of asbestos from cellulose ester filters submitted to plasma asher.

7. Check for asbestos carryover in the plasma asher by including a blank alongside the positive control sample.

8. Perform a systems check on the transmission electron microscope daily.

9. Make periodic performance checks of magnification, electron diffraction and energy dispersive X-ray systems as set forth in Table III of Unit III.K.

10. Ensure qualified operator performance by evaluation of replicate counting, duplicate analysis, and standard sample comparisons as set forth in Table III of Unit III.K.

11. Validate all data entries.

12. Recalculate a percentage of all computations and automatic data reduction steps as specified in Table III.

13. Record an electron diffraction pattern of one asbestos structure from every five samples that contain asbestos. Verify the identification of the pattern by measurement or comparison of the pattern with patterns collected from standards under the same conditions.

The outline of quality control procedures presented above is viewed as the minimum required to assure that quality data is produced for clearance testing of an asbestos abated area. Additional information may be gained by other control tests. Specifics on those control procedures and options available for environmental testing can be obtained by consulting References 6, 7, and 11 of Unit III.L.

L. References

For additional background information on this method the following references should be consulted.

1. ‘‘Guidelines for Controlling Asbestos-Containing Materials in Buildings,’’ EPA 560/5–85–024, June 1985.

2. ‘‘Measuring Airborne Asbestos Following an Abatement Action,’’ USEP/Office of Pollution Prevention and Toxics, EPA 600/4–85–049, 1985.

3. Small, John and E. Steel. Asbestos Standards: Materials and Analytical Methods. N.B.S. Special Publication 619, 1982.

4. Campbell, W.J., R.L. Blake, L.L. Brown, E.E. Cather, and J.J. Sjoberg. Selected Silicate Minerals and Their Asbestiform Varieties. Information Circular 8751, U.S. Bureau of Mines, 1977.

5. Quality Assurance Handbook for Air Pollution Measurement System. Ambient Air Methods, EPA 600/4–77–027a, USEPA, Office of Research and Development, 1977.

6. Method 2A: Direct Measurement of Gas Volume Through Pipes and Small Ducts. 40 CFR Part 60 Appendix A.

7. Burdette, G.J. Health & Safety Exec., Research & Lab. Services Div., London, ‘‘Proposed Analytical Method for Determination of Asbestos in Air.’’

8. Chatfield, E.J., Chatfield Tech. Cons., Ltd., Clark, T., PEI Assoc. ‘‘Standard Operating Procedure for Determination of Airborne Asbestos Fibers by Transmission Electron Microscopy Using Polycarbonate Membrane Filters.’’ WERL SOP 87–1, March 5, 1987.

9. NIOSH. Method 7402 for Asbestos Fibers, December 11, 1986 Draft.

10. Yamate, G., S.C. Agarwall, R.D. Gibbons, IIT Research Institute, ‘‘Methodology for the Measurement of Airborne Asbestos by Electron Microscopy.’’ Draft report, USEPA Contract 68–02–3266, July 1984.

11. Guidance to the Preparation of Quality Assurance Project Plans. USEPA, Office of Pollution Prevention and Toxics, 1984.

IV. Mandatory Interpretation of Transmission Electron Microscopy Results To Determine Completion of Response Actions

A. Introduction

A response action is determined to be completed by TEM when the abatement area has been cleaned and the airborne asbestos concentration inside the abatement area is no higher than concentrations at locations outside the abatement area. ‘‘Outside’’ means outside the abatement area, but not necessarily outside the building. EPA reasons that an asbestos removal contractor cannot be expected to clean an abatement area to an airborne asbestos concentration that is lower than the concentration of air entering the abatement area from outdoors or from other parts of the building. After the abatement area has passed a thorough visual inspection, and before the outer containment barrier is removed, a minimum of five air samples inside the abatement area and a minimum of five air samples outside the abatement area must be collected. Hence, the response action is determined to be completed when the average airborne asbestos concentration measured inside the abatement area is not statistically different from the average airborne asbestos concentration measured outside the abatement area.

The inside and outside concentrations are compared by the Z-test, a statistical test that takes into account the variability in the measurement process. A minimum of five samples inside the abatement area and five samples outside the abatement area are required to control the false negative error rate, i.e., the probability of declaring the removal complete when, in fact, the air concentration inside the abatement area is significantly higher than outside the abatement area. Additional quality control is provided by requiring three blanks (filters through which no air has been drawn) to be analyzed to check for unusually high filter contamination that would distort the test results.

When volumes greater than or equal to 1,199 L for a 25 mm filter and 2,799 L for a 37 mm filter have been collected and the average number of asbestos structures on samples inside the abatement area is no greater than 70 s/mm^2 of filter, the response action may be considered complete without comparing the inside samples to the outside samples. EPA is permitting this initial screening test to save analysis costs in situations where the airborne asbestos concentration is sufficiently low so that it cannot be distinguished from the filter contamination/background level (fibers deposited on the filter that are unrelated to the air being sampled). The screening test cannot be used when volumes of less than 1,199 L for 25 mm filter or 2,799 L for a 37 mm filter are collected because the ability to distinguish levels significantly different from filter background is reduced at low volumes.

The initial screening test is expressed in structures per square millimeter of filter because filter background levels come from sources other than the air being sampled and cannot be meaningfully expressed as a concentration per cubic centimeter of air. The value of 70 s/mm² is based on the experience of the panel of microscopists who consider one structure in 10 grid openings (each grid opening with an area of 0.0057 mm²) to be comparable with contamination/background levels of blank filters. The decision is based, in part, on Poisson statistics which indicate that four structures must be counted on a filter before the fiber count is statistically distinguishable from the count for one structure. As more information on the performance of the method is collected, this criterion may be modified. Since different combinations of the number and size of grid openings are permitted under the TEM protocol, the criterion is expressed in structures per square millimeter of filter to be consistent across all combinations. Four structures per 10 grid openings corresponds to approximately 70 s/mm².

B. Sample Collection and Analysis

1. A minimum of 13 samples is required: five samples collected inside the abatement area, five samples collected outside the abatement area, two field blanks, and one sealed blank.

2. Sampling and TEM analysis must be done according to either the mandatory or nonmandatory protocols in Appendix A. At least 0.057 mm² of filter must be examined on blank filters.

C. Interpretation of Results

1. The response action shall be considered complete if either:

a. Each sample collected inside the abatement area consists of at least 1,199 L of air for a 25 mm filter, or 2,799 L of air for a 37 mm filter, and the arithmetic mean of their asbestos structure concentrations per square millimeter of filter is less than or equal to 70 s/mm²; or

b. The three blank samples have an arithmetic mean of the asbestos structure concentration on the blank filters that is less than or equal to 70 s/mm² and the average airborne asbestos concentration measured inside the abatement area is not statistically higher than the average airborne asbestos concentration measured outside the abatement area as determined by the Z-test. The Z-test is carried out by calculating

$$Z = \frac{\bar{Y}_I - \bar{Y}_O}{0.8(1/n_I + 1/n_O)^{1/2}}$$

where Y_I is the average of the natural logarithms of the inside samples and Y_O is the average of the natural logarithms of the outside samples, n_I is the number of inside samples and n_O is the number of outside samples. The response action is considered complete if Z is less than or equal to 1.65.

NOTE: When no fibers are counted, the calculated detection limit for that analysis is inserted for the concentration.

2. If the abatement site does not satisfy either (1) or (2) of this Section C, the site must be recleaned and a new set of samples collected.

D. Sequence for Analyzing Samples

It is possible to determine completion of the response action without analyzing all samples. Also, at any point in the process, a decision may be made to terminate the analysis of existing samples, reclean the abatement site, and collect a new set of samples. The following sequence is outlined to minimize the number of analyses needed to reach a decision.

1. Analyze the inside samples.

2. If at least 1,199 L of air for a 25 mm filter or 2,799 L of air for a 37 mm filter is collected for each inside sample and the arithmetic mean concentration of structures per square millimeter of filter is less than or equal to 70 s/mm², the response action is complete and no further analysis is needed.

3. If less than 1,199 L of air for a 25 mm filter or 2,799 L of air for a 37 mm filter is collected for any of the inside samples, or the arithmetic mean concentration of structures per square millimeter of filter is greater than 70 s/mm², analyze the three blanks.

4. If the arithmetic mean concentration of structures per square millimeter on the blank filters is greater than 70 s/mm², terminate the analysis, identify and correct the source of blank contamination, and collect a new set of samples.

5. If the arithmetic mean concentration of structures per square millimeter on the blank filters is less than or equal to 70 s/mm², analyze the outside samples and perform the Z-test.

6. If the Z-statistic is less than or equal to 1.65, the response action is complete. If the Z-statistic is greater than 1.65, reclean the abatement site and collect a new set of samples.

[52 FR 41857, Oct. 30, 1987]

APPENDIX B TO SUBPART E OF PART 763 [RESERVED]

APPENDIX C TO SUBPART E OF PART 763—ASBESTOS MODEL ACCREDITATION PLAN

I. Asbestos Model Accreditation Plan for States

The Asbestos Model Accreditation Plan (MAP) for States has eight components:

(A) Definitions
(B) Initial Training
(C) Examinations
(D) Continuing Education
(E) Qualifications
(F) Recordkeeping Requirements for Training Providers
(G) Deaccreditation
(H) Reciprocity
(I) Electronic reporting

A. Definitions

For purposes of Appendix C:

1. ''Friable asbestos-containing material (ACM)'' means any material containing more than one percent asbestos which has been applied on ceilings, walls, structural members, piping, duct work, or any other part of a building, which when dry, may be crumbled, pulverized, or reduced to powder by hand pressure. The term includes non-friable asbestos-containing material after such previously non-friable material becomes damaged to the extent that when dry it may be crumbled, pulverized, or reduced to powder by hand pressure.

2. ''Friable asbestos-containing building material (ACBM)'' means any friable ACM that is in or on interior structural members or other parts of a school or public and commercial building.

3. ''Inspection'' means an activity undertaken in a school building, or a public and commercial building, to determine the presence or location, or to assess the condition of, friable or non-friable asbestos-containing building material (ACBM) or suspected ACBM, whether by visual or physical examination, or by collecting samples of such material. This term includes reinspections of friable and non-friable known or assumed ACBM which has been previously identified. The term does not include the following:

a. Periodic surveillance of the type described in 40 CFR 763.92(b) solely for the purpose of recording or reporting a change in the condition of known or assumed ACBM;

b. Inspections performed by employees or agents of Federal, State, or local government solely for the purpose of determining compliance with applicable statutes or regulations; or

c. visual inspections of the type described in 40 CFR 763.90(i) solely for the purpose of determining completion of response actions.

4. ''Major fiber release episode'' means any uncontrolled or unintentional disturbance of ACBM, resulting in a visible emission, which involves the falling or dislodging of more than 3 square or linear feet of friable ACBM.

5. ''Minor fiber release episode'' means any uncontrolled or unintentional disturbance of ACBM, resulting in a visible emission, which involves the falling or dislodging of 3 square or linear feet or less of friable ACBM.

6. ''Public and commercial building'' means the interior space of any building which is not a school building, except that the term does not include any residential apartment building of fewer than 10 units or detached single-family homes. The term includes, but is not limited to: industrial and office buildings, residential apartment buildings and condominiums of 10 or more dwelling units, government-owned buildings, colleges, museums, airports, hospitals, churches, preschools, stores, warehouses and factories. Interior space includes exterior hallways connecting buildings, porticos, and mechanical systems used to condition interior space.

7. ''Response action'' means a method, including removal, encapsulation, enclosure, repair, and operation and maintenance, that protects human health and the environment from friable ACBM.

8. ''Small-scale, short-duration activities (SSSD)'' are tasks such as, but not limited to:

a. Removal of asbestos-containing insulation on pipes.

b. Removal of small quantities of asbestos-containing insulation on beams or above ceilings.

c. Replacement of an asbestos-containing gasket on a valve.

d. Installation or removal of a small section of drywall.

e. Installation of electrical conduits through or proximate to asbestos-containing materials.

SSSD can be further defined by the following considerations:

f. Removal of small quantities of ACM only if required in the performance of another maintenance activity not intended as asbestos abatement.

g. Removal of asbestos-containing thermal system insulation not to exceed amounts greater than those which can be contained in a single glove bag.

h. Minor repairs to damaged thermal system insulation which do not require removal.

i. Repairs to a piece of asbestos-containing wallboard.

j. Repairs, involving encapsulation, enclosure, or removal, to small amounts of friable ACM only if required in the performance of emergency or routine maintenance activity and not intended solely as asbestos abatement. Such work may not exceed amounts greater than those which can be contained in a single prefabricated mini-enclosure. Such an enclosure shall conform spatially and geometrically to the localized work area, in order to perform its intended containment function.

B. Initial Training

Training requirements for purposes of accreditation are specified both in terms of required subjects of instruction and in terms of length of training. Each initial training course has a prescribed curriculum and number of days of training. One day of training equals 8 hours, including breaks and lunch. Course instruction must be provided by EPA or State-approved instructors. EPA or State instructor approval shall be based upon a review of the instructor's academic credentials and/or field experience in asbestos abatement.

Beyond the initial training requirements, individual States may wish to consider requiring additional days of training for purposes of supplementing hands-on activities or for reviewing relevant state regulations. States also may wish to consider the relative merits of a worker apprenticeship program. Further, they might consider more stringent minimum qualification standards for the approval of training instructors. EPA recommends that the enrollment in any given course be limited to 25 students so that adequate opportunities exist for individual hands-on experience.

States have the option to provide initial training directly or approve other entities to offer training. The following requirements are for the initial training of persons required to have accreditation under TSCA Title II.

Training requirements for each of the five accredited disciplines are outlined below. Persons in each discipline perform a different job function and distinct role. Inspectors identify and assess the condition of ACBM, or suspect ACBM. Management planners use data gathered by inspectors to assess the degree of hazard posed by ACBM in schools to determine the scope and timing of appropriate response actions needed for schools. Project designers determine how asbestos abatement work should be conducted. Lastly, workers and contractor/supervisors carry out and oversee abatement work. In addition, a recommended training curriculum is also presented for a sixth discipline, which is not federally-accredited, that of ''Project Monitor.'' Each accredited discipline and training curriculum is separate and distinct from the others. A person seeking accreditation in any of the five accredited MAP disciplines cannot attend two or more courses concurrently, but may attend such courses sequentially.

In several instances, initial training courses for a specific discipline (e.g., workers, inspectors) require hands-on training. For asbestos abatement contractor/supervisors and workers, hands-on training should include working with asbestos-substitute materials, fitting and using respirators, use of glovebags, donning protective clothing, and constructing a decontamination unit as well as other abatement work activities.

1. WORKERS

A person must be accredited as a worker to carry out any of the following activities with respect to friable ACBM in a school or public and commercial building: (1) A response action other than a SSSD activity, (2) a maintenance activity that disturbs friable ACBM other than a SSSD activity, or (3) a response action for a major fiber release episode. All persons seeking accreditation as asbestos abatement workers shall complete at least a 4–day training course as outlined below. The 4–day worker training course shall include lectures, demonstrations, at least 14 hours of hands-on training, individual respirator fit testing, course review, and an examination. Hands-on training must permit workers to have actual experience performing tasks associated with asbestos abatement. A person who is otherwise accredited as a contractor/supervisor may perform in the role of a worker without possessing separate accreditation as a worker.

Because of cultural diversity associated with the asbestos workforce, EPA recommends that States adopt specific standards for the approval of foreign language courses for abatement workers. EPA further recommends the use of audio-visual materials to complement lectures, where appropriate.

The training course shall adequately address the following topics:

(a) *Physical characteristics of asbestos.* Identification of asbestos, aerodynamic characteristics, typical uses, and physical appearance, and a summary of abatement control options.

(b) *Potential health effects related to asbestos exposure.* The nature of asbestos-related diseases; routes of exposure; dose-response relationships and the lack of a safe exposure level; the synergistic effect between cigarette smoking and asbestos exposure; the latency periods for asbestos-related diseases; a discussion of the relationship of asbestos exposure to asbestosis, lung cancer, mesothelioma, and cancers of other organs.

(c) *Employee personal protective equipment.* Classes and characteristics of respirator types; limitations of respirators; proper selection, inspection; donning, use, maintenance, and storage procedures for respirators; methods for field testing of the facepiece-to-face seal (positive and negative-pressure fit checks); qualitative and quantitative fit testing procedures; variability between field and laboratory protection factors that alter respiratory fit (e.g., facial hair); the components of a proper respiratory protection program; selection and use of personal protective clothing; use, storage, and handling of non-disposable clothing; and regulations covering personal protective equipment.

(d) *State-of-the-art work practices.* Proper work practices for asbestos abatement activities, including descriptions of proper construction; maintenance of barriers and decontamination enclosure systems; positioning of warning signs; lock-out of electrical and ventilation systems; proper working techniques for minimizing fiber release; use of wet methods; use of negative pressure exhaust ventilation equipment; use of high-efficiency particulate air (HEPA) vacuums; proper clean-up and disposal procedures; work practices for removal, encapsulation, enclosure, and repair of ACM; emergency procedures for sudden releases; potential exposure situations; transport and disposal procedures; and recommended and prohibited work practices.

(e) *Personal hygiene.* Entry and exit procedures for the work area; use of showers; avoidance of eating, drinking, smoking, and chewing (gum or tobacco) in the work area; and potential exposures, such as family exposure.

(f) *Additional safety hazards.* Hazards encountered during abatement activities and how to deal with them, including electrical hazards, heat stress, air contaminants other than asbestos, fire and explosion hazards, scaffold and ladder hazards, slips, trips, and falls, and confined spaces.

(g) *Medical monitoring.* OSHA and EPA Worker Protection Rule requirements for physical examinations, including a pulmonary function test, chest X-rays, and a medical history for each employee.

(h) *Air monitoring.* Procedures to determine airborne concentrations of asbestos fibers, focusing on how personal air sampling is performed and the reasons for it.

(i) *Relevant Federal, State, and local regulatory requirements, procedures, and standards.* With particular attention directed at relevant EPA, OSHA, and State regulations concerning asbestos abatement workers.

(j) *Establishment of respiratory protection programs.*

(k) *Course review.* A review of key aspects of the training course.

2. CONTRACTOR/SUPERVISORS

A person must be accredited as a contractor/supervisor to supervise any of the following activities with respect to friable ACBM in a school or public and commercial building: (1) A response action other than a SSSD activity, (2) a maintenance activity that disturbs friable ACBM other than a SSSD activity, or (3) a response action for a major fiber release episode. All persons seeking accreditation as asbestos abatement contractor/supervisors shall complete at least a 5–day training course as outlined below. The training course must include lectures, demonstrations, at least 14 hours of hands-on training, individual respirator fit testing, course review, and a written examination. Hands-on training must permit supervisors to have actual experience performing tasks associated with asbestos abatement.

EPA recommends the use of audiovisual materials to complement lectures, where appropriate.

Asbestos abatement supervisors include those persons who provide supervision and direction to workers performing response actions. Supervisors may include those individuals with the position title of foreman, working foreman, or leadman pursuant to collective bargaining agreements. At least one supervisor is required to be at the worksite at all times while response actions are being conducted. Asbestos workers must have access to accredited supervisors throughout the duration of the project.

The contractor/supervisor training course shall adequately address the following topics:

(a) *The physical characteristics of asbestos and asbestos-containing materials.* Identification of asbestos, aerodynamic characteristics, typical uses, physical appearance, a review of hazard assessment considerations, and a summary of abatement control options.

(b) *Potential health effects related to asbestos exposure.* The nature of asbestos-related diseases; routes of exposure; dose-response relationships and the lack of a safe exposure level; synergism between cigarette smoking and asbestos exposure; and latency period for diseases.

(c) *Employee personal protective equipment.* Classes and characteristics of respirator types; limitations of respirators; proper selection, inspection, donning, use, maintenance, and storage procedures for respirators; methods for field testing of the facepiece-to-face seal (positive and negative-pressure fit checks); qualitative and quantitative fit testing procedures; variability between field and laboratory protection factors that alter respiratory fit (e.g., facial hair); the components of a proper respiratory protection program; selection and use of personal protective clothing; and use, storage, and handling of non-disposable clothing; and regulations covering personal protective equipment.

(d) *State-of-the-art work practices.* Proper work practices for asbestos abatement activities, including descriptions of proper construction and maintenance of barriers and decontamination enclosure systems; positioning of warning signs; lock-out of electrical and ventilation systems; proper working techniques for minimizing fiber release; use of wet methods; use of negative pressure exhaust ventilation equipment; use of HEPA vacuums; and proper clean-up and disposal procedures. Work practices for removal, encapsulation, enclosure, and repair of ACM; emergency procedures for unplanned releases; potential exposure situations; transport and disposal procedures; and recommended and prohibited work practices. New abatement-related techniques and methodologies may be discussed.

(e) *Personal hygiene.* Entry and exit procedures for the work area; use of showers; and avoidance of eating, drinking, smoking, and chewing (gum or tobacco) in the work area. Potential exposures, such as family exposure, shall also be included.

(f) *Additional safety hazards.* Hazards encountered during abatement activities and how to deal with them, including electrical hazards, heat stress, air contaminants other than asbestos, fire and explosion hazards, scaffold and ladder hazards, slips, trips, and falls, and confined spaces.

(g) *Medical monitoring.* OSHA and EPA Worker Protection Rule requirements for physical examinations, including a pulmonary function test, chest X-rays and a medical history for each employee.

(h) *Air monitoring.* Procedures to determine airborne concentrations of asbestos fibers, including descriptions of aggressive air sampling, sampling equipment and methods, reasons for air monitoring, types of samples and interpretation of results.

EPA recommends that transmission electron microscopy (TEM) be used for analysis of final air clearance samples, and that sample analyses be performed by laboratories accredited by the National Institute of Standards and Technology's (NIST) National Voluntary Laboratory Accreditation Program (NVLAP).

(i) *Relevant Federal, State, and local regulatory requirements, procedures, and standards, including:*

(i) Requirements of TSCA Title II.

(ii) National Emission Standards for Hazardous Air Pollutants (40 CFR part 61), Subparts A (General Provisions) and M (National Emission Standard for Asbestos).

(iii) OSHA standards for permissible exposure to airborne concentrations of asbestos fibers and respiratory protection (29 CFR 1910.134).

(iv) OSHA Asbestos Construction Standard (29 CFR 1926.58). (v)EPA Worker Protection Rule, (40 CFR part 763, Subpart G).

(j) *Respiratory Protection Programs and Medical Monitoring Programs.*

(k) *Insurance and liability issues.* Contractor issues; worker's compensation coverage and exclusions; third-party liabilities and defenses; insurance coverage and exclusions.

(l) *Recordkeeping for asbestos abatement projects.* Records required by Federal, State, and local regulations; records recommended for legal and insurance purposes.

(m) *Supervisory techniques for asbestos abatement activities.* Supervisory practices to enforce and reinforce the required work practices and discourage unsafe work practices.

(n) *Contract specifications.* Discussions of key elements that are included in contract specifications.

(o) *Course review.* A review of key aspects of the training course.

3. INSPECTOR

All persons who inspect for ACBM in schools or public and commercial buildings must be accredited. All persons seeking accreditation as an inspector shall complete at least a 3–day training course as outlined below. The course shall include lectures, demonstrations, 4 hours of hands-on training, individual respirator fit-testing, course review, and a written examination.

EPA recommends the use of audiovisual materials to complement lectures, where appropriate. Hands-on training should include conducting a simulated building walkthrough inspection and respirator fit testing. The inspector training course shall adequately address the following topics:

(a) *Background information on asbestos.* Identification of asbestos, and examples and discussion of the uses and locations of asbestos in buildings; physical appearance of asbestos.

(b) *Potential health effects related to asbestos exposure.* The nature of asbestos-related diseases; routes of exposure; dose-response relationships and the lack of a safe exposure level; the synergistic effect between cigarette smoking and asbestos exposure; the latency periods for asbestos-related diseases; a discussion of the relationship of asbestos exposure to asbestosis, lung cancer, mesothelioma, and cancers of other organs.

(c) *Functions/qualifications and role of inspectors.* Discussions of prior experience and qualifications for inspectors and management planners; discussions of the functions of an accredited inspector as compared to those of an accredited management planner; discussion of inspection process including inventory of ACM and physical assessment.

(d) *Legal liabilities and defenses.* Responsibilities of the inspector and management planner; a discussion of comprehensive general liability policies, claims-made, and occurrence policies, environmental and pollution liability policy clauses; state liability insurance requirements; bonding and the relationship of insurance availability to bond availability.

(e) *Understanding building systems.* The interrelationship between building systems, including: an overview of common building physical plan layout; heat, ventilation, and air conditioning (HVAC) system types, physical organization, and where asbestos is found on HVAC components; building mechanical systems, their types and organization, and where to look for asbestos on such systems; inspecting electrical systems, including appropriate safety precautions; reading blueprints and as-built drawings.

(f) *Public/employee/building occupant relations.* Notifying employee organizations about the inspection; signs to warn building occupants; tact in dealing with occupants and the press; scheduling of inspections to minimize disruptions; and education of building occupants about actions being taken.

(g) *Pre-inspection planning and review of previous inspection records.* Scheduling the inspection and obtaining access; building record review; identification of probable homogeneous areas from blueprints or as-built drawings; consultation with maintenance or building personnel; review of previous inspection, sampling, and abatement records of a building; the role of the inspector in exclusions for previously performed inspections.

(h) *Inspecting for friable and non-friable ACM and assessing the condition of friable ACM.* Procedures to follow in conducting visual inspections for friable and non-friable ACM; types of building materials that may contain asbestos; touching materials to determine friability; open return air plenums and their importance in HVAC systems; assessing damage, significant damage, potential damage, and potential significant damage; amount of suspected ACM, both in total quantity and as a percentage of the total area; type of damage; accessibility; material's potential for disturbance; known or suspected causes of damage or significant damage; and deterioration as assessment factors.

(i) *Bulk sampling/documentation of asbestos.* Detailed discussion of the ''Simplified Sampling Scheme for Friable Surfacing Materials (EPA 560/5-85-030a October 1985)''; techniques to ensure sampling in a randomly distributed manner for other than friable surfacing materials; sampling of non-friable materials; techniques for bulk sampling; inspector's sampling and repair equipment; patching or repair of damage from sampling; discussion of polarized light microscopy; choosing an accredited laboratory to analyze bulk samples; quality control and quality assurance procedures. EPA's recommendation that all bulk samples collected from school or public and commercial buildings be analyzed by a laboratory accredited under the NVLAP administered by NIST.

(j) *Inspector respiratory protection and personal protective equipment.* Classes and characteristics of respirator types; limitations of respirators; proper selection, inspection; donning, use, maintenance, and storage procedures for respirators; methods for field testing of the facepiece-to-face seal (positive and negative-pressure fit checks); qualitative and quantitative fit testing procedures; variability between field and laboratory protection factors that alter respiratory fit (e.g., facial hair); the components of a proper respiratory protection program; selection and use of personal protective clothing; use, storage, and handling of non-disposable clothing.

(k) *Recordkeeping and writing the inspection report.* Labeling of samples and keying sample identification to sampling location; recommendations on sample labeling; detailing of ACM inventory; photographs of selected sampling areas and examples of ACM condition; information required for inclusion in the management plan required for school buildings under TSCA Title II, section 203 (i)(1). EPA recommends that States develop and require the use of standardized forms for recording the results of inspections in schools or public or commercial buildings, and that the use of these forms be incorporated into the curriculum of training conducted for accreditation.

(l) *Regulatory review.* The following topics should be covered: National Emission Standards for Hazardous Air Pollutants (NESHAP; 40 CFR part 61, Subparts A and M); EPA Worker Protection Rule (40 CFR part 763, Subpart G); OSHA Asbestos Construction Standard (29 CFR 1926.58); OSHA respirator requirements (29 CFR 1910.134); the Asbestos-Containing Materials in School Rule (40 CFR part 763, Subpart E; applicable State and local regulations, and differences between Federal and State requirements where they apply, and the effects, if any, on public and nonpublic schools or commercial or public buildings.

(m) *Field trip.* This includes a field exercise, including a walk-through inspection; on-site discussion about information gathering and the determination of sampling locations; on-site practice in physical assessment; classroom discussion of field exercise.

(n) *Course review.* A review of key aspects of the training course.

4. MANAGEMENT PLANNER

All persons who prepare management plans for schools must be accredited. All persons seeking accreditation as management planners shall complete a 3–day inspector training course as outlined above and a 2–day management planner training course. Possession of current and valid inspector accreditation shall be a prerequisite for admission to the management planner training course. The management planner course shall include lectures, demonstrations, course review, and a written examination.

EPA recommends the use of audiovisual materials to complement lectures, where appropriate.

TSCA Title II does not require accreditation for persons performing the management planner role in public and commercial buildings. Nevertheless, such persons may find this training and accreditation helpful in preparing them to design or administer asbestos operations and maintenance programs for public and commercial buildings.

The management planner training course shall adequately address the following topics:

(a) *Course overview.* The role and responsibilities of the management planner; operations and maintenance programs; setting work priorities; protection of building occupants.

(b) *Evaluation/interpretation of survey results.* Review of TSCA Title II requirements for inspection and management plans for school buildings as given in section 203(i)(1) of TSCA Title II; interpretation of field data and laboratory results; comparison of field inspector's data sheet with laboratory results and site survey.

(c) *Hazard assessment.* Amplification of the difference between physical assessment and hazard assessment; the role of the management planner in hazard assessment; explanation of significant damage, damage, potential damage, and potential significant damage; use of a description (or decision tree) code for assessment of ACM; assessment of friable ACM; relationship of accessibility, vibration sources, use of adjoining space, and air plenums and other factors to hazard assessment.

(d) *Legal implications.* Liability; insurance issues specific to planners; liabilities associated with interim control measures, in-house maintenance, repair, and removal; use of results from previously performed inspections.

(e) *Evaluation and selection of control options.* Overview of encapsulation, enclosure, interim operations and maintenance, and removal; advantages and disadvantages of each method; response actions described via a decision tree or other appropriate method; work practices for each response action; staging and prioritizing of work in both vacant and occupied buildings; the need for containment barriers and decontamination in response actions.

(f) *Role of other professionals.* Use of industrial hygienists, engineers, and architects in developing technical specifications for response actions; any requirements that may exist for architect sign-off of plans; team approach to design of high-quality job specifications.

(g) *Developing an operations and maintenance (O&M) plan.* Purpose of the plan; discussion of applicable EPA guidance documents; what actions should be taken by custodial staff; proper cleaning procedures; steam cleaning and HEPA vacuuming; reducing disturbance of ACM; scheduling O&M for off-hours; rescheduling or canceling renovation in areas with ACM; boiler room maintenance; disposal of ACM; in-house procedures for ACM—bridging and penetrating encapsulants; pipe fittings; metal sleeves; polyvinyl chloride (PVC), canvas, and wet wraps; muslin with straps, fiber mesh cloth; mineral wool, and insulating cement; discussion of employee protection programs and staff training; case study in developing an O&M plan (development, implementation process, and problems that have been experienced).

(h) *Regulatory review.* Focusing on the OSHA Asbestos Construction Standard found at 29 CFR 1926.58; the National Emission Standard for Hazardous Air Pollutants (NESHAP) found at 40 CFR part 61, Subparts A (General Provisions) and M (National Emission Standard for Asbestos); EPA Worker Protection Rule found at 40 CFR part 763, Subpart G; TSCA Title II; applicable State regulations.

(i) *Recordkeeping for the management planner.* Use of field inspector's data sheet along with laboratory results; on-going recordkeeping as a means to track asbestos disturbance; procedures for recordkeeping. EPA recommends that States require the use of standardized forms for purposes of management plans and incorporate the use of such forms into the initial training course for management planners.

(j) *Assembling and submitting the management plan.* Plan requirements for schools in TSCA Title II section 203(i)(1); the management plan as a planning tool.

(k) *Financing abatement actions.* Economic analysis and cost estimates; development of cost estimates; present costs of abatement versus future operation and maintenance costs; Asbestos School Hazard Abatement Act grants and loans.

(l) *Course review.* A review of key aspects of the training course.

5. PROJECT DESIGNER

A person must be accredited as a project designer to design any of the following activities with respect to friable ACBM in a school or public and commercial building: (1) A response action other than a SSSD maintenance activity, (2) a maintenance activity that disturbs friable ACBM other than a SSSD maintenance activity, or (3) a response action for a major fiber release episode. All persons seeking accreditation as a project designer shall complete at least a minimum

3–day training course as outlined below. The project designer course shall include lectures, demonstrations, a field trip, course review and a written examination.

EPA recommends the use of audiovisual materials to complement lectures, where appropriate.

The abatement project designer training course shall adequately address the following topics:

(a) *Background information on asbestos.* Identification of asbestos; examples and discussion of the uses and locations of asbestos in buildings; physical appearance of asbestos.

(b) *Potential health effects related to asbestos exposure.* Nature of asbestos-related diseases; routes of exposure; dose-response relationships and the lack of a safe exposure level; the synergistic effect between cigarette smoking and asbestos exposure; the latency period of asbestos-related diseases; a discussion of the relationship between asbestos exposure and asbestosis, lung cancer, mesothelioma, and cancers of other organs.

(c) *Overview of abatement construction projects.* Abatement as a portion of a renovation project; OSHA requirements for notification of other contractors on a multi-employer site (29 CFR 1926.58).

(d) *Safety system design specifications.* Design, construction, and maintenance of containment barriers and decontamination enclosure systems; positioning of warning signs; electrical and ventilation system lock-out; proper working techniques for minimizing fiber release; entry and exit procedures for the work area; use of wet methods; proper techniques for initial cleaning; use of negative-pressure exhaust ventilation equipment; use of HEPA vacuums; proper clean-up and disposal of asbestos; work practices as they apply to encapsulation, enclosure, and repair; use of glove bags and a demonstration of glove bag use.

(e) *Field trip.* A visit to an abatement site or other suitable building site, including on-site discussions of abatement design and building walk-through inspection. Include discussion of rationale for the concept of functional spaces during the walk-through.

(f) *Employee personal protective equipment.* Classes and characteristics of respirator types; limitations of respirators; proper selection, inspection; donning, use, maintenance, and storage procedures for respirators; methods for field testing of the facepiece-to-face seal (positive and negative-pressure fit checks); qualitative and quantitative fit testing procedures; variability between field and laboratory protection factors that alter respiratory fit (e.g., facial hair); the components of a proper respiratory protection program; selection and use of personal protective clothing; use, storage, and handling of non-disposable clothing.

(g) *Additional safety hazards.* Hazards encountered during abatement activities and how to deal with them, including electrical hazards, heat stress, air contaminants other than asbestos, fire, and explosion hazards.

(h) *Fiber aerodynamics and control.* Aerodynamic characteristics of asbestos fibers; importance of proper containment barriers; settling time for asbestos fibers; wet methods in abatement; aggressive air monitoring following abatement; aggressive air movement and negative-pressure exhaust ventilation as a clean-up method.

(i) *Designing abatement solutions.* Discussions of removal, enclosure, and encapsulation methods; asbestos waste disposal.

(j) *Final clearance process.* Discussion of the need for a written sampling rationale for aggressive final air clearance; requirements of a complete visual inspection; and the relationship of the visual inspection to final air clearance.

EPA recommends the use of TEM for analysis of final air clearance samples. These samples should be analyzed by laboratories accredited under the NIST NVLAP.

(k) *Budgeting/cost estimating.* Development of cost estimates; present costs of abatement versus future operation and maintenance costs; setting priorities for abatement jobs to reduce costs.

(l) *Writing abatement specifications.* Preparation of and need for a written project design; means and methods specifications versus performance specifications; design of abatement in occupied buildings; modification of guide specifications for a particular building; worker and building occupant health/medical considerations; replacement of ACM with non-asbestos substitutes.

(m) *Preparing abatement drawings.* Significance and need for drawings, use of as-built drawings as base drawings; use of inspection photographs and on-site reports; methods of preparing abatement drawings; diagramming containment barriers; relationship of drawings to design specifications; particular problems related to abatement drawings.

(n) *Contract preparation and administration.*

(o) *Legal/liabilities/defenses.* Insurance considerations; bonding; hold-harmless clauses; use of abatement contractor's liability insurance; claims made versus occurrence policies.

(p) *Replacement.* Replacement of asbestos with asbestos-free substitutes.

(q) *Role of other consultants.* Development of technical specification sections by industrial hygienists or engineers; the multi-disciplinary team approach to abatement design.

(r) *Occupied buildings.* Special design procedures required in occupied buildings; education of occupants; extra monitoring recommendations; staging of work to minimize occupant exposure; scheduling of renovation to minimize exposure.

(s) *Relevant Federal, State, and local regulatory requirements, procedures and standards, including, but not limited to:*

(i) Requirements of TSCA Title II.

(ii) National Emission Standards for Hazardous Air Pollutants, (40 CFR part 61) subparts A (General Provisions) and M (National Emission Standard for Asbestos).

(iii) OSHA Respirator Standard found at 29 CFR 1910.134.

(iv) EPA Worker Protection Rule found at 40 CFR part 763, subpart G.

(v) OSHA Asbestos Construction Standard found at 29 CFR 1926.58.

(vi) OSHA Hazard Communication Standard found at 29 CFR 1926.59.

(t) *Course review.* A review of key aspects of the training course.

6. PROJECT MONITOR

EPA recommends that States adopt training and accreditation requirements for persons seeking to perform work as project monitors. Project monitors observe abatement activities performed by contractors and generally serve as a building owner's representative to ensure that abatement work is completed according to specification and in compliance with all relevant statutes and regulations. They may also perform the vital role of air monitoring for purposes of determining final clearance. EPA recommends that a State seeking to accredit individuals as project monitors consider adopting a minimum 5–day training course covering the topics outlined below. The course outlined below consists of lectures and demonstrations, at least 6 hours of hands-on training, course review, and a written examination. The hands-on training component might be satisfied by having the student simulate participation in or performance of any of the relevant job functions or activities (or by incorporation of the workshop component described in item ''n'' below of this unit).

EPA recommends that the project monitor training course adequately address the following topics:

(a) *Roles and responsibilities of the project monitor.* Definition and responsibilities of the project monitor, including regulatory/specification compliance monitoring, air monitoring, conducting visual inspections, and final clearance monitoring.

(b) *Characteristics of asbestos and asbestos-containing materials.* Typical uses of asbestos; physical appearance of asbestos; review of asbestos abatement and control techniques; presentation of the health effects of asbestos exposure, including routes of exposure, dose-response relationships, and latency periods for asbestos-related diseases.

(c) *Federal asbestos regulations.* Overview of pertinent EPA regulations, including: NESHAP, 40 CFR part 61, subparts A and M; AHERA, 40 CFR part 763, subpart E; and the EPA Worker Protection Rule, 40 CFR part 763, subpart G. Overview of pertinent OSHA regulations, including: Construction Industry Standard for Asbestos, 29 CFR 1926.58; Respirator Standard, 29 CFR 1910.134; and the Hazard Communication Standard, 29 CFR 1926.59. Applicable State and local asbestos regulations; regulatory interrelationships.

(d) *Understanding building construction and building systems.* Building construction basics, building physical plan layout; understanding building systems (HVAC, electrical, etc.); layout and organization, where asbestos is likely to be found on building systems; renovations and the effect of asbestos abatement on building systems.

(e) *Asbestos abatement contracts, specifications, and drawings.* Basic provisions of the contract; relationships between principle parties, establishing chain of command; types of specifications, including means and methods, performance, and proprietary and nonproprietary; reading and interpreting records and abatement drawings; discussion of change orders; common enforcement responsibilities and authority of project monitor.

(f) *Response actions and abatement practices.* Pre-work inspections; pre-work considerations, precleaning of the work area, removal of furniture, fixtures, and equipment; shutdown/modification of building systems; construction and maintenance of containment barriers, proper demarcation of work areas; work area entry/exit, hygiene practices; determining the effectiveness of air filtration equipment; techniques for minimizing fiber release, wet methods, continuous cleaning; abatement methods other than removal; abatement area clean-up procedures; waste transport and disposal procedures; contingency planning for emergency response.

(g) *Asbestos abatement equipment.* Typical equipment found on an abatement project; air filtration devices, vacuum systems, negative pressure differential monitoring; HEPA filtration units, theory of filtration, design/construction of HEPA filtration units, qualitative and quantitative performance of HEPA filtration units, sizing the ventilation requirements, location of HEPA filtration units, qualitative and quantitative tests of containment barrier integrity; best available technology.

(h) *Personal protective equipment.* Proper selection of respiratory protection; classes and characteristics of respirator types, limitations of respirators; proper use of other safety equipment, protective clothing selection, use, and proper handling, hard/bump hats, safety shoes; breathing air systems, high pressure v. low pressure, testing for Grade D air, determining proper backup air volumes.

(i) *Air monitoring strategies.* Sampling equipment, sampling pumps (low v. high volume), flow regulating devices (critical and limiting orifices), use of fibrous aerosol monitors on abatement projects; sampling media, types of filters, types of cassettes, filter orientation, storage and shipment of filters; calibration techniques, primary calibration standards, secondary calibration standards, temperature/pressure effects, frequency of calibration, recordkeeping and field work documentation, calculations; air sample analysis, techniques available and limitations of AHERA on their use, transmission electron microscopy (background to sample preparation and analysis, air sample conditions which prohibit analysis, EPA's recommended technique for analysis of final air clearance samples), phase contrast microscopy (background to sample preparation, and AHERA's limits on the use of phase contrast microscopy), what each technique measures; analytical methodologies, AHERA TEM protocol, NIOSH 7400, OSHA reference method (non clearance), EPA recommendation for clearance (TEM); sampling strategies for clearance monitoring, types of air samples (personal breathing zone v. fixed-station area) sampling location and objectives (pre-abatement, during abatement, and clearance monitoring), number of samples to be collected, minimum and maximum air volumes, clearance monitoring (post-visual-inspection) (number of samples required, selection of sampling locations, period of sampling, aggressive sampling, interpretations of sampling results, calculations), quality assurance; special sampling problems, crawl spaces, acceptable samples for laboratory analysis, sampling in occupied buildings (barrier monitoring).

(j) *Safety and health issues other than asbestos.* Confined-space entry, electrical hazards, fire and explosion concerns, ladders and scaffolding, heat stress, air contaminants other than asbestos, fall hazards, hazardous materials on abatement projects.

(k) *Conducting visual inspections.* Inspections during abatement, visual inspections using the ASTM E1368 document; conducting inspections for completeness of removal; discussion of "how clean is clean?"

(l) *Legal responsibilities and liabilities of project monitors.* Specification enforcement capabilities; regulatory enforcement; licensing; powers delegated to project monitors through contract documents.

(m) *Recordkeeping and report writing.* Developing project logs/daily logs (what should be included, who sees them); final report preparation; recordkeeping under Federal regulations.

(n) *Workshops (6 hours spread over 3 days).* Contracts, specifications, and drawings: This workshop could consist of each participant being issued a set of contracts, specifications, and drawings and then being asked to answer questions and make recommendations to a project architect, engineer or to the building owner based on given conditions and these documents.

Air monitoring strategies/asbestos abatement equipment: This workshop could consist of simulated abatement sites for which sampling strategies would have to be developed (i.e., occupied buildings, industrial situations). Through demonstrations and exhibition, the project monitor may also be able to gain a better understanding of the function of various pieces of equipment used on abatement projects (air filtration units, water filtration units, negative pressure monitoring devices, sampling pump calibration devices, etc.).

Conducting visual inspections: This workshop could consist, ideally, of an interactive video in which a participant is "taken through" a work area and asked to make notes of what is seen. A series of questions will be asked which are designed to stimulate a person's recall of the area. This workshop could consist of a series of two or three videos with different site conditions and different degrees of cleanliness.

C. Examinations

1. Each State shall administer a closed book examination or designate other entities such as State-approved providers of training courses to administer the closed-book examination to persons seeking accreditation who have completed an initial training course. Demonstration testing may also be included as part of the examination. A person seeking initial accreditation in a specific discipline must pass the examination for that discipline in order to receive accreditation. For example, a person seeking accreditation as an abatement project designer must pass the State's examination for abatement project designer.

States may develop their own examinations, have providers of training courses develop examinations, or use standardized examinations developed for purposes of accreditation under TSCA Title II. In addition, States may supplement standardized examinations with questions about State regulations. States may obtain commercially developed standardized examinations, develop standardized examinations independently, or do so in cooperation with other States, or with commercial or non-profit providers on a regional or national basis. EPA recommends the use of standardized, scientifically-validated testing instruments, which may be beneficial in terms of both promoting competency and in fostering accreditation reciprocity between States.

Each examination shall adequately cover the topics included in the training course for that discipline. Each person who completes a training course, passes the required examination, and fulfills whatever other requirements the State imposes must receive an accreditation certificate in a specific discipline. Whether a State directly issues accreditation certificates, or authorizes training providers to issue accreditation certificates, each certificate issued to an accredited person must contain the following minimum information:

a. A unique certificate number

b. Name of accredited person

c. Discipline of the training course completed.

d. Dates of the training course.

e. Date of the examination.

f. An expiration date of 1 year after the date upon which the person successfully completed the course and examination.

g. The name, address, and telephone number of the training provider that issued the certificate.

h. A statement that the person receiving the certificate has completed the requisite training for asbestos accreditation under TSCA Title II.

States or training providers who reaccredit persons based upon completion of required refresher training must also provide accreditation certificates with all of the above information, except the examination date may be omitted if a State does not require a refresher examination for reaccreditation.

Where a State licenses accredited persons but has authorized training providers to issue accreditation certificates, the State may issue licenses in the form of photo-identification cards. Where this applies, EPA recommends that the State licenses should include all of the same information required for the accreditation certificates. A State may also choose to issue photo-identification cards in addition to the required accreditation certificates.

Accredited persons must have their initial and current accreditation certificates at the location where they are conducting work.

2. The following are the requirements for examination in each discipline:

a. Worker:

i. 50 multiple-choice questions

ii. Passing score: 70 percent correct

b. Contractor/Supervisor:

i. 100 multiple-choice questions

ii. Passing score: 70 percent correct

c. Inspector:

i. 50 Multiple-choice questions

ii. Passing score: 70 percent correct

d. Management Planner:

i. 50 Multiple-choice questions

ii. Passing score: 70 percent correct

e. Project Designer:

i. 100 multiple-choice questions

ii. Passing score: 70 percent correct

D. Continuing Education

For all disciplines, a State's accreditation program shall include annual refresher training as a requirement for reaccreditation as indicated below:

1. Workers: One full day of refresher training.

2. Contractor/Supervisors: One full day of refresher training.

3. Inspectors: One half-day of refresher training.

4. Management Planners: One half-day of inspector refresher training and one half-day of refresher training for management planners.

5. Project Designers: One full day of refresher training.

The refresher courses shall be specific to each discipline. Refresher courses shall be conducted as separate and distinct courses and not combined with any other training during the period of the refresher course. For each discipline, the refresher course shall review and discuss changes in Federal, State, and local regulations, developments in state-of-the-art procedures, and a review of key aspects of the initial training course as determined by the State. After completing the annual refresher course, persons shall have their accreditation extended for an additional year from the date of the refresher course. A State may consider requiring persons to pass reaccreditation examinations at specific intervals (for example, every 3 years).

EPA recommends that States formally establish a 12-month grace period to enable formerly accredited persons with expired certificates to complete refresher training and have their accreditation status reinstated without having to re-take the initial training course.

E. Qualifications

In addition to requiring training and an examination, a State may require candidates for accreditation to meet other qualification and/or experience standards that the State considers appropriate for some or all disciplines. States may choose to consider requiring qualifications similar to the examples outlined below for inspectors, management planners and project designers. States may modify these examples as appropriate. In addition, States may want to include some requirements based on experience in performing a task directly as a part of a job or in an apprenticeship role. They may also wish to consider additional criteria for the approval of training course instructors beyond those prescribed by EPA.

1. Inspectors: Qualifications - possess a high school diploma. States may want to require an Associate's Degree in specific fields (e.g., environmental or physical sciences).

2. Management Planners: Qualifications - Registered architect, engineer, or certified industrial hygienist or related scientific field.

3. Project Designers: Qualifications - registered architect, engineer, or certified industrial hygienist.

4. Asbestos Training Course Instructor: Qualifications - academic credentials and/or field experience in asbestos abatement.

EPA recommends that States prescribe minimum qualification standards for training instructors employed by training providers.

F. Recordkeeping Requirements for Training Providers

All approved providers of accredited asbestos training courses must comply with the following minimum recordkeeping requirements.

1. Training course materials. A training provider must retain copies of all instructional materials used in the delivery of the classroom training such as student manuals, instructor notebooks and handouts.

2. Instructor qualifications. A training provider must retain copies of all instructors' resumes, and the documents approving each instructor issued by either EPA or a State. Instructors must be approved by either EPA or a State before teaching courses for accreditation purposes. A training provider must notify EPA or the State, as appropriate, in advance whenever it changes course instructors. Records must accurately identify the instructors that taught each particular course for each date that a course is offered.

3. Examinations. A training provider must document that each person who receives an accreditation certificate for an initial training course has achieved a passing score on the examination. These records must clearly indicate the date upon which the exam was administered, the training course and discipline for which the exam was given, the name of the person who proctored the exam, a copy of the exam, and the name and test score of each person taking the exam. The topic and dates of the training course must correspond to those listed on that person's accreditation certificate. States may choose to apply these same requirements to examinations for refresher training courses.

4. Accreditation certificates. The training providers or States, whichever issues the accreditation certificate, shall maintain records that document the names of all persons who have been awarded certificates, their certificate numbers, the disciplines for which accreditation was conferred, training and expiration dates, and the training location. The training provider or State shall maintain the records in a manner that allows verification by telephone of the required information.

5. Verification of certificate information. EPA recommends that training providers of refresher training courses confirm that their students possess valid accreditation before granting course admission. EPA further recommends that training providers offering the initial management planner training course verify that students have met the prerequisite of possessing valid inspector accreditation at the time of course admission.

6. Records retention and access. (a) The training provider shall maintain all required records for a minimum of 3 years. The training provider, however, may find it advantageous to retain these records for a longer period of time.

(b) The training provider must allow reasonable access to all of the records required by the MAP, and to any other records which may be required by States for the approval of asbestos training providers or the accreditation of asbestos training courses, to both EPA and to State Agencies, on request. EPA encourages training providers to make this information equally accessible to the general public.

(c) If a training provider ceases to conduct training, the training provider shall notify the approving government body (EPA or the State) and give it the opportunity to take possession of that providers asbestos training records.

G. Deaccreditation

1. States must establish criteria and procedures for deaccrediting persons accredited as workers, contractor/supervisors, inspectors, management planners, and project designers. States must follow their own administrative procedures in pursuing deaccreditation actions. At a minimum, the criteria shall include:

(a) Performing work requiring accreditation at a job site without being in physical possession of initial and current accreditation certificates;

(b) Permitting the duplication or use of one's own accreditation certificate by another;

(c) Performing work for which accreditation has not been received; or

(d) Obtaining accreditation from a training provider that does not have approval to offer training for the particular discipline from either EPA or from a State that has a contractor accreditation plan at least as stringent as the EPA MAP.

EPA may directly pursue deaccreditation actions without reliance on State deaccreditation or enforcement authority or actions. In addition to the above-listed situations, the Administrator may suspend or revoke the accreditation of persons who have been subject to a final order imposing a civil penalty or convicted under section 16 of TSCA, 15 U.S.C. 2615 or 2647, for violations of 40 CFR part 763, or section 113 of the Clean

Air Act, 42 U.S.C. 7413, for violations of 40 CFR part 61, subpart M.

2. Any person who performs asbestos work requiring accreditation under section 206(a) of TSCA, 15 U.S.C. 2646(a), without such accreditation is in violation of TSCA. The following persons are not accredited for purposes of section 206(a) of TSCA:

(a) Any person who obtains accreditation through fraudulent representation of training or examination documents;

(b) Any person who obtains training documentation through fraudulent means;

(c) Any person who gains admission to and completes refresher training through fraudulent representation of initial or previous refresher training documentation; or

(d) Any person who obtains accreditation through fraudulent representation of accreditation requirements such as education, training, professional registration, or experience.

H. Reciprocity

EPA recommends that each State establish reciprocal arrangements with other States that have established accreditation programs that meet or exceed the requirements of the MAP. Such arrangements might address cooperation in licensing determinations, the review and approval of training programs and/or instructors, candidate testing and exam administration, curriculum development, policy formulation, compliance monitoring, and the exchange of information and data. The benefits to be derived from these arrangements include a potential cost-savings from the reduction of duplicative activity and the attainment of a more professional accredited workforce as States are able to refine and improve the effectiveness of their programs based upon the experience and methods of other States.

I. Electronic Reporting

States that choose to receive electronic documents must include, at a minimum, the requirements of 40 CFR Part 3—(Electronic reporting) in their programs.

II. EPA Approval Process for State Accreditation Programs

A. States may seek approval for a single discipline or all disciplines as specified in the MAP. For example, a State that currently only requires worker accreditation may receive EPA approval for that discipline alone. EPA encourages States that currently do not have accreditation requirements for all disciplines required under section 206(b)(2) of TSCA, 15 U.S.C. 2646(b)(2), to seek EPA approval for those disciplines the State does accredit. As States establish accreditation requirements for the remaining disciplines, the requested information outlined below should be submitted to EPA as soon as possible. Any State that had an accreditation program approved by EPA under an earlier version of the MAP may follow the same procedures to obtain EPA approval of their accreditation program under this MAP.

B. Partial approval of a State Program for the accreditation of one or more disciplines does not mean that the State is in full compliance with TSCA where the deadline for that State to have adopted a State Plan no less stringent than the MAP has already passed. State Programs which are at least as stringent as the MAP for one or more of the accredited disciplines may, however, accredit persons in those disciplines only.

C. States seeking EPA approval or reapproval of accreditation programs shall submit the following information to the Regional Asbestos Coordinator at their EPA Regional office:

1. A copy of the legislation establishing or upgrading the State's accreditation program (if applicable).

2. A copy of the State's accreditation regulations or revised regulations.

3. A letter to the Regional Asbestos Coordinator that clearly indicates how the State meets the program requirements of this MAP. Addresses for each of the Regional Asbestos Coordinators are shown below:

EPA, Region I, (ATC-111) Asbestos Coordinator, JFK Federal Bldg., Boston, MA 02203-2211, (617) 565-3836.

EPA, Region II, (MS-500), Asbestos Coordinator, 2890 Woodbridge Ave., Edison, NJ 08837-3679, (908) 321-6671.

EPA, Region III, (3AT-33), Asbestos Coordinator, 841 Chestnut Bldg., Philadelphia, PA 19107, (215) 597-3160.

EPA, Region IV, Asbestos Coordinator, 345 Courtland St., N.E., Atlanta, GA 30365, (404) 347-5014.

EPA, Region V, (SP-14J), Asbestos Coordinator, 77 W. Jackson Blvd., Chicago, IL 60604-3590, (312) 886-6003.

EPA, Region VI, (6T-PT), Asbestos Coordinator, 1445 Ross Ave. Dallas, TX 75202-2744, (214) 655-7244.

EPA, Region VII, (ARTX/ASBS), Asbestos Coordinator, 726 Minnesota Ave., Kansas City, KS 66101, (913) 551-7020.

EPA, Region VIII, (8AT-TS), Asbestos Coordinator, 1 Denver Place, Suite 500 999 - 18th St., Denver, CO 80202-2405, (303) 293-1442.

EPA, Region IX, (A-4-4), Asbestos Coordinator, 75 Hawthorne St., San Francisco, CA 94105, (415) 744-1128.

EPA, Region X, (AT-083), Asbestos Coordinator, 1200 Sixth Ave., Seattle, WA 98101, (206) 553-4762.

EPA maintains a listing of all those States that have applied for and received EPA approval for having accreditation requirements that are at least as stringent as the MAP for one or more disciplines. Any training courses approved by an EPA-approved State Program are considered to be EPA-approved for purposes of accreditation.

III. Approval of Training Courses

Individuals or groups wishing to sponsor training courses for disciplines required to be accredited under section 206(b)(1)(A) of TSCA, 15 U.S.C. 2646(b)(1)(A), may apply for approval from States that have accreditation program requirements that are at least as stringent as this MAP. For a course to receive approval, it must meet the requirements for the course as outlined in this MAP, and any other requirements imposed by the State from which approval is being sought. Courses that have been approved by a State with an accreditation program at least as stringent as this MAP are approved under section 206(a) of TSCA, 15 U.S.C. 2646(a), for that particular State, and also for any other State that does not have an accreditation program as stringent as this MAP.

A. Initial Training Course Approval

A training provider must submit the following minimum information to a State as part of its application for the approval of each training course:

1. The course provider's name, address, and telephone number.
2. A list of any other States that currently approve the training course.
3. The course curriculum.
4. A letter from the provider of the training course that clearly indicates how the course meets the MAP requirements for:
   a. Length of training in days.
   b. Amount and type of hands-on training.
   c. Examination (length, format, and passing score).
   d. Topics covered in the course.
5. A copy of all course materials (student manuals, instructor notebooks, handouts, etc.).
6. A detailed statement about the development of the examination used in the course.
7. Names and qualifications of all course instructors. Instructors must have academic and/or field experience in asbestos abatement.
8. A description of and an example of the numbered certificates issued to students who attend the course and pass the examination.

B. Refresher Training Course Approval

The following minimum information is required for approval of refresher training courses by States:

1. The length of training in half-days or days.
2. The topics covered in the course.
3. A copy of all course materials (student manuals, instructor notebooks, handouts, etc.).
4. The names and qualifications of all course instructors. Instructors must have academic and/or field experience in asbestos abatement.
5. A description of and an example of the numbered certificates issued to students who complete the refresher course and pass the examination, if required.

C. Withdrawal of Training Course Approval

States must establish criteria and procedures for suspending or withdrawing approval from accredited training programs. States should follow their own administrative procedures in pursuing actions for suspension or withdrawal of approval of training programs. At a minimum, the criteria shall include:

(1) Misrepresentation of the extent of a training course's approval by a State or EPA;

(2) Failure to submit required information or notifications in a timely manner;

(3) Failure to maintain requisite records;

(4) Falsification of accreditation records, instructor qualifications, or other accreditation information; or

(5) Failure to adhere to the training standards and requirements of the EPA MAP or State Accreditation Program, as appropriate.

In addition to the criteria listed above, EPA may also suspend or withdraw a training course's approval where an approved training course instructor, or other person with supervisory authority over the delivery of training has been found in violation of other asbestos regulations administered by EPA. An administrative or judicial finding of violation, or execution of a consent agreement and order under 40 CFR 22.18, constitutes evidence of a failure to comply with relevant statutes or regulations. States may wish to adopt this criterion modified to include their own asbestos statutes or regulations. EPA may also suspend or withdraw approval of training programs where a training provider has submitted false information as a part of the self-certification required under Unit V.B. of the revised MAP.

Training course providers shall permit representatives of EPA or the State which approved their training courses to attend, evaluate, and monitor any training course without charge. EPA or State compliance inspection staff are not required to give advance notice of their inspections. EPA may suspend or withdraw State or EPA approval of a training course based upon the criteria specified in this Unit III.C.

IV. EPA Procedures for Suspension or Revocation of Accreditation or Training Course Approval.

A. If the Administrator decides to suspend or revoke the accreditation of any person or suspend or withdraw the approval of a training course, the Administrator will notify the affected entity of the following:

1. The grounds upon which the suspension, revocation, or withdrawal is based.

2. The time period during which the suspension, revocation, or withdrawal is effective, whether permanent or otherwise.

3. The conditions, if any, under which the affected entity may receive accreditation or approval in the future.

4. Any additional conditions which the Administrator may impose.

5. The opportunity to request a hearing prior to final Agency action to suspend or revoke accreditation or suspend or withdraw approval.

B. If a hearing is requested by the accredited person or training course provider pursuant to the preceding paragraph, the Administrator will:

1. Notify the affected entity of those assertions of law and fact upon which the action to suspend, revoke, or withdraw is based.

2. Provide the affected entity an opportunity to offer written statements of facts, explanations, comments, and arguments relevant to the proposed action.

3. Provide the affected entity such other procedural opportunities as the Administrator may deem appropriate to ensure a fair and impartial hearing.

4. Appoint an EPA attorney as Presiding Officer to conduct the hearing. No person shall serve as Presiding Officer if he or she has had any prior connection with the specific case.

C. The Presiding Officer appointed pursuant to the preceding paragraph shall:

1. Conduct a fair, orderly, and impartial hearing, without unnecessary delay.

2. Consider all relevant evidence, explanation, comment, and argument submitted pursuant to the preceding paragraph.

3. Promptly notify the affected entity of his or her decision and order. Such an order is a final Agency action.

D. If the Administrator determines that the public health, interest, or welfare warrants immediate action to suspend the accreditation of any person or the approval of any training course provider, the Administrator will:

1. Notify the affected entity of the grounds upon which the emergency suspension is based;

2. Notify the affected entity of the time period during which the emergency suspension is effective.

3. Notify the affected entity of the Administrator's intent to suspend or revoke accreditation or suspend or withdraw training course approval, as appropriate, in accordance with Unit IV.A. above. If such suspension, revocation, or withdrawal notice has not previously been issued, it will be issued at the same time the emergency suspension notice is issued.

E. Any notice, decision, or order issued by the Administrator under this section, and any documents filed by an accredited person or approved training course provider in a hearing under this section, shall be available to the public except as otherwise provided by section 14 of TSCA or by 40 CFR part 2. Any such hearing at which oral testimony is presented shall be open to the public, except that the Presiding Officer may exclude the public to the extent necessary to allow presentation of information which may be entitled to confidential treatment under section 14 of TSCA or 40 CFR part 2.

V. Implementation Schedule

The various requirements of this MAP become effective in accordance with the following schedules:

A. Requirements applicable to State Programs

1. Each State shall adopt an accreditation plan that is at least as stringent as this MAP within 180 days after the commencement of the first regular session of the legislature of the State that is convened on or after April 4, 1994.

2. If a State has adopted an accreditation plan at least as stringent as this MAP as of April 4, 1994, the State may continue to:

a. Conduct TSCA training pursuant to this MAP.

b. Approve training course providers to conduct training and to issue accreditation that satisfies the requirements for TSCA accreditation under this MAP.

c. Issue accreditation that satisfies the requirements for TSCA accreditation under this MAP.

3. A State that had complied with an earlier version of the MAP, but has not adopted an accreditation plan at least as stringent as this MAP by April 4, 1994, may:

a. Conduct TSCA training which remains in compliance with the requirements of Unit V.B. of this MAP. After such training has been self-certified in accordance with Unit V.B. of this MAP, the State may issue accreditation that satisfies the requirement for TSCA accreditation under this MAP.

b. Sustain its approval for any training course providers to conduct training and issue TSCA accreditation that the State had approved before April 4, 1994, and that remain in compliance with Unit V.B. of this MAP.

c. Issue accreditation pursuant to an earlier version of the MAP that provisionally satisfies the requirement for TSCA accreditation until October 4, 1994.

Such a State may not approve new TSCA training course providers to conduct training or to issue TSCA accreditation that satisfies the requirements of this MAP until the State adopts an accreditation plan that is at least as stringent as this MAP.

4. A State that had complied with an earlier version of the MAP, but fails to adopt a plan as stringent as this MAP by the deadline established in Unit V.A.1., is subject to the following after that deadline date:

a. The State loses any status it may have held as an EPA-approved State for accreditation purposes under section 206 of TSCA, 15 U.S.C. 2646.

b. All training course providers approved by the State lose State approval to conduct training and issue accreditation that satisfies the requirements for TSCA accreditation under this MAP.

c. The State may not:

i. Conduct training for accreditation purposes under section 206 of TSCA, 15 U.S.C. 2646.

ii. Approve training course providers to conduct training or issue accreditation that satisfies the requirements for TSCA accreditation; or

iii. Issue accreditation that satisfies the requirement for TSCA accreditation.

EPA will extend EPA-approval to any training course provider that loses State approval because the State does not comply with the deadline, so long as the provider is in compliance with Unit V.B. of this MAP, and the provider is approved by a State that had complied with an earlier version of the MAP as of the day before the State loses its EPA approval.

5. A State that does not have an accreditation program that satisfies the requirements for TSCA accreditation under either an earlier version of the MAP or this MAP, may not:

a. Conduct training for accreditation purposes under section 206 of TSCA, 15 U.S.C. 2646;

b. Approve training course providers to conduct training or issue accreditation that satisfies the requirements for TSCA accreditation; or

c. Issue accreditation that satisfies the requirement for TSCA accreditation.

B. Requirements applicable to Training Courses and Providers

As of October 4, 1994, an approved training provider must certify to EPA and to any State that has approved the provider for TSCA accreditation, that each of the provider's training courses complies with the requirements of this MAP. The written submission must document in specific detail the changes made to each training course in order to comply with the requirements of this MAP and clearly state that the provider is also in compliance with all other requirements of this MAP, including the new recordkeeping and certificate provisions. Each submission must include the following statement signed by an authorized representative of the training provider: ‘‘Under civil and criminal penalties of law for the making or submission of false or fraudulent statements or representations (18 U.S.C. 1001 and 15 U.S.C. 2615), I certify that the training described in this submission complies with all applicable requirements of Title II of TSCA, 40 CFR part 763, Appendix C to Subpart E, as revised, and any other applicable Federal, state, or local requirements.’’ A consolidated self-certification submission from each training provider that addresses all of its approved training courses is permissible and encouraged.

The self-certification must be sent via registered mail, to EPA Headquarters at the following address: Attn. Self-Certification Program, Field Programs Branch, Chemical Management Division (7404), Office of Pollution Prevention and Toxics, Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460. A duplicate copy of the complete submission must also be sent to any States from which approval had been obtained.

The timely receipt of a complete self-certification by EPA and all approving States shall have the effect of extending approval under this MAP to the training courses offered by the submitting provider. If a self-certification is not received by the approving government bodies on or before the due date, the affected training course is not approved under this MAP. Such training providers must then reapply for approval of these training courses pursuant to the procedures outlined in Unit III.

C. Requirements applicable to Accredited Persons.

Persons accredited by a State with an accreditation program no less stringent than an earlier version of the MAP or by an EPA-approved training provider as of April 3, 1994, are accredited in accordance with the requirements of this MAP, and are not required to retake initial training. They must continue to comply with the requirements for annual refresher training in Unit I.D. of the revised MAP.

D. Requirements applicable to Non-Accredited Persons.

In order to perform work requiring accreditation under TSCA Title II, persons who are not accredited by a State with an accreditation program no less stringent than an earlier version of the MAP or by an EPA-approved training provider as of April 3, 1994, must comply with the upgraded training requirements of this MAP by no later than October 4, 1994. Non-accredited persons may obtain initial accreditation on a provisional basis by successfully completing any of the training programs approved under an earlier version of the MAP, and thereby perform work during the first 6 months after this MAP takes effect. However, by October 4, 1994, these persons must have successfully completed an upgraded training program that fully complies with the requirements of this MAP in order to continue to perform work requiring accreditation under section 206 of TSCA, 15 U.S.C. 2646.

[59 FR 5251, Feb. 3, 1994, as amended at 60 FR 31922, June 19, 1995; 70 FR 59889, Oct. 13, 2005]

APPENDIX D TO SUBPART E OF PART 763—TRANSPORT AND DISPOSAL OF ASBESTOS WASTE

For the purposes of this appendix, transport is defined as all activities from receipt of the containerized asbestos waste at the generation site until it has been unloaded at the disposal site. Current EPA regulations state that there must be no visible emissions to the outside air during waste transport. However, recognizing the potential hazards and subsequent liabilities associated with exposure, the following additional precautions are recommended.

Recordkeeping. Before accepting wastes, a transporter should determine if the waste is properly wetted and containerized. The transporter should then require a chain-of-custody form signed by the generator. A chain-of-custody form may include the name and address of the generator, the name and address of the pickup site, the estimated quantity of asbestos waste, types of containers used, and the destination of the waste. The chain-of-custody form should then be signed over to a disposal site operator to transfer responsibility for the asbestos waste. A copy of the form signed by the disposal site operator should be maintained by the transporter as evidence of receipt at the disposal site.

Waste handling. A transporter should ensure that the asbestos waste is properly contained in leak-tight containers with appropriate labels, and that the outside surfaces of the containers are not contaminated with asbestos debris adhering to the containers. If there is reason to believe that the condition of the asbestos waste may allow significant fiber release, the transporter should not accept the waste. Improper containerization of wastes is a violation of the NESHAPs regulation and should be reported to the appropriate EPA Regional Asbestos NESHAPs contact below:

Region I

Asbestos NESHAPs Contact, Air Management Division, USEPA, Region I, JFK Federal Building, Boston, MA 02203, (617) 223–3266.

Region II

Asbestos NESHAPs Contact, Air & Waste Management Division, USEPA, Region II, 26 Federal Plaza, New York, NY 10007, (212) 264–6770.

Region III

Asbestos NESHAPs Contact, Air Management Division, USEPA, Region III, 841 Chestnut Street, Philadelphia, PA 19107, (215) 597–9325.

Region IV

Asbestos NESHAPs Contact, Air, Pesticide & Toxic Management, USEPA, Region IV, 345 Courtland Street, NE., Atlanta, GA 30365, (404) 347–4298.

Region V

Asbestos NESHAPs Contact, Air Management Division, USEPA, Region V, 77 West Jackson Boulevard, Chicago, IL 60604, (312) 353–6793.

Region VI

Asbestos NESHAPs Contact, Air & Waste Management Division, USEPA, Region VI, 1445 Ross Avenue, Dallas, TX 75202, (214) 655–7229.

Region VII

Asbestos NESHAPs Contact, Air & Waste Management Division, USEPA, Region VII, 726 Minnesota Avenue, Kansas City, KS 66101, (913) 236–2896.

Region VIII

Asbestos NESHAPs Contact, Air & Waste Management Division, USEPA, Region VIII, 999 18th Street, Suite 500, Denver, CO 80202, (303) 293–1814.

Region IX

Asbestos NESHAPs Contact, Air Management Division, USEPA, Region IX, 215 Fremont Street, San Francisco, CA 94105, (415) 974–7633.

Region X

Asbestos NESHAPs Contact, Air & Toxics Management Division, USEPA, Region X, 1200 Sixth Avenue, Seattle, WA 98101, (206) 442–2724.

Once the transporter is satisfied with the condition of the asbestos waste and agrees to handle it, the containers should be loaded into the transport vehicle in a careful manner to prevent breaking of the containers. Similarly, at the disposal site, the asbestos waste containers should be transferred carefully to avoid fiber release.

Waste transport. Although there are no regulatory specifications regarding the transport vehicle, it is recommended that vehicles used for transport of containerized asbestos waste have an enclosed carrying compartment or utilize a canvas covering sufficient to contain the transported waste, prevent damage to containers, and prevent fiber release. Transport of large quantities of asbestos waste is commonly conducted in a 20-cubic-yard ''roll off'' box, which should also be covered. Vehicles that use compactors to reduce waste volume should not be used because these will cause the waste containers to rupture. Vacuum trucks used to transport waste slurry must be inspected to ensure that water is not leaking from the truck.

Disposal involves the isolation of asbestos waste material in order to prevent fiber release to air or water. Landfilling is recommended as an environmentally sound isolation method because asbestos fibers are virtually immobile in soil. Other disposal techniques such as incineration or chemical treatment are not feasible due to the unique properties of asbestos. EPA has established asbestos disposal requirements for active and inactive disposal sites under NESHAPs (40 CFR Part 61, subpart M) and specifies general requirements for solid waste disposal under RCRA (40 CFR Part 257). Advance EPA notification of the intended disposal site is required by NESHAPs.

Selecting a disposal facility. An acceptable disposal facility for asbestos wastes must adhere to EPA's requirements of no visible emissions to the air during disposal, or minimizing emissions by covering the waste within 24 hours. The minimum required cover is 6 inches of nonasbestos material, normally soil, or a dust-suppressing chemical. In addition to these Federal requirements, many state or local government agencies require more stringent handling procedures. These agencies usually 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. A list of state solid waste agencies may be obtained by calling the RCRA hotline: 1–800–424–9346 (382–3000 in Washington, DC). Some landfill owners or operators place special requirements on asbestos waste, such as placing all bagged waste into 55-gallon metal drums. Therefore, asbestos removal contractors should contact the intended landfill before arriving with the waste.

Receiving asbestos waste. A landfill approved for receipt of asbestos waste should require notification by the waste hauler that the load contains asbestos. The landfill operator should inspect the loads to verify that asbestos waste is properly contained in leak-tight containers and labeled appropriately. The appropriate EPA Regional Asbestos NESHAPs Contact should be notified if the landfill operator believes that the asbestos waste is in a condition that may cause significant fiber release during disposal. In situations when the wastes are not properly containerized, the landfill operator should thoroughly soak the asbestos with a water spray prior to unloading, rinse out the truck, and immediately cover the wastes with non-asbestos material prior to compacting the waste in the landfill.

Waste deposition and covering. Recognizing the health dangers associated with asbestos exposure, the following procedures are recommended to augment current federal requirements:

- Designate a separate area for asbestos waste disposal. Provide a record for future landowners that asbestos waste has been buried there and that it would be hazardous to attempt to excavate that area. (Future regulations may require property deeds to identify the location of any asbestos wastes and warn against excavation.)
- Prepare a separate trench to receive asbestos wastes. The size of the trench will depend upon the quantity and frequency of asbestos waste delivered to the disposal site. The trenching technique allows application of soil cover without disturbing the asbestos waste containers. The trench should be ramped to allow the transport vehicle to back into it, and the trench should be as narrow as possible to reduce the amount of cover required. If possible, the trench should be aligned perpendicular to prevailing winds.
- Place the asbestos waste containers into the trench carefully to avoid breaking them. Be particularly careful with plastic bags because when they break under pressure asbestos particles can be emitted.
- Completely cover the containerized waste within 24 hours with a minimum of 6 inches of nonasbestos material. Improperly containerized waste is a violation of the NESHAPs and EPA should be notified.

However, if improperly containerized waste is received at the disposal site, it should be covered immediately after unloading. Only after the wastes, including properly containerized wastes, are completely covered, can the wastes be compacted or other heavy equipment run over it. During compacting, avoid exposing wastes to the air or tracking asbestos material away from the trench.

- For final closure of an area containing asbestos waste, cover with at least an additional 30 inches of compacted nonasbestos material to provide a 36-inch final cover. To control erosion of the final cover, it should be properly graded and vegetated. In areas of the United States where excessive soil erosion may occur or the frost line exceeds 3 feet, additional final cover is recommended. In desert areas where vegetation would be difficult to maintain, 3–6 inches of well graded crushed rock is recommended for placement on top of the final cover.

Controlling public access. Under the current NESHAPs regulation, EPA does not require that a landfill used for asbestos disposal use warning signs or fencing if it meets the requirement to cover asbestos wastes. However, under RCRA, EPA requires that access be controlled to prevent exposure of the public to potential health and safety hazards at the disposal site. Therefore, for liability protection of operators of landfills that handle asbestos, fencing and warning signs are recommended to control public access when natural barriers do not exist. Access to a landfill should be limited to one or two entrances with gates that can be locked when left unattended. Fencing should be installed around the perimeter of the disposal site in a manner adequate to deter access by the general public. Chain-link fencing, 6-ft high and topped with a barbed wire guard, should be used. More specific fencing requirements may be specified by local regulations. Warning signs should be displayed at all entrances and at intervals of 330 feet or less along the property line of the landfill or perimeter of the sections where asbestos waste is deposited. The sign should read as follows:

ASBESTOS WASTE DISPOSAL SITE
BREATHING ASBESTOS DUST MAY CAUSE LUNG DISEASE AND CANCER

Recordkeeping. For protection from liability, and considering possible future requirements for notification on disposal site deeds, a landfill owner should maintain documentation of the specific location and quantity of the buried asbestos wastes. In addition, the estimated depth of the waste below the surface should be recorded whenever a landfill section is closed. As mentioned previously, such information should be recorded in the land deed or other record along with a notice warning against excavation of the area.

[52 FR 41897, Oct. 30, 1987, as amended at 62 FR 1834, Jan. 14, 1997]

APPENDIX E TO SUBPART E OF PART 763—INTERIM METHOD OF THE DETERMINATION OF ASBESTOS IN BULK INSULATION SAMPLES

SECTION 1. POLARIZED LIGHT MICROSCOPY

1.1 Principle and Applicability

Bulk samples of building materials taken for asbestos identification are first examined for homogeneity and preliminary fiber identification at low magnification. Positive identification of suspect fibers is made by analysis of subsamples with the polarized light microscope.

The principles of optical mineralogy are well established.[1,2] 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 the determination of refractive indices along specific crystallographic axes. Morphology and color are also observed. A retardation plate is placed in the polarized light path for determination of the sign of elongation using orthoscopic illumination. Orientation of the two filters such that their vibration planes are perpendicular (crossed polars) allows observation of the birefringence and extinction characteristics of anisotropic particles.

Quantitative analysis involves the use of point counting. Point counting is a standard technique in petrography for determining the relative areas occupied by separate minerals in thin sections of rock. Background information on the use of point counting[2] and the interpretation of point count data[3] is available.

This method is applicable to all bulk samples of friable insulation materials submitted for identification and quantitation of asbestos components.

1.2 Range

The point counting method may be used for analysis of samples containing from 0 to 100 percent asbestos. The upper detection limit is 100 percent. The lower detection limit is less than 1 percent.

1.3 Interferences

Fibrous organic and inorganic constituents of bulk samples may interfere with the identification and quantitation of the asbestos mineral content. Spray-on binder materials may coat fibers and affect color or obscure optical characteristics to the extent of masking fiber identity. Fine particles of other materials may also adhere to fibers to an extent sufficient to cause confusion in identification. Procedures that may be used for the removal of interferences are presented in Section 1.7.2.2.

1.4 Precision and Accuracy

Adequate data for measuring the accuracy and precision of the method for samples with various matrices are not currently available. Data obtained for samples containing a single asbestos type in a simple matrix are available in the EPA report *Bulk Sample Analysis for Asbestos Content: Evaluation of the Tentative Method.*[4]

1.5 Apparatus

1.5.1 Sample Analysis

A low-power binocular microscope, preferably stereoscopic, is used to examine the bulk insulation sample as received.

- *Microscope:* binocular, 10–45X (approximate).
- *Light Source:* incandescent or fluorescent.
- *Forceps, Dissecting Needles, and Probes*
- *Glassine Paper or Clean Glass Plate*

Compound microscope requirements: A polarized light microscope complete with polarizer, analyzer, port for wave retardation plate, 360° graduated rotating stage, substage condenser, lamp, and lamp iris.

- *Polarized Light Microscope:* described above.
- *Objective Lenses:* 10X, 20X, and 40X or near equivalent.
- *Dispersion Staining Objective Lens* (optional)
- *Ocular Lens:* 10X minimum.
- *Eyepiece Reticle:* cross hair or 25 point Chalkley Point Array.
- *Compensator Plate:* 550 millimicron retardation.

1.5.2 Sample Preparation

Sample preparation apparatus requirements will depend upon the type of insulation sample under consideration. Various physical and/or chemical means may be employed for an adequate sample assessment.

- *Ventilated Hood* or negative pressure glove box.
- *Microscope Slides*
- *Coverslips*
- *Mortar and Pestle:* agate or porcelain. (optional)
- *Wylie Mill* (optional)
- *Beakers and Assorted Glassware* (optional)
- *Certrifuge* (optional)
- *Filtration apparatus* (optional)
- *Low temperature asher* (optional)

1.6 Reagents

1.6.1 Sample Preparation

- *Distilled Water (optional)*
- *Dilute CH_3COOH:* ACS reagent grade (optional)
- *Dilute HCl:* ACS reagent grade (optional)
- *Sodium metaphosphate* $(NaPO_3)_6$ (optional)

1.6.2 Analytical Reagents

Refractive Index Liquids: 1.490–1.570, 1.590–1.720 in increments of 0.002 or 0.004.

- *Refractive Index Liquids for Dispersion Staining:* high-dispersion series, 1.550, 1.605, 1.630 (optional).
- *UICC Asbestos Reference Sample Set:* Available from: UICC MRC Pneumoconiosis Unit, Llandough Hospital, Penarth, Glamorgan CF6 1XW, UK, and commercial distributors.
- *Tremolite-asbestos* (source to be determined)
- *Actinolite-asbestos* (source to be determined)

1.7 Procedures

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

1.7.1 Sampling

Samples for analysis of asbestos content shall be taken in the manner prescribed in Reference 5 and information on design of sampling and analysis programs may be found in Reference 6. If there are any questions about the representative nature of the sample, another sample should be requested before proceeding with the analysis.

1.7.2 Analysis

1.7.2.1 Gross Examination

Bulk samples of building materials taken for the identification and quantitation of asbestos are first examined for homogeneity at low magnification with the aid of a stereomicroscope. The core sample may be examined in its container or carefully removed from the container onto a glassine transfer paper or clean glass plate. If possible, note is made of the top and bottom orientation. When discrete strata are identified, each is treated as a separate material so that fibers are first identified and quantified in that layer only, and then the results for each layer are combined to yield an estimate of asbestos content for the whole sample.

1.7.2.2 Sample Preparation

Bulk materials submitted for asbestos analysis involve a wide variety of matrix materials. Representative subsamples may not be readily obtainable by simple means in heterogeneous materials, and various steps may be required to alleviate the difficulties encountered. In most cases, however, the best preparation is made by using forceps to sample at several places from the bulk material. Forcep samples are immersed in a refractive index liquid on a microscope slide, teased apart, covered with a cover glass, and observed with the polarized light microscope.

Alternatively, attempts may be made to homogenize the sample or eliminate interferences before further characterization. The selection of appropriate procedures is dependent upon the samples encountered and personal preference. The following are presented as possible sample preparation steps.

A mortar and pestle can sometimes be used in the size reduction of soft or loosely bound materials though this may cause matting of some samples. Such samples may be reduced in a Wylie mill. Apparatus should be clean and extreme care exercised to avoid cross-contamination of samples. Periodic checks of the particle sizes should be made during the grinding operation so as to preserve any fiber bundles present in an identifiable form. These procedures are not recommended for samples that contain amphibole minerals or vermiculite. Grinding of amphiboles may result in the separation of fiber bundles or the production of cleavage fragments with aspect ratios greater than 3:1. Grinding of vermiculite may also produce fragments with aspect ratios greater than 3:1.

Acid treatment may occasionally be required to eliminate interferences. Calcium carbonate, gypsum, and bassanite (plaster) are frequently present in sprayed or trowelled insulations. These materials may be removed by treatment with warm dilute acetic acid. Warm dilute hydrochloric acid may also be used to remove the above materials. If acid treatment is required, wash the sample at least twice with distilled water, being careful not to lose the particulates during decanting steps. Centrifugation or filtration of the suspension will prevent significant fiber loss. The pore size of the filter should be 0.45 micron or less. Caution: prolonged acid contact with the sample may alter the optical characteristics of chrysotile fibers and should be avoided.

Coatings and binding materials adhering to fiber surfaces may also be removed by treatment with sodium metaphosphate.[7] Add 10 mL of 10g/L sodium metaphosphate solution to a small (0.1 to 0.5 mL) sample of bulk material in a 15-mL glass centrifuge tube. For approximately 15 seconds each, stir the mixture on a vortex mixer, place in an ultrasonic bath and then shake by hand. Repeat the series. Collect the dispersed solids by centrifugation at 1000 rpm for 5 minutes. Wash the sample three times by suspending in 10 mL distilled water and recentrifuging. After washing, resuspend the pellet in 5 mL distilled water, place a drop of the suspension on a microscope slide, and dry the slide at 110 °C.

In samples with a large portion of cellulosic or other organic fibers, it may be useful to ash part of the sample and view the residue. Ashing should be performed in a low temperature asher. Ashing may also be performed in a muffle furnace at temperatures of 500 °C or lower. Temperatures of 550 °C or higher will cause dehydroxylation of the asbestos minerals, resulting in changes of the refractive index and other key parameters. If a muffle furnace is to be used, the furnace thermostat should be checked and calibrated to ensure that samples will not be heated at temperatures greater than 550 °C.

Ashing and acid treatment of samples should not be used as standard procedures. In order to monitor possible changes in fiber characteristics, the material should be viewed microscopically before and after any sample preparation procedure. Use of these procedures on samples to be used for quantitation requires a correction for percent weight loss.

1.7.2.3 Fiber Identification

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

- Morphology
- Color and pleochroism
- Refractive indices
- Birefringence
- Extinction characteristics
- Sign of elongation

Table 1–1 lists the above properties for commercial asbestos fibers. Figure 1–1 presents a flow diagram of the examination procedure. Natural variations in the conditions under which deposits of asbestiform minerals are formed will occasionally produce exceptions to the published values and differences from the UICC standards. The sign of elongation is determined by use of the compensator plate and crossed polars. Refractive indices may be determined by the Becke line test. Alternatively, dispersion staining may be used. Inexperienced operators may find that the dispersion staining technique is more easily learned, and should consult Reference 9 for guidance. Central stop dispersion staining colors are presented in Table 1–2. Available high-dispersion (HD) liquids should be used.

TABLE 1–1—OPTICAL PROPERTIES OF ASBESTOC FIBERS

Mineral	Morphology, color[a]	Refrac- tive indices[b]		Birefring-ence	Extinction	Sign of elonation
		α	γ			
Chrysotile (asbestiform serpentine).	Wavy fibers. Fiber bundles have splayed ends and ‘‘kinks’’. Aspect ratio typically >10:1. Colorless[3], nonpleochroic.	1.493–1.560	1.517–1.562[f] (normally 1.556).	.008	| to fiber length.	+ (length slow)
Amosite (asbestiform grunerite).	Straight, rigid fibers. Aspect ratio typically >10:1. Colorless to brown, nonpleochroic or weakly so. Opaque inclusions may be present.	1.635–1.696	1.655–1.729[f] (normally 1.696–1.710.	.020–.033	| to fiber length.	+ (length slow)

TABLE 1–1—OPTICAL PROPERTIES OF ASBESTOC FIBERS—Continued

Mineral	Morphology, color[a]	Refrac- tive indices[b]		Birefring- ence	Extinction	Sign of elonation
		α	γ			
Crocidolite (asbestiform Riebeckite).	Straight, rigid fibers. Thick fibers and bundles common, blue to purple-blue in color. Pleochroic. Birefringence is generally masked by blue color.	1.654–1.701	1.668–1.717[3e] (normally close to 1.700).	.014–.016	| to fiber length.	– (length fast)
Anthophyllite-asbestos.	Straight fibers and acicular cleavage fragments.[d] Some composite fibers. Aspect ratio <10:1. Colorless to light brown.	1.596–1.652	1.615–1.676[f].	.019–.024	| to fiber length.	+ (length slow)
Tremolite-actinolite-asbestos.	Normally present as acicular or prismatic cleavage fragments.[d] Single crystals predominate, aspect ratio <10:1. Colorless to pale green.	1.599–1.668	1.622–1.688[f].	.023–.020	Oblique extinction, 10–20° for fragments. Composite fibers show | extinction.	+ (length slow)

---

[a] From reference 5; colors cited are seen by observation with plane polarized light.
[b] From references 5 and 8.
[c] Fibers subjected to heating may be brownish.
[d] Fibers defined as having aspect ratio >3:1.
[e] to fiber length.
[f] |To fiber length.

Polarized light microscopy analysis: For each type of material identified by examination of sample at low magnification. Mount spacially dispersed sample in 1.550 RI liquid. (If using dispersion staining, mount in 1.550 HD.) View at 100X with both plane polarized light and crossed polars. More than one fiber type may be present.

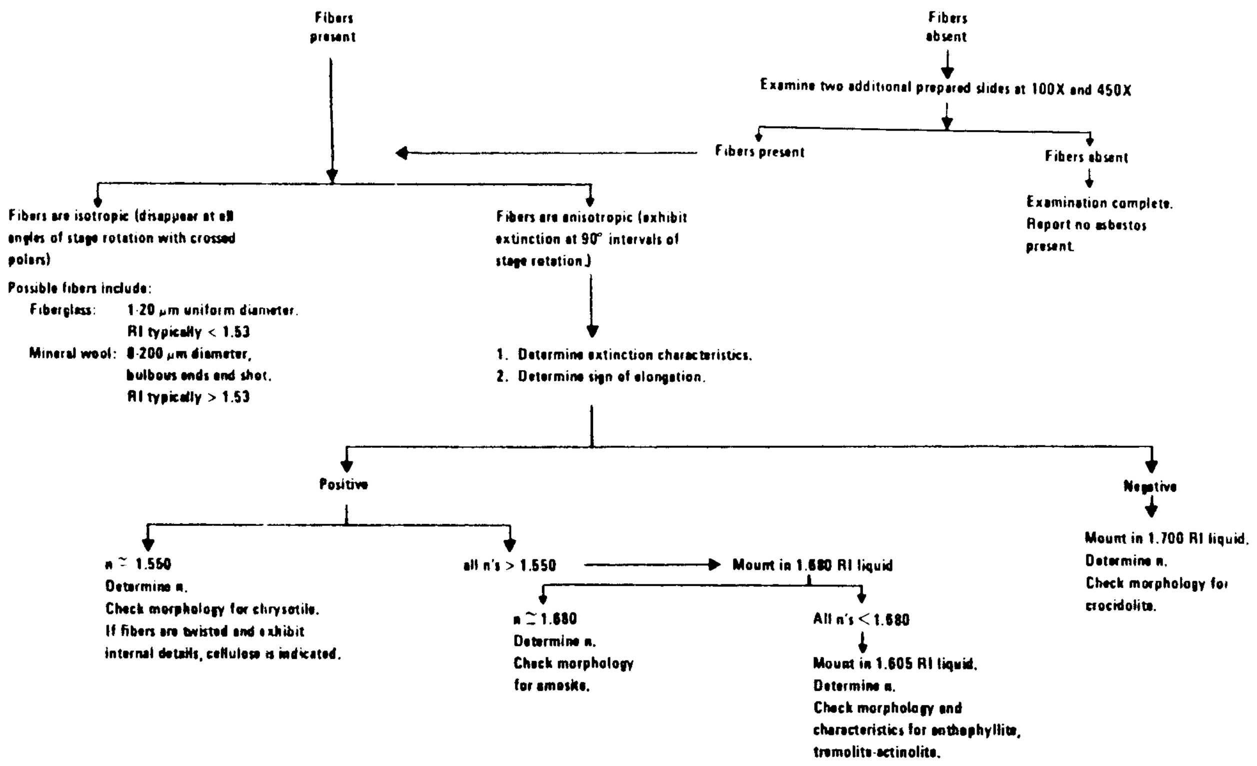


Figure 1-1. Flow chart for analysis of bulk samples by polarized light microscopy.

TABLE 1–2—CENTRAL STOP DISPERSION STAINING COLORS [A]

Mineral	RI Liquid	η	η|
Chrysotile	1.550^{HD}	Blue	Blue-magenta
Amosite	1.680	Blue-magenta to pale blue.	Golden-yellow
	1.550^{HD}	Yellow to white.	Yellow to white
Crocidolite [b] ..	1.700	Red magenta	Blue-magenta
	1.550^{HD}	Yellow to white.	Yellow to white
Anthophyllite	1.605^{HD}	Blue	Gold to gold-magenta
Tremolite	1.605^{HD} [c]	Pale blue	Gold
Actinolite	1.605^{HD}	Gold-magenta to blue.	Gold
	1.630^{HD} [c]	Magenta	Golden-yellow

[a] From reference 9.
[b] Blue absorption color.
[c] Oblique extinction view.

1.7.2.4 Quantitation of Asbestos Content

Asbestos quantitation is performed by a point-counting procedure or an equivalent estimation method. An ocular reticle (cross-hair or point array) is used to visually superimpose a point or points on the microscope field of view. Record the number of points positioned directly above each kind of particle or fiber of interest. Score only points directly over asbestos fibers or nonasbestos matrix material. Do not score empty points for the closest particle. If an asbestos fiber and a matrix particle overlap so that a point is superimposed on their visual intersection, a point is scored for both categories. Point counting provides a determination of the area percent asbestos. Reliable conversion of area percent to percent of dry weight is not currently feasible unless the specific gravities and relative volumes of the materials are known.

For the purpose of this method, ‘‘asbestos fibers’’ are defined as having an aspect ratio greater than 3:1 and being positively identified as one of the minerals in Table 1–1.

A total of 400 points superimposed on either asbestos fibers or nonasbestos matrix material must be counted over at least eight different preparations of representative subsamples. Take eight forcep samples and mount each separately with the appropriate refractive index liquid. The preparation should not be heavily loaded. The sample should be uniformly dispersed to avoid overlapping particles and allow 25–50 percent empty area within the fields of view. Count 50 nonempty points on each preparation, using either

- A cross-hair reticle and mechanical stage; or
- A reticle with 25 points (Chalkley Point Array) and counting at least 2 randomly selected fields.

For samples with mixtures of isotropic and anisotropic materials present, viewing the sample with slightly uncrossed polars or the addition of the compensator plate to the polarized light path will allow simultaneous discrimination of both particle types. Quantitation should be performed at 100X or at the lowest magnification of the polarized light microscope that can effectively distinguish the sample components. Confirmation of the quantitation result by a second analyst on some percentage of analyzed samples should be used as standard quality control procedure.

The percent asbestos is calculated as follows:

% asbestos=(a/n) 100%

where

a=number of asbestos counts,

n=number of nonempty points counted (400).

If a=0, report ‘‘No asbestos detected.’’ If 0< a≤3, report ‘‘<1% asbestos’’.

The value reported should be rounded to the nearest percent.

1.8 References

1. Paul F. Kerr, *Optical Mineralogy,* 4th ed., New York, McGraw-Hill, 1977.

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

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

4. E. P. Brantly, Jr., K. W. Gold, L. E. Myers, and D. E. Lentzen, *Bulk Sample Analysis for Asbestos Content: Evaluation of the Tentative Method,* U.S. Environmental Protection Agency, October 1981.

5. U.S. Environmental Protection Agency, *Asbestos-Containing Materials in School Buildings: A Guidance Document,* Parts 1 and 2, EPA/OPPT No. C00090, March 1979.

6. D. Lucas, T. Hartwell, and A. V. Rao, *Asbestos-Containing Materials in School Buildings: Guidance for Asbestos Analytical Programs,* EPA 560/13–80–017A, U.S. Environmental Protection Agency, December 1980, 96 pp.

7. D. H. Taylor and J. S. Bloom, Hexametaphosphate pretreatment of insulation samples for identification of fibrous constituents, *Microscope, 28,* 1980.

8. W. J. Campbell, R. L. Blake, L. L. Brown, E. E. Cather, and J. J. Sjoberg. *Selected Silicate Minerals and Their Asbestiform Varieties: Mineralogical Definitions and Identification-Characterization*, U.S. Bureau of Mines Information Circular 8751, 1977.

9. Walter C. McCrone, *Asbestos Particle Atlas,* Ann Arbor: Ann Arbor Science Publishers, June 1980.

SECTION 2. X-RAY POWDER DIFFRACTION

2.1 Principle and Applicability

The principle of X-ray powder diffraction (XRD) analysis is well established.[1,2] Any solid, crystalline material will diffract an impingent 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 spacing 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, in most cases, will be uniquely characteristic of both the chemical composition and 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 2–1). However, when used in conjunction with optical methods such as polarized light microscopy (PLM), 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 are initially scanned over limited diagnostic peak regions for the serpentine (~7.4 Å) and amphibole (8.2–8.5 Å) minerals (Table 2–2). Standard slow-scanning methods for bulk sample analysis may be used for materials shown by PLM to contain significant amounts of asbestos (>5–10 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 are submitted to a full (5°–60° 2θ; 1° 2θ/min) qualitative XRD scan, and their diffraction patterns are 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.

TABLE 2–1—THE ASBESTOS MINERALS AND THEIR NONASBESTIFORM ANALOGS

Asbestiform	Nonasbestiform
SERPENTINE	
Chrysotile	Antigorite, lizardite
AMPHIBOLE	
Anthophyllite asbestos	Anthophyllite
Cummingtonite-grunerite asbestos (''Amosite'')	Cummingtonite-grunerite
Crocidolite	Riebeckite
Tremolite asbestos	Tremolite
Actinolite asbestos	Actinolite

TABLE 2–2—PRINCIPAL LATTICE SPACINGS OF ASBESTIFORM MINERALS[a]

Minerals	Principal d-spacings (Å) and relative intensities			JCPDS Powder diffraction file[3] number
Chrysotile	7.37_{100}	3.65_{70}	4.57_{50}	21–543[b]
	7.36_{100} ..	3.66_{80}	2.45_{65}	25–645
	7.10_{100} ..	2.33_{80}	3.55_{70}	22–1162 (theoretical)
''Amosite''	8.33_{100}	3.06_{70}	2.756_{70}	17–745 (nonfibrous)
	8.22_{100} ..	3.060_{85}	3.25_{70}	27–1170 (UICC)
Anthophyllite	3.05_{100}	3.24_{60}	8.26_{55}	9–455
	3.06_{100} ..	8.33_{70}	3.23_{50}	16–401 (synthetic)
Anthophyllite	2.72_{100}	2.54_{100}	3.480_{80}	25–157
Crocidolite	8.35_{100}	3.10_{55}	2.720_{35}	27–1415 (UICC)
Tremolite	8.38_{100}	3.12_{100}	2.705_{90}	13–437[b]
	2.706_{100}	3.14_{95}	8.43_{40}	20–1310[b] (synthetic)
	3.13_{100} ..	2.706_{60}	8.44_{40}	23–666 (synthetic mixture with richterite)

[a] This information is intended as a guide, only. Complete powder diffraction data, including mineral type and source, should be referred to, 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. Bureaus of Mines.[4]

[b] Fibrosity questionable.

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 is selected for quantitation of each asbestiform mineral. A ''thin-layer'' method of analysis[5,6] is recommended in which, subsequent to comminution of the bulk material to ~10 µm 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] may be used for *semi-quantitative analysis.*

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.

2.2 Range and Sensitivity

The range of the method has not been determined.

The sensitivity of the method has not been determined. It will be variable and dependent upon many factors, including matrix effects (absoprtion and interferences), diagnostic reflections selected, and their relative intensities.

2.3 Limitations

2.3.1 Interferences

Since the fibrous and nonfibrous forms of the serpentine and amphibole minerals (Table 2–1) 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 2–3) and present more serious problems in identification and quantitation.[10] Potential interferences are summarized in Table 2–4 and include the following:

- *Chlorite* has major peaks at 7.19 Å and 3.58 Å That interfere with both the primary (7.36 Å) and secondary (3.66 Å) peaks for chrysotile. Resolution of the primary peak to give good quantitative results may be possible when a step-scanning mode of operation is employed.
- *Halloysite* has a peak at 3.63 Å that interferes with the secondary (3.66 Å) peak for chrysotile.
- *Kaolinite* has a major peak at 7.15 Å that may interfere with the primary peak of chrysotile at 7.36 Å when present at concentrations of >10 percent. However, the secondary chrysotile peak at 3.66 Å may be used for quantitation.
- *Gypsum* has a major peak at 7.5 Å that overlaps the 7.36 Å peak of chrysotile when present as a major sample constituent. This may be removed by careful washing with distilled water, or be heating to 300 °C to convert gypsum to plaster of paris.
- *Cellulose* has a broad peak that partially overlaps the secondary (3.66 Å) chrysotile peak.[8]
- Overlap of major diagnostic peaks of the amphibole asbestos minerals, amosite, anthophyllite, 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, adquate resolution may be attained by using step-scanning methods and/or by decreasing the collimator slit width at the X-ray port.

TABLE 2–3—COMMON CONSTITUENTS IN INSULATION AND WALL MATERIALS

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 fillers)
  Calcium silicates (synthetic)
  Opaques (chromite, magnetite inclusions in serpentine)
  Hematite (inclusions in ‘‘amosite’’)
  Magnesite
  *Diatomaceous earth
B. 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 ($CaSO_4 \cdot 2H_2O$)
  Quartz
  *Organic binders and thickeners
  Hyrdomagnesite
  Wollastonite
  Opaques (chromite, magnetite inclusions in serpentine)
  Hematite (inclusions in ‘‘amosite’’)

*Amorphous materials____contribute only to overall scattered radiation and increased background radiation.

TABLE 2–4—INTERFERENCES IN XRD ANALYSIS ASBESTIFORM MINERALS

Asbestiform mineral	Primary diagnostic peaks (approximate d-spacings, in Å)	Interference
Serpentine		
Chrysotile	7.4	Nonasbestiform serpentines (antigorite, lizardite) Chlorite Kaolinite Gypsum
	3.7	Chlorite Halloysite Cellulose
Amphibole		
"Amosite" Anthophyllite Crocidolite Tremolite	3.1	Nonasbestiform amphiboles (cummingtonite-grunerite, anthophyllite, riebeckite, tremolite) Mutual interferences Carbonates Talc
	8.3	Mutual interferences

- *Carbonates* may also interfere with quantitative analysis of the amphibole asbestos minerals, amosite, anthophyllite, crocidolite, and tremolite. 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, if present, chrysotile may be partially dissolved by this treatment.[11]
- A major *talc* peak at 3.12 Å interferes with the primary tremolite peak at this same position and with secondary peaks of crocidolite (3.10 Å), 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 interferences 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, with the result being that their diffraction patterns are chracterized by having major (110) reflections of the monoclinic amphiboles and (210) reflections of the orthorhombic anthophyllite separated by less than 0.2 Å.[12]

2.3.2 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 along with increased background intensity and an overall decrease in sensitivity. This situation may be corrected by choosing 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 raditation, 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]

2.3.3 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 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.

2.3.4 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] However, 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] (Further investigation into preferred orientation effects in both thin layer and bulk samples is required.)

2.3.5 Lack of Suitably Characterized Standard Materials

The problem of obtaining and characterizing suitable reference materials for asbestos analysis is clearly recognized. NIOSH has recently directed a major research effort toward the preparation and characterization of analytical reference materials, including asbestos standards;[16,17] however, these are not available in large quantities for routine analysis.

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 underestimated 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 Precision and Accuracy

Precision of the method has not been determined.

Accuracy of the method has not been determined.

2.5 Apparatus

2.5.1 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, and 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 Pipettes*
- *Pipette 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*

2.5.2 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*
- *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.

2.6 Reagents

2.6.1 Standard Reference Materials

The reference materials listed below are 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, or NIEHS Plastibest. (UICC reference materials available from: UICC, MRC Pneumoconiosis Unit, Llandough Hospital, Penarth, Glamorgan, CF61XW, UK).
- *Crocidolite:* UICC
- *Amosite:* UICC
- *Anthophyllite:* UICC
- *Tremolite Asbestos:* Wards Natural Science Establishment, Rochester, N.Y.; Cyprus Research Standard, Cyprus Research, 2435 Military Ave., Los Angeles, CA 90064 (washed with dilute HCl to remove small amount of calcite impurity); India tremolite, Rajasthan State, India.
- *Actinolite Asbestos*

2.6.2 Adhesive

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

2.6.3 Surfactant

1 percent aerosol OT aqueous solution or equivalent.

2.6.4 Isopropanol

ACS Reagent Grade.

2.7 Procedure

2.7.1 Sampling

Samples for analysis of asbestos content shall be collected as specified in EPA Guidance Document #C0090, *Asbestos-Containing Materials in School Buildings.*[10]

2.7.2 Analysis

All samples must be analyzed initially for asbestos content by PLM. XRD should be used as an auxiliary method when a second, independent analysis is requested.

NOTE: Asbestos is a toxic substance. All handling of dry materials should be performed in an operating fume hood.

2.7.2.1 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, quantitative, thin layer or bulk).

Bulk materials are usually received as inhomogeneous 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 2.7.2.2 and 2.7.2.3.

NOTE: All samples should be examined microscopically before and after each matrix reduction step to monitor changes in sample particle size, composition, and crystallinity, and to ensure sample representativeness and homogeneity for analysis.

2.7.2.1.1 *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.[19,22] 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 exposures.

For accurate, reproducible *quantitative analysis,* the particle size of both sample and standard materials should be reduced to ~10 µm (see Section 2.3.3). Dry ball milling at liquid nitrogen temperatures (e.g., Spex Freezer Mill, or equivalent) for a maximum time of 10 min. 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 µm.[8,16]

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

2.7.2.1.2 *Low temperature ashing*—For materials shown by PLM to contain large amounts of gypsum, cellulosic, or other organic materials, it may be desirable to ash the samples 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,[23,24] ashing temperatures should be kept below 500 °C. Use of a low temperature asher is recommended. In all cases, calibration of the oven is essential to ensure that a maximum ashing temperature of 500 °C is not exceeded.

2.7.2.1.3 *Acid leaching*—Because of the interference caused by gypsum and some carbonates in the detection of asbestiform minerals by XRD (see Section 2.3.1), it may be necessary to remove these interferents by a simple acid leaching procedure prior to analysis (see Section 1.7.2.2).

2.7.2.2 Qualitative Analysis

2.7.2.2.1 *Initial screening of bulk material*—Qualitative analysis should be performed on a representative, homogeneous portion of the sample with a minimum of sample treatment.

1. Grind and mix the sample with a mortar and pestle (or equivalent method, see Section 2.7.2.1.1.) to a final particle size sufficiently small (~100 µm) to allow adequate packing into the sample holder.
2. Pack the 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 a back-packing method[25] of 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 (~67.4 Å) and amphibole (8.2–8.5 Å) minerals (see Table 2–2). The X-ray diffraction equipment should be optimized for intensity. A slow scanning speed of 1° 2θ/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° 2θ; 1°2θ/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 2–2; common constituents of bulk insulation and wall materials are listed in Table 2–3.

2.7.2.2.2 *Detection of minor or trace constituents*— Routine screening of bulk materials by XRD may fail to detect small concentrations (<5 percent) 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 where 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 2.7.2.2.1) is in conflict with previous PLM results, it may be desirable to prepare the sample as described for quantitative analysis (see Section 2.7.2.3) and step-scan over appropriate 2θ ranges of selected diagnostic peaks (Table 2–2). Accurate transfer of the sample to the silver membrane filter is not necessary unless subsequent quantitative analysis is to be performed.

2.7.2.3 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.[5] A thick-layer or bulk method involving pelletizing the sample may be used for semiquantitative 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 2.7.2.1.1.

2. Dry at 100 °C for 2 hr; 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 2.7.2.1.2 and 2.7.2.1.3. 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 with approximately 200 mL isopropanol to which 3 to 4 drops of surfactant have been added.

6. Ultrasonicate for 10 min 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 a 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 resume 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 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 2–2).

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:

$$\hat{I}_a = \frac{I_a}{I^\circ_r}, \quad \hat{I}_{Ag} = \frac{I_{Ag}}{I^\circ_r}, \text{ and } \hat{I}^\circ_{Ag} = \frac{I^\circ_{Ag}}{I^\circ_r}$$

2.8 Calibration

2.8.1 Preparation of Calibration Standards

1. Mill and size standard asbestos materials according to the procedure outlined in Section 2.7.2.1.1. *Equivalent, standardized matrix reduction and sizing techniques should be used for both standard and sample materials.*

2. Dry at 100 °C for 2 hr; 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. Quantitatively transfer each to a 1–L volumetric flask with approximately 200 mL isopropanol to which a few drops of surfactant have been added.

4. Ultrasonicate for 10 min 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 and the following procedure.

Mount a silver membrane filter on the filtration apparatus. Place a few milliliters 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.

2.8.2 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 2.7.2.3, 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 2.7.2.3, step 14.

2.9 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 $\hat{I}2^\circ_{std}$ on w. Poor reproducibility (±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:[26,27]

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

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

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

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 appropriate calibration data and 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 2.7.2.3).

2.10 References

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

2. L. V. Azaroff 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 File,* U.S. Department of Commerce, National Bureau of Standards, and Joint Committee on Powder Diffraction Studies, Swarthmore, PA.

4. W. J. Campbell, 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 RI8452, 1980.

5. B. A. Lange 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):520–525, 1979.

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

7. H. Dunn and J. H. Stewart, Jr., Quantitative determination of chrysotile in building materials, *The Microscope, 29*(1), 1981.

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

9. L. Birks, 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. U.S. Environmental Protection Agency, *Asbestos-Containing Materials in School Buildings: A Guidance Document,* Parts 1 and 2, EPA/OPPT No. C00090, March 1979.

11. J. B. Krause and W. H. Ashton, Misidentification of asbestos in talc, pp. 339–353, 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).

12. H. D. Stanley, The detection and identification of asbestos and asbesti-form 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. A. L. Rickards, Estimation of trace amounts of chrysotile asbestos by X-ray diffraction, *Anal. Chem., 44*(11):1872–3, 1972.

14. P. M. Cook, 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. A. N. Rohl and A. M. Langer, Identification and quantitation of asbestos in talc, *Environ. Health Perspectives, 9:*95–109, 1974.

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

17. J. C. Haartz, 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, Environmental Sciences Laboratory, Mount

Sinai School of Medicine of the City University of New York, New York, New York.

19. A. M. Langer, 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.

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

21. E. Occella 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.

22. K. R. Spurny, W. Stöber, 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.

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

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

25. Reference 1, pp. 372–374.

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

27. J. A. Leroux, B. C. Davey, and A. Paillard, *Am. Ind. Hyg. Assoc. J., 34:*409, 1973.

[47 FR 23369, May 27, 1982; 47 FR 38535, Sept. 1, 1982; Redesignated at 60 FR 31922, June 19, 1995]

Subpart F [Reserved]

Subpart G—Asbestos Worker Protection

SOURCE: 65 FR 69216, Nov. 15, 2000, unless otherwise noted.

§ 763.120 What is the purpose of this subpart?

This subpart protects certain State and local government employees who are not protected by the Asbestos Standards of the Occupational Safety and Health Administration (OSHA). This subpart applies the OSHA Asbestos Standards in 29 CFR 1910.1001 and 29 CFR 1926.1101 to these employees.

§ 763.121 Does this subpart apply to me?

If you are a State or local government employer and you are not subject to a State asbestos standard that OSHA has approved under section 18 of the Occupational Safety and Health Act or a State asbestos plan that EPA has exempted from the requirements of this subpart under § 763.123, you must follow the requirements of this subpart to protect your employees from occupational exposure to asbestos.

§ 763.122 What does this subpart require me to do?

If you are a State or local government employer whose employees perform:

(a) Construction activities identified in 29 CFR 1926.1101(a), you must:

(1) Comply with the OSHA standards in 29 CFR 1926.1101.

(2) Submit notifications required for alternative control methods to the Director, National Program Chemicals Division (7404), Office of Pollution Prevention and Toxics, Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460.

(b) Custodial activities not associated with the construction activities identified in 29 CFR 1926.1101(a), you must comply with the OSHA standards in 29 CFR 1910.1001.

(c) Repair, cleaning, or replacement of asbestos-containing clutch plates and brake pads, shoes, and linings, or removal of asbestos-containing residue from brake drums or clutch housings, you must comply with the OSHA standards in 29 CFR 1910.1001.

§ 763.123 May a State implement its own asbestos worker protection plan?

This section describes the process under which a State may be exempted from the requirements of this subpart.

(a) *States seeking an exemption.* If your State wishes to implement its own asbestos worker protection plan, rather than complying with the requirements of this subpart, your State must apply for and receive an exemption from EPA.

(1) *What must my State do to apply for an exemption?* To apply for an exemption from the requirements of this subpart, your State must send to the Director of EPA's Office of Pollution Prevention and Toxics (OPPT) a copy of its asbestos worker protection regulations and a detailed explanation of how your State's asbestos worker protection plan meets the requirements of TSCA section 18 (15 U.S.C. 2617).

(2) *What action will EPA take on my State's application for an exemption?* EPA will review your State's application and make a preliminary determination whether your State's asbestos worker protection plan meets the requirements of TSCA section 18.

(i) If EPA's preliminary determination is that your State's plan does meet the requirements of TSCA section 18, EPA will initiate a rulemaking, including an opportunity for public comment, to exempt your State from the requirements of this subpart. After considering any comments, EPA will issue a final rule granting or denying the exemption.

(ii) If EPA's preliminary determination is that the State plan does not meet the requirements of TSCA section 18, EPA will notify your State in writing and will give your State a reasonable opportunity to respond to that determination.

(iii) If EPA does not grant your State an exemption, then the State and local government employers in your State are subject to the requirements of this subpart.

(b) *States that have been granted an exemption.* If EPA has exempted your State from the requirements of this subpart, your State must update its asbestos worker protection regulations as necessary to implement changes to meet the requirements of this subpart, and must apply to EPA for an amendment to its exemption.

(1) *What must my State do to apply for an amendment to its exemption?* To apply for an amendment to its exemption, your State must send to the Director of OPPT a copy of its updated asbestos worker protection regulations and a detailed explanation of how your State's updated asbestos worker protection plan meets the requirements of TSCA section 18. Your State must submit its application for an amendment within 6 months of the effective date of any changes to the requirements of this subpart, or within a reasonable time agreed upon by your State and OPPT.

(2) *What action will EPA take on my State's application for an amendment?* EPA will review your State's application for an amendment and make a preliminary determination whether your State's updated asbestos worker protection plan meets the requirements of TSCA section 18.

(i) If EPA determines that the updated State plan does meet the requirements of TSCA section 18, EPA will issue your State an amended exemption.

(ii) If EPA determines that the updated State plan does not meet the requirements of TSCA section 18, EPA will notify your State in writing and will give your State a reasonable opportunity to respond to that determination.

(iii) If EPA does not grant your State an amended exemption, or if your State does not submit a timely request for amended exemption, then the State and local government employers in your State are subject to the requirements of this subpart.

Subpart H [Reserved]

Subpart I—Prohibition of the Manufacture, Importation, Processing, and Distribution in Commerce of Certain Asbestos-Containing Products; Labeling Requirements

SOURCE: 54 FR 29507, July 12, 1989, unless otherwise noted.

§763.160 Scope.

This subpart prohibits the manufacture, importation, processing, and distribution in commerce of the asbestos-containing products identified and at the dates indicated in §§763.165, 763.167, and 763.169. This subpart requires that products subject to this rule's bans, but not yet subject to a ban on distribution in commerce, be labeled. This subpart also includes general exemptions and procedures for requesting exemptions from the provisions of this subpart.

§763.163 Definitions.

For purposes of this subpart:

Act means the Toxic Substances Control Act, 15 U.S.C. 2601 *et seq.*

Agency means the United States Environmental Protection Agency.

Asbestos means the asbestiform varieties of: chrysotile (serpentine); crocidolite (riebeckite); amosite (cummingtonite-grunerite); tremolite; anthophyllite; and actinolite.

Asbestos-containing product means any product to which asbestos is deliberately added in any concentration or which contains more than 1.0 percent asbestos by weight or area.

Chemical substance, has the same meaning as in section 3 of the Act.

Commerce has the same meaning as in section 3 of the Act.

Commercial paper means an asbestos-containing product which is made of paper intended for use as general insulation paper or muffler paper. Major applications of commercial papers are insulation against fire, heat transfer, and corrosion in circumstances that require a thin, but durable, barrier.

Corrugated paper means an asbestos-containing product made of corrugated paper, which is often cemented to a flat backing, may be laminated with foils or other materials, and has a corrugated surface. Major applications of asbestos corrugated paper include: thermal insulation for pipe coverings; block insulation; panel insulation in elevators; insulation in appliances; and insulation in low-pressure steam, hot water, and process lines.

Customs territory of the United States means the 50 States, Puerto Rico, and the District of Columbia.

Distribute in commerce has the same meaning as in section 3 of the Act, but the term does not include actions taken with respect to an asbestos-containing product (to sell, resale, deliver, or hold) in connection with the end use of the product by persons who are users (persons who use the product for its intended purpose after it is manufactured or processed). The term also does not include distribution by manufacturers, importers, and processors, and other persons solely for purposes of disposal of an asbestos-containing product.

Flooring felt means an asbestos-containing product which is made of paper felt intended for use as an underlayer for floor coverings, or to be bonded to the underside of vinyl sheet flooring.

Import means to bring into the customs territory of the United States, except for: (1) Shipment through the customs territory of the United States for export without any use, processing, or disposal within the customs territory of the United States; or (2) entering the customs territory of the United States as a component of a product during normal personal or business activities involving use of the product.

Importer means anyone who imports a chemical substance, including a chemical substance as part of a mixture or article, into the customs territory of the United States. *Importer* includes the person primarily liable for the payment of any duties on the merchandise or an authorized agent acting on his or her behalf. The term includes as appropriate:

(1) The consignee.

(2) The importer of record.

(3) The actual owner if an actual owner's declaration and superseding bond has been filed in accordance with 19 CFR 141.20.

(4) The transferee, if the right to withdraw merchandise in a bonded warehouse has been transferred in accordance with subpart C of 19 CFR part 144.

Manufacture means to produce or manufacture in the United States.

Manufacturer means a person who produces or manufactures in the United States.

New uses of asbestos means commercial uses of asbestos not identified in § 763.165 the manufacture, importation or processing of which would be initiated for the first time after August 25, 1989.

Person means any natural person, firm, company, corporation, joint-venture, partnership, sole proprietorship, association, or any other business entity; any State or political subdivision thereof, or any municipality; any interstate body and any department, agency, or instrumentality of the Federal Government.

Process has the same meaning as in section 3 of the Act.

Processor has the same meaning as in section 3 of the Act.

Rollboard means an asbestos-containing product made of paper that is produced in a continuous sheet, is flexible, and is rolled to achieve a desired thickness. Asbestos rollboard consists of two sheets of asbestos paper laminated together. Major applications of this product include: office partitioning; garage paneling; linings for stoves and electric switch boxes; and fire-proofing agent for security boxes, safes, and files.

Specialty paper means an asbestos-containing product that is made of paper intended for use as filters for beverages or other fluids or as paper fill for cooling towers. Cooling tower fill consists of asbestos paper that is used as a cooling agent for liquids from industrial processes and air conditioning systems.

State has the same meaning as in section 3 of the Act.

Stock-on-hand means the products which are in the possession, direction, or control of a person and are intended for distribution in commerce.

United States has the same meaning as in section 3 of the Act.

[59 FR 33208, June 28, 1994]

§ 763.165 Manufacture and importation prohibitions.

(a) After August 27, 1990, no person shall manufacture or import the following asbestos-containing products, either for use in the United States or for export: flooring felt and new uses of asbestos.

(b) After August 26, 1996, no person shall manufacture or import the following asbestos-containing products, either for use in the United States or for export: commercial paper, corrugated paper, rollboard, and specialty paper.

(c) The import prohibitions of this subpart do not prohibit:

(1) The import into the customs territory of the United States of products imported solely for shipment outside the customs territory of the United States, unless further repackaging or processing of the product is performed in the United States; or

(2) Activities involving purchases or acquisitions of small quantities of products made outside the customs territory of the United States for personal use in the United States.

[59 FR 33209, June 28, 1994]

§ 763.167 Processing prohibitions.

(a) After August 27, 1990, no person shall process for any use, either in the United States or for export, any of the asbestos-containing products listed at § 763.165(a).

(b) After August 26, 1996, no person shall process for any use, either in the United States or for export, any of the asbestos-containing products listed at § 763.165(b).

[59 FR 33209, June 28, 1994]

§ 763.169 Distribution in commerce prohibitions.

(a) After August 25, 1992, no person shall distribute in commerce, either for use in the United States or for export, any of the asbestos-containing products listed at § 763.165(a).

(b) After August 25, 1997, no person shall distribute in commerce, either for use in the United States or for export, any of the asbestos-containing products listed at § 763.165(b).

(c) A manufacturer, importer, processor, or any other person who is subject to a ban on distribution in commerce in paragraph (a) or (b) of this section must, within 6 months of the effective date of the ban of a specific asbestos-containing product from distribution in commerce, dispose of all their remaining stock-on-hand of that product, by means that are in compliance with applicable local, State, and Federal restrictions which are current at that time.

[59 FR 33209, June 28, 1994]

§ 763.171 Labeling requirements.

(a) After August 27, 1990, manufacturers, importers, and processors of all asbestos-containing products that are identified in § 763.165(a) shall label the products as specified in this subpart at the time of manufacture, import, or processing. This requirement includes labeling all manufacturers', importers', and processors' stock-on-hand as of August 27, 1990.

(b) After August 25, 1995, manufacturers, importers, and processors of all asbestos-containing products that are identified in § 763.165(b), shall label the products as specified in this subpart at the time of manufacture, import, or processing. This requirement includes labeling all manufacturers', importers', and processors' stock-on-hand as of August 25, 1995.

(c) The label shall be placed directly on the visible exterior of the wrappings and packaging in which the product is placed for sale, shipment, or storage. If the product has more than one layer of external wrapping or packaging, the label must be attached to the innermost layer adjacent to the product. If the innermost layer of product wrapping or packaging does not have a visible exterior surface larger than 5 square inches, either a tag meeting the requirements of paragraph (d) of this section must be securely attached to the product's innermost layer of product wrapping or packaging, or a label must be attached to the next outer layer of product packaging or wrapping. Any products that are distributed in commerce to someone other than the end user, shipped, or stored without packaging or wrapping must be labeled or tagged directly on a visible exterior surface of the product as described in paragraph (d) of this section.

(d)(1) Labels must be either printed directly on product packaging or in the form of a sticker or tag made of plastic, paper, metal, or other durable substances. Labels must be attached in such a manner that they cannot be removed without defacing or destroying them. Product labels shall appear as in paragraph (d)(2) of this section and consist of block letters and numerals of color that contrasts with the background of the label or tag. Labels shall be sufficiently durable to equal or exceed the life, including storage and disposal, of the product packaging or wrapping. The size of the label or tag must be at least 15.25 cm (6 inches) on each side. If the product packaging is too small to accommodate a label of this size, the label may be reduced in size proportionately to the size of the product packaging or wrapping down to a minimum 2.5 cm (1 inch) on each side if the product wrapping or packaging has a visible exterior surface larger than 5 square inches.

(2) Products subject to this subpart shall be labeled in English as follows:

NOTICE

This product contains *ASBESTOS*. The U.S. Environmental Protection Agency has banned the distribution in U.S. commerce of this product under section 6 of the Toxic Substances Control Act (15 U.S.C. 2605) as of (insert effective date of ban on distribution in commerce). Distribution of this product in commerce after this date and intentionally removing or tampering with this label are *violations of Federal law*.

(e) No one may intentionally remove, deface, cover, or otherwise obscure or tamper with a label or sticker that has been applied in compliance with this section, except when the product is used or disposed of.

[59 FR 33209, June 28, 1994]

§ 763.173 Exemptions.

(a) Persons who are subject to the prohibitions imposed by §§ 763.165, 763.167, or 763.169 may file an application for an exemption. Persons whose exemption applications are approved by the Agency may manufacture, import, process, or distribute in commerce the banned product as specified in the Agency's approval of the application. No applicant for an exemption may continue the banned activity that is the subject of an exemption application after the effective date of the ban unless the Agency has granted the exemption or the applicant receives an extension under paragraph (b)(4) or (5) of this section.

(b) Application filing dates. (1) Applications for products affected by the prohibitions under §§ 763.165(a) and 763.167(a) may be submitted at any time and will be either granted or denied by EPA as soon as is feasible.

(2) Applications for products affected by the ban under § 763.169(a) may be submitted at any time and will be either granted or denied by EPA as soon as is feasible.

(3) Applications for products affected by the ban under §§ 763.165(b) and 763.167(b) may not be submitted prior to February 27, 1995. Complete applications received after that date, but before August 25, 1995, will be either granted or denied by the Agency prior to the effective date of the ban for the product. Applications received after August 25, 1995, will be either granted or denied by EPA as soon as is feasible.

(4) Applications for products affected by the ban under § 763.169(b) may not be submitted prior to February 26, 1996. Complete applications received after that date, but before August 26, 1996, will be either granted or denied by the Agency prior to the effective date of the ban for the product. Applications received after August 26, 1996, will be either granted or denied by EPA as soon as is feasible.

(5) The Agency will consider an application for an exemption from a ban under § 763.169 for a product at the same time the applicant submits an application for an exemption from a ban under § 763.165 or § 763.167 for that product. EPA will grant an exemption at that time from a ban under § 763.169 if the Agency determines it appropriate to do so.

(6) If the Agency denies an application less than 30 days before the effective date of a ban for a product, the applicant can continue the activity for 30 days after receipt of the denial from the Agency.

(7) If the Agency fails to meet the deadlines stated in paragraphs (b)(3) and (b)(4) of this section for granting or denying a complete application in instances in which the deadline is before the effective date of the ban to which the application applies, the applicant will be granted an extension of 1 year from the Agency's deadline date. During this extension period the applicant may continue the activity that is the subject of the exemption application. The Agency will either grant or deny the application during the extension period. The extension period will terminate either on the date the Agency grants the application or 30 days after the applicant receives the Agency's denial of the application. However, no extension will be granted if the Agency is scheduled to grant or deny an application at some date after the effective date of the ban, pursuant to the deadlines stated in paragraphs (b)(3) and (b)(4) of this section.

(c) *Where to file.* All applications must be submitted to the following location: TSCA Docket Receipts Office (7407), Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency, Rm E-G99, 1200 Pennsylvania Ave., NW., Washington, DC 20460, ATTENTION: Asbestos Exemption. For information regarding the submission of exemptions containing information claimed as confidential business information (CBI), see § 763.179.

(d) *Content of application and criteria for decisionmaking.*

(1) *Content of application.* Each application must contain the following:

(i) Name, address, and telephone number of the applicant.

(ii) Description of the manufacturing, import, processing, and/or distribution in commerce activity for which an exemption is requested, including a description of the asbestos-containing product to be manufactured, imported, processed, or distributed in commerce.

(iii) Identification of locations at which the exempted activity would take place.

(iv) Length of time requested for exemption (maximum length of an exemption is 4 years).

(v) Estimated amount of asbestos to be used in the activity that is the subject of the exemption application.

(vi) Data demonstrating the exposure level over the life cycle of the product that is the subject of the application.

(vii) Data concerning:

(A) The extent to which non-asbestos substitutes for the product that is the subject of the application fall significantly short in performance under necessary product standards or requirements, including laws or ordinances mandating product safety standards.

(B) The costs of non-asbestos substitutes relative to the costs of the asbestos-containing product and, in the case in which the product is a component of another product, the effect on the cost of the end use product of using the substitute component.

(C) The extent to which the product or use serves a high-valued use.

(viii) Evidence of demonstrable good faith attempts by the applicant to develop and use a non-asbestos substance or product which may be substituted for the asbestos-containing product or the asbestos in the product or use that is the subject to the application.

(ix) Evidence, in addition to that provided in the other information required with the application, showing that the continued manufacture, importation, processing, distribution in commerce, and use, as applicable, of the product will not present an unreasonable risk of injury to human health.

(2) Criteria for decision (existing products). After considering all the information provided by an applicant under paragraphs (d)(1) and (e) of this section, and any other information available to EPA, EPA will grant an exemption from the prohibitions in §§ 763.165, 763.167, or 763.169 for an applicant's asbestos-containing product only if EPA determines both of the following:

(i) The applicant has made good faith attempts to develop and use a non-asbestos substance or product which may be substituted for the asbestos-containing product or the asbestos in the product or use, and those attempts have failed to produce a substitute or a substitute that results in a product that can be economically produced.

(ii) Continued manufacturing, processing, distribution in commerce, and use, as applicable, of the product will not present an unreasonable risk of injury to human health.

(3) Criteria for decision (new products). Requests to develop and use an asbestos substance or product will be treated as a petition pursuant to section 21 of TSCA.

(e) The Agency reserves the right to request further information from an exemption applicant if necessary to complete the Agency's evaluation of an application.

(f) Upon receipt of a complete application, the Agency will issue a notice in the FEDERAL REGISTER announcing its receipt and invite public comments on the merits of the application.

(g) If the application does not include all of the information required in paragraph (d) of this section, the Agency will return it to the applicant as incomplete and any resubmission of the application will be considered a new application for purposes of the availability of any extension period. If the application is substantially inadequate to allow the Agency to make a reasoned judgment on any of the information required in paragraph (d) of this section and the Agency chooses to request additional information from the applicant, the Agency may also determine that an extension period provided for in paragraph (b)(5) of this section is unavailable to the applicant.

(h) When denying an application, the Agency will notify the applicant by registered mail of its decision and rationale. Whenever possible, the Agency will send this letter prior to the appropriate ban. This letter will be considered a final Agency action for purposes of judicial review. A notice announcing the Agency's denial of the application will be published in the FEDERAL REGISTER.

(i) If the Agency proposes to approve an exemption, it will issue a notice in the FEDERAL REGISTER announcing this intent and invite public comments. If, after considering any timely comments received, the Agency approves an exemption, its decision will be published in the FEDERAL REGISTER. This notice will be considered a final Agency action for purposes of judicial review.

(j) The length of an exemption period will be specified by the agency when it approves the exemption. To extend an exemption period beyond the period stipulated by EPA, applicants must submit a new application to the Agency, following the application procedures described in this section. Applications may not be submitted prior to 15 months before the expiration of the exemption period, unless stated otherwise in the notice granting the exemption. Applications received between 15 months and 1 year before the end of the exemption period will be either granted or denied by the Agency before the end of the exemption period. Applications received after the date 1 year prior to the end of the exemption period will be either granted or denied by the Agency as soon as is feasible. Applicants may not continue the activity that is the subject of the renewal application after the date of the end of the exemption period.

[54 FR 29507, July 12, 1989; 54 FR 37531, Sept. 11, 1989, as amended at 54 FR 46898, Nov. 8, 1989; 59 FR 33210, June 28, 1994]

§ 763.175 Enforcement.

(a) Failure to comply with any provision of this subpart is a violation of section 15 of the Act (15 U.S.C. 2614).

(b) Failure or refusal to establish and maintain records, or to permit access to or copying of records as required by section 11 of the Act (15 U.S.C. 2610) is a violation of section 15 of the Act (15 U.S.C. 2614).

(c) Failure or refusal to permit entry or inspection as required by section 11 of the Act (15 U.S.C. 2610) is a violation of section 15 of the Act (15 U.S.C. 2614).

(d) Violators may be subject to the civil and criminal penalties in section 16 of the Act (15 U.S.C. 2615) for each violation.

(e) The Agency may seek to enjoin the manufacture, import, processing, or distribution in commerce of asbestos-containing products in violation of this subpart, or act to seize any asbestos-containing products manufactured, imported, processed, or distributed in commerce in violation of this subpart, or take any other actions under the authority of section 7 or 17 of the Act (15 U.S.C. 2606 or 2616) that are appropriate.

§763.176 Inspections.

The Agency will conduct inspections under section 11 of the Act (15 U.S.C. 2610) to ensure compliance with this subpart.

§763.178 Recordkeeping.

(a) *Inventory.* (1) Each person who is subject to the prohibitions imposed by §§763.165 and 763.167 must perform an inventory of the stock-on-hand of each banned product as of the effective date of the ban for that product for the applicable activity.

(2) The inventory shall be in writing and shall include the type of product, the number of product units currently in the stock-on-hand of the person performing the inventory, and the location of the stock.

(3) Results of the inventory for a banned product must be maintained by the person for 3 years after the effective date of the §763.165 or §763.167 ban on the product.

(b) *Records.* (1) Each person whose activities are subject to the bans imposed by §§763.165, 763.167, and 763.169 for a product must, between the effective date of the §763.165 or §763.167 ban on the product and the §763.169 ban on the product, keep records of all commercial transactions regarding the product, including the dates of purchases and sales and the quantities purchased or sold. These records must be maintained for 3 years after the effective date of the §763.169 ban for the product.

(2) Each person who is subject to the requirements of §763.171 must, for each product required to be labeled, maintain a copy of the label used in compliance with §763.171. These records must be maintained for 3 years after the effective date of the ban on distribution in commerce for the product for which the §763.171 requirements apply.

[54 FR 29507, July 12, 1989, as amended by 54 FR 46898, Nov. 8, 1989; 58 FR 34205, June 23, 1993]

§763.179 Confidential business information claims.

(a) Applicants for exemptions under §763.173 may assert a Confidential Business Information (CBI) claim for information in an exemption application or supplement submitted to the Agency under this subpart only if the claim is asserted in accordance with this section, and release of the information would reveal trade secrets or confidential commercial or financial information, as provided in section 14(a) of the Act. Information covered by a CBI claim will be treated in accordance with the procedures set forth in 40 CFR part 2, subpart B. The Agency will place all information not claimed as CBI in the manner described in this section in a public file without further notice to the applicant.

(b) Applicants may assert CBI claims only at the time they submit a completed exemption application and only in the specified manner. If no such claim accompanies the information when it is received by the Agency, the information may be made available to the public without further notice to the applicant. Submitters that claim information as business confidential must do so by writing the word ‘‘Confidential’’ at the top of the page on which the information appears and by underlining, circling, or placing brackets ([ ]) around the information claimed CBI.

(c) Applicants who assert a CBI claim for submitted information must provide the Agency with two copies of their exemption application. The first copy must be complete and contain all information being claimed as CBI. The second copy must contain only information not claimed as CBI. The Agency will place the second copy of the submission in a public file. Failure to furnish a second copy of the submission when information is claimed as CBI in the first copy will be considered a presumptive waiver of the claim of confidentiality. The Agency will notify the applicant by certified mail that a finding of a presumptive waiver of the claim of confidentiality has been made. The applicant has 30 days from the date of receipt of notification to submit the required second copy. Failure to submit the second copy will cause the Agency to place the first copy in a public file.

(d) Applicants must substantiate all claims of CBI at the time the applicant asserts the claim, i.e., when the exemption application or supplement is submitted, by responding to the questions in paragraph (e) of this section. Failure to provide substantiation of a claim at the time the applicant submits the application will result in a waiver of the CBI claim, and the information may be disclosed to the public without further notice to the applicant.

(e) Applicants who assert any CBI claims must substantiate all claims by providing detailed responses to the following:

(1) Is this information subject to a patent or patent application in the United States or elsewhere? If so, why is confidentiality necessary?

(2) For what period do you assert a claim of confidentiality? If the claim is to extend until a certain event or point in time, please indicate that event or time period. Explain why such information should remain confidential until such point.

(3) Has the information that you are claiming as confidential been disclosed to persons outside of your company? Will it be disclosed to such persons in the future? If so, what restrictions, if any, apply to use or further disclosure of the information?

(4) Briefly describe measures taken by your company to guard against undesired disclosure of the information you are claiming as confidential to others.

(5) Does the information claimed as confidential appear or is it referred to in advertising or promotional materials for the product or the resulting end product, safety data sheets or other similar materials for the product or the resulting end product, professional or trade publications, or any other media available to the public or to your competitors? If you answered yes, indicate where the information appears.

(6) If the Agency disclosed the information you are claiming as confidential to the public, how difficult would it be for the competitor to enter the market for your product? Consider in your answer such constraints as capital and marketing cost, specialized technical expertise, or unusual processes.

(7) Has the Agency, another Federal agency, or a Federal court made any confidentiality determination regarding this information? If so, provide copies of such determinations.

(8) How would your company's competitive position be harmed if the Agency disclosed this information? Why should such harm be considered substantial? Describe the causal relationship between the disclosure and harm.

(9) In light of section 14(b) of TSCA, if you have claimed information from a health and safety study as confidential, do you assert that disclosure of this information would disclose a process used in the manufacturing or processing of a product or information unrelated to the effects of asbestos on human health and the environment? If your answer is yes, explain.

PART 766—DIBENZO-PARA-DIOXINS/DIBENZOFURANS

Subpart A—General Provisions

Attachment H from the 1989 Rule 1403 Staff Report: Referencing 40 CFR section 768.107 for sampling protocol

ATTACHMENT H

The following information are the references found in Proposed Rule 1403.

29 CFR Section 1926.58(k)(2)(iii)

(2) *Labels.* (i) Labels shall be affixed to all products containing asbestos, tremolite, anthophyllite, or actinolite and to all containers containing such products, including waste containers. Where feasible, installed asbestos, tremolite, anthophyllite, or actinolite products shall contain a visible label.

(ii) Labels shall be printed in large, bold letters on a contrasting background.

(iii) Labels shall be used in accordance with the requirements of 29 CFR 1910.1200(f) of OSHA's Hazard Communication standard, and shall contain the folowing information:

DANGER

CONTAINS ASBESTOS FIBERS

AVOID CREATING DUST

CANCER AND LUNG DISEASE HAZARD

(iv) Where minerals to be labeled are only tremolite, anthophyllite and actinolite, the employer may replace the term "asbestos" with the appropriate mineral name.

(v) Labels shall contain a warning statement against breathing airborne asbestos, tremolite, anthophyllite, or actinolite fibers.

(vi) The provisions for labels required by paragraphs (k)(2)(i)-(k)(2)(iv) do not apply where:

(A) Asbestos, tremolite, anthophyllite, or actinolite fibers have been modified by a bonding agent, coating, binder, or other material, provided that the manufacturer can demonstrate that, during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos, tremolite, anthophyllite, actinolite, or a combination of these mineral fibers in excess of the action level will be released, or

(B) asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals is present in a product in concentrations less than 0.1 percent by weight.

29 CFR Section 1910.1001(j)(2)

(2) *Warning labels.* (i) Labeling. Warning labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos, tremolite, anthophyllite, or actinolite fibers, or to their containers.

(ii) Label specifications. The labels shall comply with the requirements of 29 CFR 1910.1200(f) of OSHA's Hazard Communication standard, and shall include the following information:

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

(iii) Where minerals to be labeled are only tremolite, anthophyllite, or actinolite, the employer may replace the term "asbestos" with the appropriate mineral name.

40 CFR Section 768.107

§ 763.107 Sampling friable material.

(a) If friable materials are found in a school building, local education agencies shall identify each distinct sampling area of friable materials within the school building, take at least three samples from locations distributed throughout the sampling area, and label each sample container with a sample identification number unique to the sampling location and building.

(b) Officials should consult "Asbestos-Containing Materials in School Buildings: A Guidance Document," Part 1, Chapter 5, for further information on sampling procedures. The requirement that three samples be taken in each sampling area supersedes the recommendation made in the Guidance Document to take one sample per 5000 square feet of friable material.

(c) Sampling locations should be randomly distributed within the sampling; the locations should not be selected simply for convenience or ease of reaching the sample, or because the sampler judges the location to be representative. Samples shall be taken using small sealable containers; samples shall penetrate the depth of the friable material to the substrate.

EPA Test Method EPA/600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials

United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

EPA/600/R-93/116
July 1993

Test Method

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

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

TABLE OF CONTENTS (cont'd)

TABLE OF CONTENTS (cont'd)

TABLES

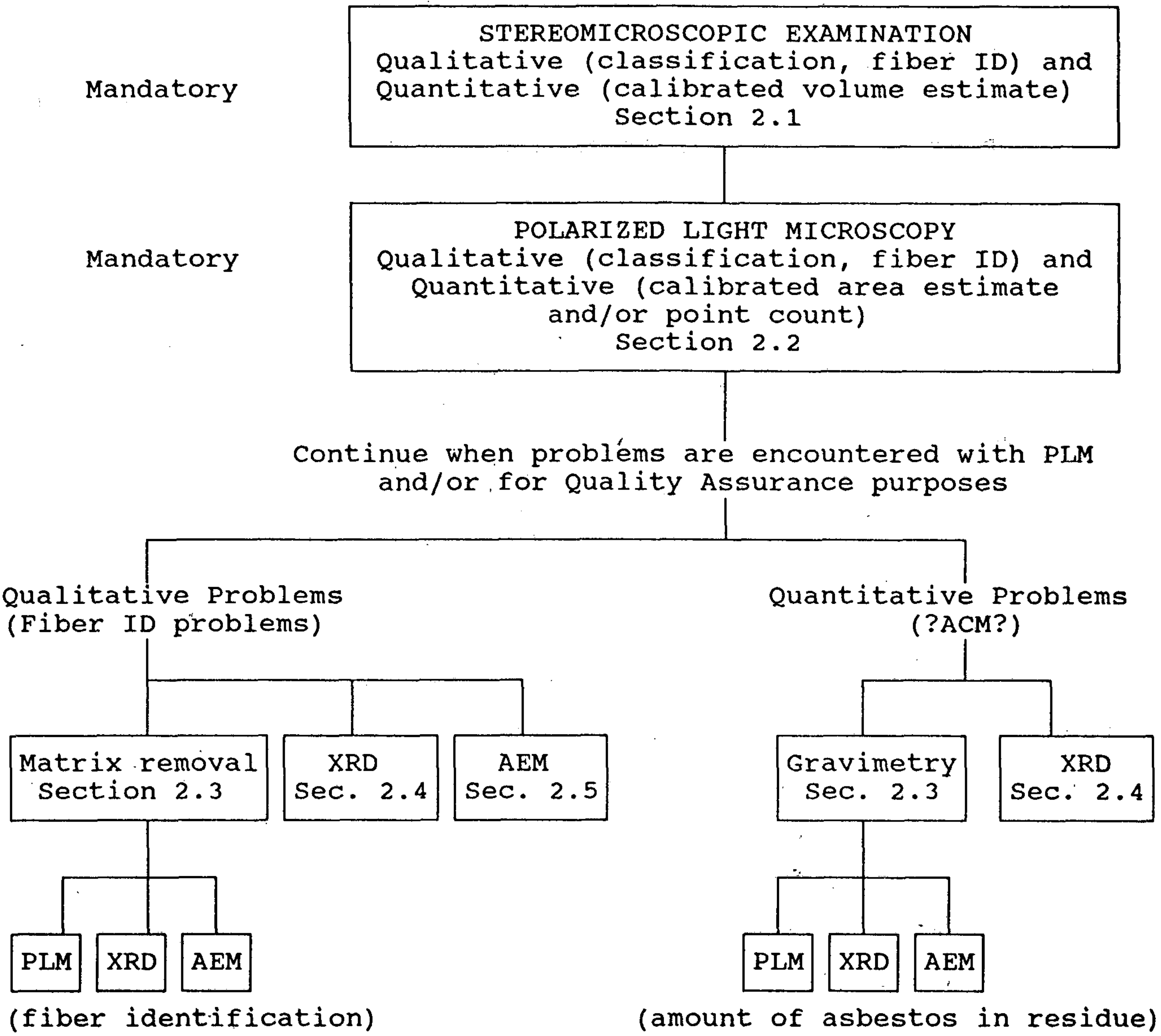
1.0 INTRODUCTION

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 <u>client</u> 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 <u>randomly</u> 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 are not measured 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 the true extinction angle; true α will be the minimum 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 maximum 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 <u>accuracy and precision improve with number of counts</u>. 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]		Birefringence[6]	Extinction	Sign of Elongation
		α	γ[5]			
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]	 1.625-1.655 1.627-1.635 1.625-1.637 1.6343[7] 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	$n\parallel \sim 1.580$ $n\perp \sim 1.530$	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	$n\parallel \sim 1.556$ $n\perp \sim 1.512$	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	$n\parallel \sim 1.560\text{-}1.590$ $n\perp \sim 1.580\text{-}1.600$	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	$n\parallel \sim 1.630$ $n\perp \sim 1.632$ $n\perp$ 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	$n\parallel \sim 1.60$ $n\perp \sim 1.54$	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 ($Ti0_2$, 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 ~10 μm 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 ($CaSO_4 \cdot 2H_20$)
- 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 ($CaC0_3$) 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 ~ 10 μm . 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 μm.[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 (~100 μm) 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° 2θ/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° 2θ; 1° 2θ/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}:

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

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:

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

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**, 1 03(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 not 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 both 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:

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

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?

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

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

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

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

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?

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

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

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.

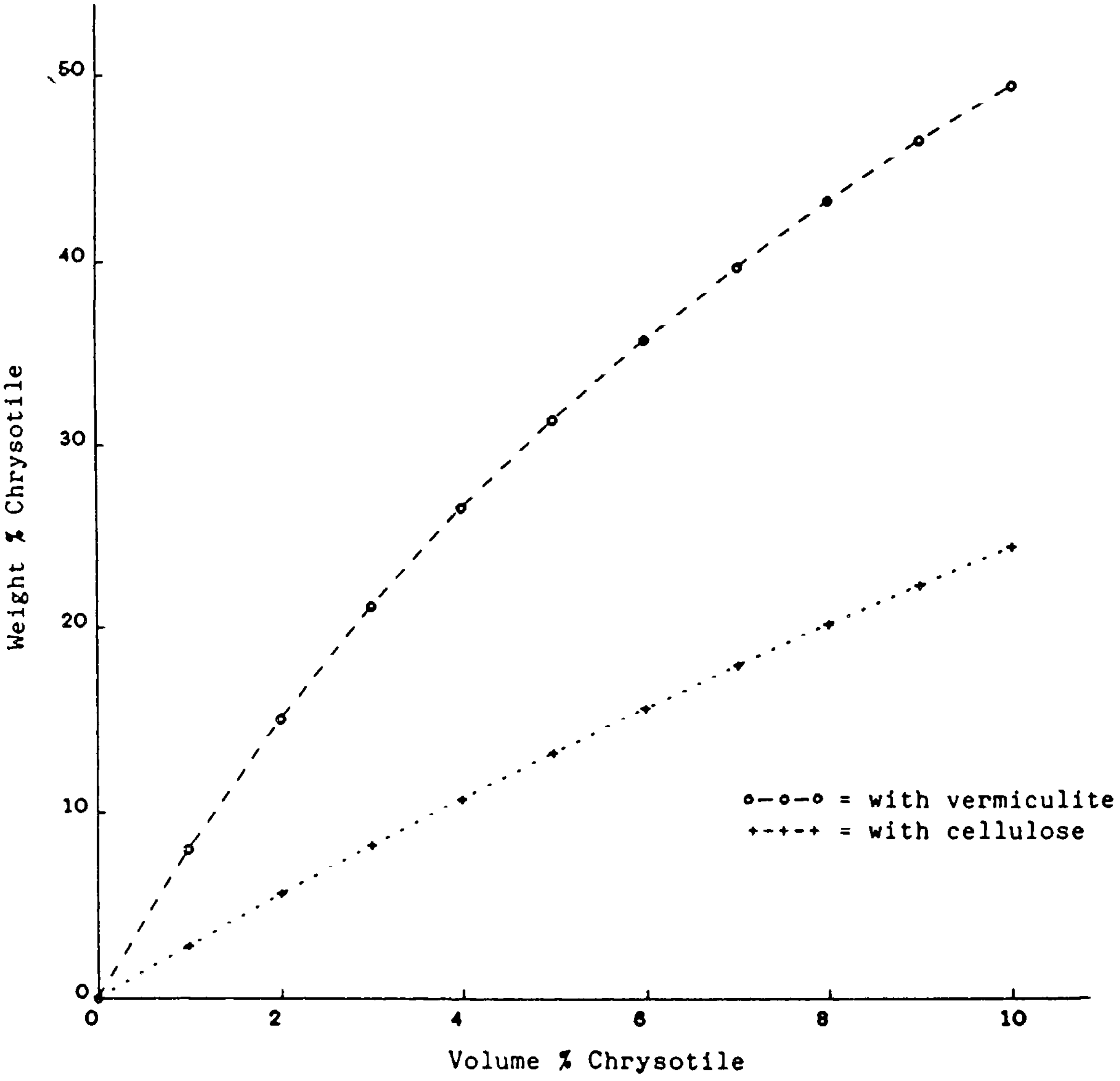


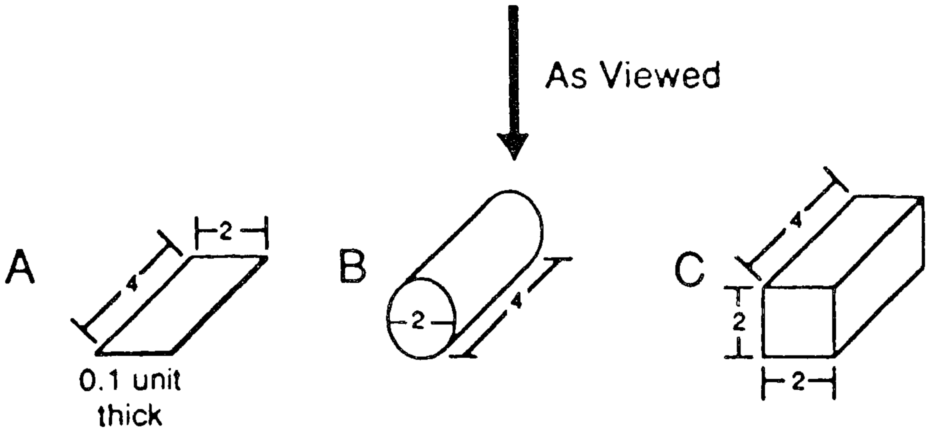
Figure C1. Relationship between volume % and weight % of chrysotile mixed with a)vermiculite and b) cellulose.

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%
Vm = 95%
T = 10

$$Aa = \frac{5}{\frac{95}{10} + 5} \times 100 = 34.5\%$$

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?

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

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?

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

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.)

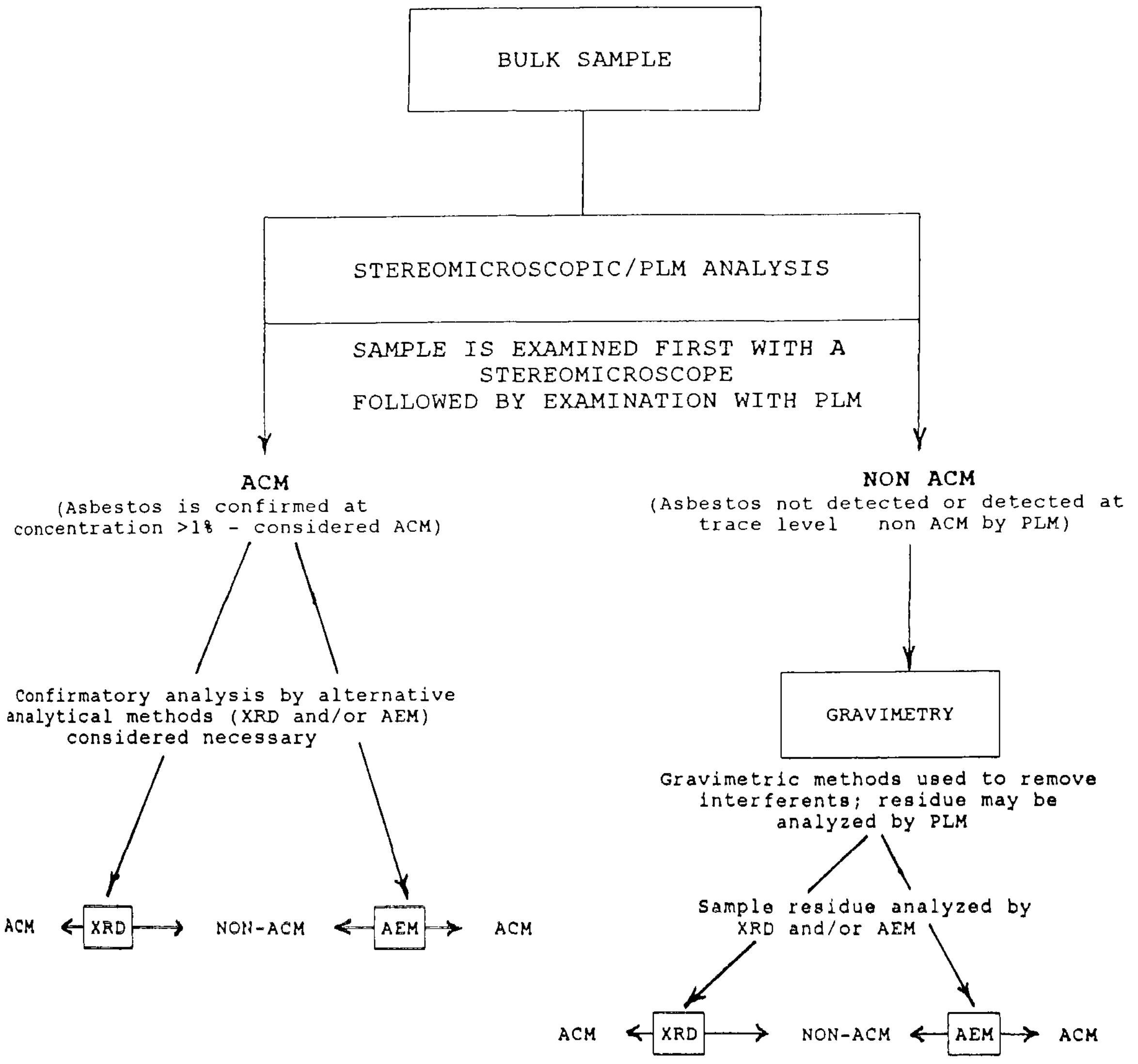
Materials characterized by interfering binder/matrix, low asbestos content, and/or small fiber size may require that additional sample treatment(s) and analysis be performed beyond routine PLM analysis. The sample treatment(s) required is(are) determined by the dominant nonasbestos sample components (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

Federal Register Document 95–30797: Asbestos NESHAP Clarification Regarding Analysis of Multi-Layered Systems

[FR Doc. 95–30797 Filed 12–18–95; 8:45 am]
BILLING CODE 6560–50–P

---

40 CFR Part 61

[FRL–5399–3]

Asbestos NESHAP Clarification Regarding Analysis of Multi-Layered Systems

AGENCY: Environmental Protection Agency.

ACTION: Notice of clarification to the final rule.

SUMMARY: This document provides clarification regarding the requirements of the National Emission Standards for Hazardous Air Pollutants (NESHAP) for asbestos. It is intended to address common questions regarding situations where one or more layers which may contain asbestos are present, and supplement the January 5, 1994 Federal Register clarification (59 FR 542).

EFFECTIVE DATE: December 19, 1995.

FOR FURTHER INFORMATION CONTACT: For copies, contact Mr. Larry Tessier at 1–800–368–5888 or at (703) 305–5938. For questions about the clarification, please contact Mr. Tom Ripp at (202) 564–7003.

SUPPLEMENTARY INFORMATION: On November 20, 1990, the Federal Register published the Environmental Protection Agency's (the Agency's) revision of the National Emission Standards for Hazardous Air Pollutants for Asbestos (asbestos NESHAP), 40 CFR part 61, subpart M, 55 FR 48406. The asbestos NESHAP applies to any facility as defined in 40 CFR 61.141. The Agency has learned that some of the regulated community have further questions concerning the analysis of samples which may contain multiple layers, any or all of which may be asbestos containing materials (ACM) under the asbestos NESHAP. Because these questions are frequently asked, EPA is making this clarification.

I. Clarification of Multi-Layered ACM System

At the time the original asbestos NESHAP was promulgated (April 6, 1973), a standardized reference method had not been developed to determine quantitatively the content of asbestos in a material. The definition for ''friable asbestos material'' was added in the October 14, 1975 asbestos NESHAP, but still did not specify an analytical method. EPA's unwritten policy based on the definition of ''friable asbestos material'' was that each layer in a multi-layered system was to be analyzed as a separate material (no averaging or dilution by combining layers of asbestos-containing material with nonasbestos-containing material was allowed). The November 20, 1990 revision of the asbestos NESHAP finally specified that Appendix A, Subpart F, 40 CFR Part 763, Section 1, Polarized Light Microscopy (PLM method) be used to determine whether or not a material contains greater that one percent asbestos. Section 1.7.2.1 of the PLM method states that ''* * * When discrete strata are identified, each is treated as a separate material so that fibers are first quantified in that layer only, and then the results for each layer are combined to yield an estimate of asbestos content for the whole sample.'' This language has led to considerable confusion as to how to analyze multi-layered samples for NESHAP purposes. EPA published a clarification regarding the analysis of multi-layered systems in the January 5, 1994 Federal Register. This clarification basically stated that all multi-layered systems except for wall systems where joint compound was used only at the joints and nail holes must be analyzed as separate materials, and results were not allowed to be combined to determine average asbestos content (continuing the policy that dilution of an asbestos-containing material is not allowed).

The Environmental Protection Agency has received many questions about analyzing multi-layered systems for asbestos content to determine the applicability of the asbestos NESHAP since its January 5, 1994 clarification (59 FR 542). This clarification reiterates EPA's position for analysis of multi-layered samples for applicability of the asbestos NESHAP.

This clarification applies to all multi-layered systems (other than wallboard systems where asbestos-containing joint compound is used only at the joints and nail holes) under both the NESHAP and the Asbestos Hazard Emergency Response Act (AHERA) (40 CFR Part 763) programs.

Any source sending multi-layered bulk samples to a lab may request that certain sample(s) or portions of sample(s) be composited for analysis first (to potentially reduce time and cost of sampling).

(Note: A composite sample does not mean that multiple samples may be composited into one sample. It means that multiple layers of one core sample may be composited for analysis.)

If this alternative method is chosen, then the following requirements must be followed. To analyze the composite sample, the procedures in EPA/600–93/116 ''Method for the Determination of Asbestos in Bulk Building Materials'' (''the Method''), specifically Section 2.3 ''Gravimetry,'' must be used. Additionally, for the composite sample, the recommendations in Appendix D of the method must be followed. This procedure is consistent with the procedures outlined in 40 CFR Part 763, Appendix E to Subpart E (formerly Appendix A to Subpart F), which is referenced in the asbestos NESHAP (40 CFR 61.141 and 61.146), but the procedures in the new method are more clear. EPA finds that this method is an acceptable alternative method of compliance under section 61.13(h)(1)(ii). EPA intends to amend the asbestos NESHAP in the near future to refer specifically to these procedures. When using the gravimetric procedures, the result may be recorded as percent asbestos by weight.

If the result of the composite analysis shows that the average content for the multi-layered system (across the layers) is greater than one percent, then the multi-layered system must be treated as asbestos-containing and analysis by layers is not necessary. If the result of the composite sample analysis indicates that the multi-layered system as a whole contains asbestos in the amount of one percent or less, but greater than none detected, then analysis by layers is required to ensure that no layer in the system contains greater than one percent asbestos. If any layer contains greater than one percent asbestos, that layer must be treated as asbestos-containing. This will have the effect of requiring all layers in a multi-layered system to be treated as asbestos-containing if the layers can not be separated without disturbing the asbestos-containing layer. Once any one layer is shown to have greater than one percent asbestos, further analysis of the other layers is not necessary if all the layers will be treated as asbestos-containing. If several of the layers will be removed without removing the entire system, then all layers that will be disturbed must be analyzed. This includes the material being removed; however, the material being removed may be analyzed using the composite analysis procedures. Please note that the same requirements to perform point counting as stated in our May 8, 1991 clarification (see enclosed memorandum) still apply for any layers being analyzed individually.

Dated: September 28, 1995.

Richard Biondi,

Acting Director, Manufacturing, Energy, and Transportation Division, Office of Compliance.

[FR Doc. 95–30790 Filed 12–18–95; 8:45 am]

BILLING CODE 6560–50–P

FEDERAL COMMUNICATIONS COMMISSION

47 CFR Part 73

[MM Docket No. 90–468; RM–7380]

Radio Broadcasting Services; Wickenburg and Lake Havasu City, AZ

AGENCY: Federal Communications Commission.

ACTION: Final rule; petition for reconsideration.

SUMMARY: This documents grants a Petition for Reconsideration filed by Interstate Broadcasting System of Arizona, Inc., licensee of Station KRDS-FM, Channel 287C2, Wickenburg, Arizona, directed to the *Report and Order* in this proceeding which had upgraded the Station KRDS-FM license to specify operation on Channel 287C1. *See* 56 FR 43884, September 5, 1991. With this action, the proceeding is terminated.

EFFECTIVE DATE: January 26, 1996.

FOR FURTHER INFORMATION CONTACT: Robert Hayne, Mass Media Bureau, (202) 776–1654.

SUPPLEMENTARY INFORMATION: This is a synopsis of the Commission's *Memorandum Opinion and Order* in MM Docket No. 90– 468, adopted December 6, 1995, and released December 12, 1995. The full text of this decision is available for inspection and copying during normal business hours in the FCC Reference Center (Room 239), 1919 M Street, NW., Washington, DC. The complete text of this decision may also be purchased from the Commission's copy contractor, International Transcription Service, Inc., (202) 857–3800, 1919 M Street, NW., Room 246, or 2100 M Street, NW., Suite 140, Washington, DC 20037.

List of Subjects in 47 CFR Part 73

Radio broadcasting.

Part 73 of title 47 of the Code of Federal Regulations is amended as follows:

PART 73—[AMENDED]

1. The authority citation for part 73 continues to read as follows:

Authority: Secs. 303, 48 Stat., as amended, 1082; 47 U.S.C. 154, as amended.

§ 73.202 [Amended]

2. Section 202(b), the Table of FM Allotments under Arizona, is amended by removing Channel 287C1 and adding Channel 287C2 at Wickenburg.

Federal Communications Commission.

Douglas W. Webbink,

Chief, Policy and Rules Division, Mass Media Bureau.

[FR Doc. 95–30757 Filed 12–18–95; 8:45 am]

BILLING CODE 6712–01–F

Interim Method of the Determination of Asbestos in Bulk Insulation Samples - 40 CFR Appendix E to Subpart E of Part 763

warning signs or fencing if it meets the requirement to cover asbestos wastes. However, under RCRA, EPA requires that access be controlled to prevent exposure of the public to potential health and safety hazards at the disposal site. Therefore, for liability protection of operators of landfills that handle asbestos, fencing and warning signs are recommended to control public access when natural barriers do not exist. Access to a landfill should be limited to one or two entrances with gates that can be locked when left unattended. Fencing should be installed around the perimeter of the disposal site in a manner adequate to deter access by the general public. Chain-link fencing, 6-ft high and topped with a barbed wire guard, should be used. More specific fencing requirements may be specified by local regulations. Warning signs should be displayed at all entrances and at intervals of 330 feet or less along the property line of the landfill or perimeter of the sections where asbestos waste is deposited. The sign should read as follows:

ASBESTOS WASTE DISPOSAL SITE
BREATHING ASBESTOS DUST MAY CAUSE LUNG DISEASE AND CANCER

Recordkeeping. For protection from liability, and considering possible future requirements for notification on disposal site deeds, a landfill owner should maintain documentation of the specific location and quantity of the buried asbestos wastes. In addition, the estimated depth of the waste below the surface should be recorded whenever a landfill section is closed. As mentioned previously, such information should be recorded in the land deed or other record along with a notice warning against excavation of the area.

[52 FR 41897, Oct. 30, 1987, as amended at 62 FR 1834, Jan. 14, 1997; 75 FR 69353, Nov. 12, 2010]

APPENDIX E TO SUBPART E OF PART 763—INTERIM METHOD OF THE DETERMINATION OF ASBESTOS IN BULK INSULATION SAMPLES

SECTION 1. POLARIZED LIGHT MICROSCOPY

1.1 Principle and Applicability

Bulk samples of building materials taken for asbestos identification are first examined for homogeneity and preliminary fiber identification at low magnification. Positive identification of suspect fibers is made by analysis of subsamples with the polarized light microscope.

The principles of optical mineralogy are well established.[1,2] 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 the determination of refractive indices along specific crystallographic axes. Morphology and color are also observed. A retardation plate is placed in the polarized light path for determination of the sign of elongation using orthoscopic illumination. Orientation of the two filters such that their vibration planes are perpendicular (crossed polars) allows observation of the birefringence and extinction characteristics of anisotropic particles.

Quantitative analysis involves the use of point counting. Point counting is a standard technique in petrography for determining the relative areas occupied by separate minerals in thin sections of rock. Background information on the use of point counting[2] and the interpretation of point count data[3] is available.

This method is applicable to all bulk samples of friable insulation materials submitted for identification and quantitation of asbestos components.

1.2 Range

The point counting method may be used for analysis of samples containing from 0 to 100 percent asbestos. The upper detection limit is 100 percent. The lower detection limit is less than 1 percent.

1.3 Interferences

Fibrous organic and inorganic constituents of bulk samples may interfere with the identification and quantitation of the asbestos mineral content. Spray-on binder materials may coat fibers and affect color or obscure optical characteristics to the extent of masking fiber identity. Fine particles of other materials may also adhere to fibers to an extent sufficient to cause confusion in identification. Procedures that may be used for the removal of interferences are presented in Section 1.7.2.2.

1.4 Precision and Accuracy

Adequate data for measuring the accuracy and precision of the method for samples with various matrices are not currently available. Data obtained for samples containing a single asbestos type in a simple matrix are available in the EPA report *Bulk Sample Analysis for Asbestos Content: Evaluation of the Tentative Method.[4]*

1.5 Apparatus

1.5.1 Sample Analysis

A low-power binocular microscope, preferably stereoscopic, is used to examine the bulk insulation sample as received.

- *Microscope:* binocular, 10–45X (approximate).
- *Light Source:* incandescent or fluorescent.
- *Forceps, Dissecting Needles, and Probes*
- *Glassine Paper or Clean Glass Plate*

Compound microscope requirements: A polarized light microscope complete with polarizer, analyzer, port for wave retardation plate, 360° graduated rotating stage, substage condenser, lamp, and lamp iris.

- *Polarized Light Microscope:* described above.
- *Objective Lenses:* 10X, 20X, and 40X or near equivalent.
- *Dispersion Staining Objective Lens* (optional)
- *Ocular Lens:* 10X minimum.
- *Eyepiece Reticle:* cross hair or 25 point Chalkley Point Array.
- *Compensator Plate:* 550 millimicron retardation.

1.5.2 Sample Preparation

Sample preparation apparatus requirements will depend upon the type of insulation sample under consideration. Various physical and/or chemical means may be employed for an adequate sample assessment.

- *Ventilated Hood* or negative pressure glove box.
- *Microscope Slides*
- *Coverslips*
- *Mortar and Pestle:* agate or porcelain. (optional)
- *Wylie Mill* (optional)
- *Beakers and Assorted Glassware* (optional)
- *Certrifuge* (optional)
- *Filtration apparatus* (optional)
- *Low temperature asher* (optional)

1.6 Reagents

1.6.1 Sample Preparation

- *Distilled Water (optional)*
- *Dilute CH_3COOH:* ACS reagent grade (optional)
- *Dilute HCl:* ACS reagent grade (optional)
- *Sodium metaphosphate* $(NaPO_3)_6$ (optional)

1.6.2 Analytical Reagents

Refractive Index Liquids: 1.490–1.570, 1.590–1.720 in increments of 0.002 or 0.004.

- *Refractive Index Liquids for Dispersion Staining:* high-dispersion series, 1.550, 1.605, 1.630 (optional).
- *UICC Asbestos Reference Sample Set:* Available from: UICC MRC Pneumoconiosis Unit, Llandough Hospital, Penarth, Glamorgan CF6 1XW, UK, and commercial distributors.
- *Tremolite-asbestos* (source to be determined)
- *Actinolite-asbestos* (source to be determined)

1.7 Procedures

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

1.7.1 Sampling

Samples for analysis of asbestos content shall be taken in the manner prescribed in Reference 5 and information on design of sampling and analysis programs may be found in Reference 6. If there are any questions about the representative nature of the sample, another sample should be requested before proceeding with the analysis.

1.7.2 Analysis

1.7.2.1 Gross Examination

Bulk samples of building materials taken for the identification and quantitation of asbestos are first examined for homogeneity at low magnification with the aid of a stereomicroscope. The core sample may be examined in its container or carefully removed from the container onto a glassine transfer paper or clean glass plate. If possible, note is made of the top and bottom orientation. When discrete strata are identified, each is treated as a separate material so that fibers are first identified and quantified in that layer only, and then the results for each layer are combined to yield an estimate of asbestos content for the whole sample.

1.7.2.2 Sample Preparation

Bulk materials submitted for asbestos analysis involve a wide variety of matrix materials. Representative subsamples may not be readily obtainable by simple means in heterogeneous materials, and various steps may be required to alleviate the difficulties encountered. In most cases, however, the best preparation is made by using forceps to sample at several places from the bulk material. Forcep samples are immersed in a refractive index liquid on a microscope slide, teased apart, covered with a cover glass, and observed with the polarized light microscope.

Alternatively, attempts may be made to homogenize the sample or eliminate interferences before further characterization. The selection of appropriate procedures is dependent upon the samples encountered and personal preference. The following are presented as possible sample preparation steps.

A mortar and pestle can sometimes be used in the size reduction of soft or loosely bound materials though this may cause matting of some samples. Such samples may be reduced in a Wylie mill. Apparatus should be clean and extreme care exercised to avoid cross-contamination of samples. Periodic checks of the particle sizes should be made during the grinding operation so as to preserve any fiber bundles present in an identifiable form. These procedures are not recommended for samples that contain amphibole minerals or vermiculite. Grinding of amphiboles may result in the separation of fiber bundles or the production of cleavage fragments with aspect ratios greater than 3:1. Grinding of vermiculite may also produce fragments with aspect ratios greater than 3:1.

Acid treatment may occasionally be required to eliminate interferences. Calcium carbonate, gypsum, and bassanite (plaster) are frequently present in sprayed or trowelled insulations. These materials may be removed by treatment with warm dilute acetic acid. Warm dilute hydrochloric acid may also be used to remove the above materials. If acid treatment is required, wash the sample at least twice with distilled water, being careful not to lose the particulates during decanting steps. Centrifugation or filtration of the suspension will prevent significant fiber loss. The pore size of the filter should be 0.45 micron or less. Caution: prolonged acid contact with the sample may alter the optical characteristics of chrysotile fibers and should be avoided.

Coatings and binding materials adhering to fiber surfaces may also be removed by treatment with sodium metaphosphate.[7] Add 10 mL of 10g/L sodium metaphosphate solution to a small (0.1 to 0.5 mL) sample of bulk material in a 15-mL glass centrifuge tube. For approximately 15 seconds each, stir the mixture on a vortex mixer, place in an ultrasonic bath and then shake by hand. Repeat the series. Collect the dispersed solids by centrifugation at 1000 rpm for 5 minutes. Wash the sample three times by suspending in 10 mL distilled water and recentrifuging. After washing, resuspend the pellet in 5 mL distilled water, place a drop of the suspension on a microscope slide, and dry the slide at 110 °C.

In samples with a large portion of cellulosic or other organic fibers, it may be useful to ash part of the sample and view the residue. Ashing should be performed in a low temperature asher. Ashing may also be performed in a muffle furnace at temperatures of 500 °C or lower. Temperatures of 550 °C or higher will cause dehydroxylation of the asbestos minerals, resulting in changes of the refractive index and other key parameters. If a muffle furnace is to be used, the furnace thermostat should be checked and calibrated to ensure that samples will not be heated at temperatures greater than 550 °C.

Ashing and acid treatment of samples should not be used as standard procedures. In order to monitor possible changes in fiber characteristics, the material should be viewed microscopically before and after any sample preparation procedure. Use of these procedures on samples to be used for quantitation requires a correction for percent weight loss.

1.7.2.3 Fiber Identification

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

- Morphology
- Color and pleochroism
- Refractive indices
- Birefringence
- Extinction characteristics
- Sign of elongation

Table 1–1 lists the above properties for commercial asbestos fibers. Figure 1–1 presents a flow diagram of the examination procedure. Natural variations in the conditions under which deposits of asbestiform minerals are formed will occasionally produce exceptions to the published values and differences from the UICC standards. The sign of elongation is determined by use of the compensator plate and crossed polars. Refractive indices may be determined by the Becke line test. Alternatively, dispersion staining may be used. Inexperienced operators may find that the dispersion staining technique is more easily learned, and should consult Reference 9 for guidance. Central stop dispersion staining colors are presented in Table 1–2. Available high-dispersion (HD) liquids should be used.

Table 1–1—Optical Properties of Asbestoc Fibers

Mineral	Morphology, color[a]	Refrac- tive indices[b]		Birefringence	Extinction	Sign of elonation
		α	γ			
Chrysotile (asbestiform serpentine).	Wavy fibers. Fiber bundles have splayed ends and “kinks”. Aspect ratio typically >10:1. Colorless[3], nonpleochroic.	1.493–1.560	1.517–1.562[f] (normally 1.556).	.008	| to fiber length.	+ (length slow)
Amosite (asbestiform grunerite).	Straight, rigid fibers. Aspect ratio typically >10:1. Colorless to brown, nonpleochroic or weakly so. Opaque inclusions may be present.	1.635–1.696	1.655–1.729[f] (normally 1.696–1.710.	.020–.033	| to fiber length.	+ (length slow)

TABLE 1–1—OPTICAL PROPERTIES OF ASBESTOC FIBERS—Continued

Mineral	Morphology, color[a]	Refrac- tive indices[b]		Birefringence	Extinction	Sign of elonation
		α	γ			
Crocidolite (asbestiform Riebeckite).	Straight, rigid fibers. Thick fibers and bundles common, blue to purple-blue in color. Pleochroic. Birefringence is generally masked by blue color.	1.654–1.701	1.668–1.717[3e] (normally close to 1.700).	.014–.016	| to fiber length.	– (length fast)
Anthophyllite-asbestos.	Straight fibers and acicular cleavage fragments.[d] Some composite fibers. Aspect ratio <10:1. Colorless to light brown.	1.596–1.652	1.615–1.676 [f].	.019–.024	| to fiber length.	+ (length slow)
Tremolite-actinolite-asbestos.	Normally present as acicular or prismatic cleavage fragments.[d] Single crystals predominate, aspect ratio <10:1. Colorless to pale green.	1.599–1.668	1.622–1.688 [f].	.023–.020	Oblique extinction, 10–20° for fragments. Composite fibers show | extinction.	+ (length slow)

[a] From reference 5; colors cited are seen by observation with plane polarized light.

[b] From references 5 and 8.

[c] Fibers subjected to heating may be brownish.

[d] Fibers defined as having aspect ratio >3:1.

[e] to fiber length.

[f] |To fiber length.

Polarized light microscopy analysis: For each type of material identified by examination of sample at low magnification. Mount spacially dispersed sample in 1.550 RI liquid. (If using dispersion staining, mount in 1.550 HD.) View at 100X with both plane polarized light and crossed polars. More than one fiber type may be present.

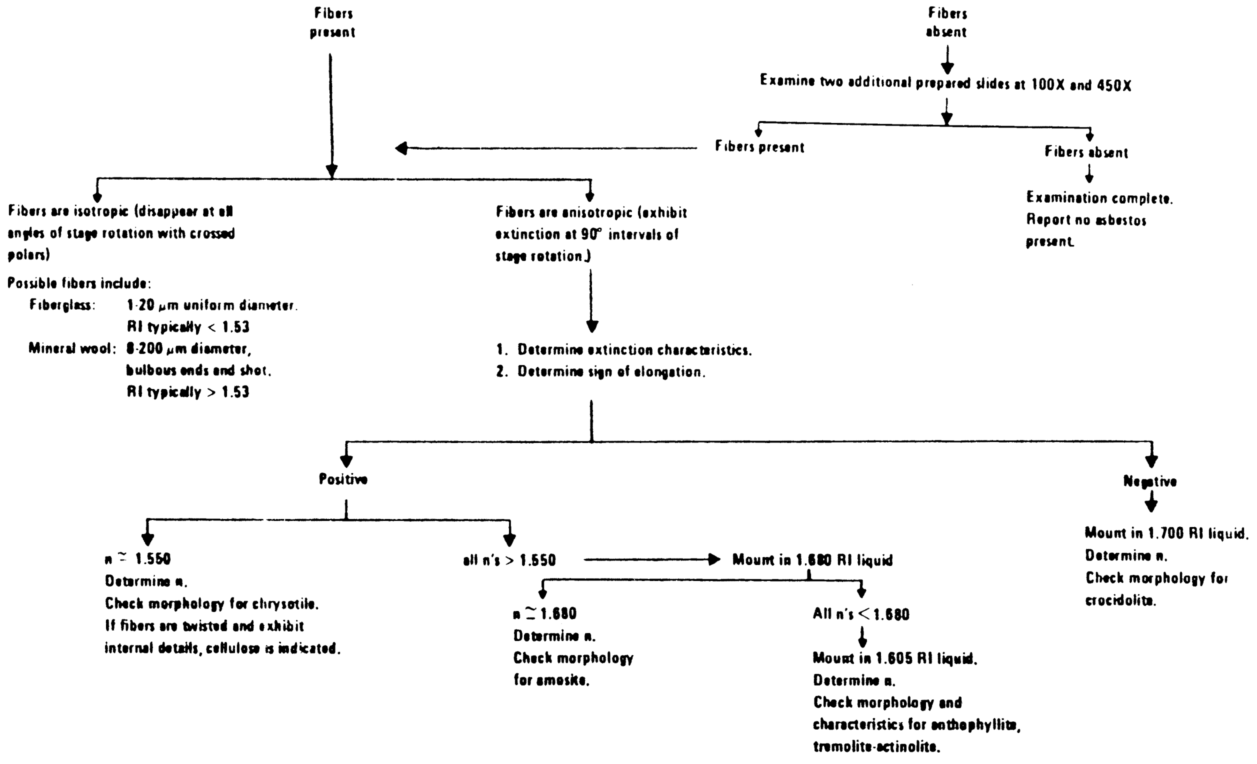


Figure 1-1. Flow chart for analysis of bulk samples by polarized light microscopy.

TABLE 1–2—CENTRAL STOP DISPERSION STAINING COLORS[A]

Mineral	RI Liquid	η	η|
Chrysotile	1.550^{HD}	Blue	Blue-magenta
Amosite	1.680	Blue-magenta to pale blue.	Golden-yellow
	1.550^{HD}	Yellow to white.	Yellow to white
Crocidolite[b] ..	1.700	Red magenta	Blue-magenta
	1.550^{HD}	Yellow to white.	Yellow to white
Anthophyllite	1.605^{HD}	Blue	Gold to gold-magenta
Tremolite	1.605^{HD} [c]	Pale blue	Gold
Actinolite	1.605^{HD}	Gold-magenta to blue.	Gold
	1.630^{HD} [c]	Magenta	Golden-yellow

[a] From reference 9.
[b] Blue absorption color.
[c] Oblique extinction view.

1.7.2.4 Quantitation of Asbestos Content

Asbestos quantitation is performed by a point-counting procedure or an equivalent estimation method. An ocular reticle (cross-hair or point array) is used to visually superimpose a point or points on the microscope field of view. Record the number of points positioned directly above each kind of particle or fiber of interest. Score only points directly over asbestos fibers or nonasbestos matrix material. Do not score empty points for the closest particle. If an asbestos fiber and a matrix particle overlap so that a point is superimposed on their visual intersection, a point is scored for both categories. Point counting provides a determination of the area percent asbestos. Reliable conversion of area percent to percent of dry weight is not currently feasible unless the specific gravities and relative volumes of the materials are known.

For the purpose of this method, ‘‘asbestos fibers’’ are defined as having an aspect ratio greater than 3:1 and being positively identified as one of the minerals in Table 1–1.

A total of 400 points superimposed on either asbestos fibers or nonasbestos matrix material must be counted over at least eight different preparations of representative subsamples. Take eight forcep samples and mount each separately with the appropriate refractive index liquid. The preparation should not be heavily loaded. The sample should be uniformly dispersed to avoid overlapping particles and allow 25–50 percent empty area within the fields of view. Count 50 nonempty points on each preparation, using either

- A cross-hair reticle and mechanical stage; or
- A reticle with 25 points (Chalkley Point Array) and counting at least 2 randomly selected fields.

For samples with mixtures of isotropic and anisotropic materials present, viewing the sample with slightly uncrossed polars or the addition of the compensator plate to the polarized light path will allow simultaneous discrimination of both particle types. Quantitation should be performed at 100X or at the lowest magnification of the polarized light microscope that can effectively distinguish the sample components. Confirmation of the quantitation result by a second analyst on some percentage of analyzed samples should be used as standard quality control procedure.

The percent asbestos is calculated as follows:

% asbestos=(a/n) 100%

where

a=number of asbestos counts,

n=number of nonempty points counted (400).

If a=0, report ‘‘No asbestos detected.’’ If $0<a\leq 3$, report ‘‘<1% asbestos’’.

The value reported should be rounded to the nearest percent.

1.8 References

1. Paul F. Kerr, *Optical Mineralogy*, 4th ed., New York, McGraw-Hill, 1977.

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

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

4. E. P. Brantly, Jr., K. W. Gold, L. E. Myers, and D. E. Lentzen, *Bulk Sample Analysis for Asbestos Content: Evaluation of the Tentative Method*, U.S. Environmental Protection Agency, October 1981.

5. U.S. Environmental Protection Agency, *Asbestos-Containing Materials in School Buildings: A Guidance Document*, Parts 1 and 2, EPA/OPPT No. C00090, March 1979.

6. D. Lucas, T. Hartwell, and A. V. Rao, *Asbestos-Containing Materials in School Buildings: Guidance for Asbestos Analytical Programs*, EPA 560/13–80–017A, U.S. Environmental Protection Agency, December 1980, 96 pp.

7. D. H. Taylor and J. S. Bloom, Hexametaphosphate pretreatment of insulation samples for identification of fibrous constituents, *Microscope*, *28*, 1980.

8. W. J. Campbell, R. L. Blake, L. L. Brown, E. E. Cather, and J. J. Sjoberg. *Selected Silicate Minerals and Their Asbestiform Varieties: Mineralogical Definitions and Identification-Characterization*, U.S. Bureau of Mines Information Circular 8751, 1977.

9. Walter C. McCrone, *Asbestos Particle Atlas*, Ann Arbor: Ann Arbor Science Publishers, June 1980.

SECTION 2. X-RAY POWDER DIFFRACTION

2.1 *Principle and Applicability*

The principle of X-ray powder diffraction (XRD) analysis is well established.[1,2] Any solid, crystalline material will diffract an impingent 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 spacing 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, in most cases, will be uniquely characteristic of both the chemical composition and 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 2–1). However, when used in conjunction with optical methods such as polarized light microscopy (PLM), 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 are initially scanned over limited diagnostic peak regions for the serpentine (~7.4 Å) and amphibole (8.2–8.5 Å) minerals (Table 2–2). Standard slow-scanning methods for bulk sample analysis may be used for materials shown by PLM to contain significant amounts of asbestos (>5–10 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 are submitted to a full (5°–60° 2θ; 1° 2θ/min) qualitative XRD scan, and their diffraction patterns are 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.

TABLE 2–1—THE ASBESTOS MINERALS AND THEIR NONASBESTIFORM ANALOGS

Asbestiform	Nonasbestiform
SERPENTINE	
Chrysotile	Antigorite, lizardite
AMPHIBOLE	
Anthophyllite asbestos	Anthophyllite
Cummingtonite-grunerite asbestos (“Amosite”)	Cummingtonite-grunerite
Crocidolite	Riebeckite
Tremolite asbestos	Tremolite
Actinolite asbestos	Actinolite

TABLE 2–2—PRINCIPAL LATTICE SPACINGS OF ASBESTIFORM MINERALS[A]

Minerals	Principal d-spacings (Å) and relative intensities			JCPDS Powder diffraction file[3] number
Chrysotile	7.37_{100}	3.65_{70}	4.57_{50}	21–543[b]
	7.36_{100} ..	3.66_{80}	2.45_{65}	25–645
	7.10_{100} ..	2.33_{80}	3.55_{70}	22–1162 (theoretical)
“Amosite”	8.33_{100}	3.06_{70}	2.756_{70}	17–745 (nonfibrous)
	8.22_{100} ..	3.060_{85}	3.25_{70}	27–1170 (UICC)
Anthophyllite	3.05_{100}	3.24_{60}	8.26_{55}	9–455
	3.06_{100} ..	8.33_{70}	3.23_{50}	16–401 (synthetic)
Anthophyllite	2.72_{100}	2.54_{100}	3.480_{80}	25–157
Crocidolite	8.35_{100}	3.10_{55}	2.720_{35}	27–1415 (UICC)
Tremolite	8.38_{100}	3.12_{100}	2.705_{90}	13–437[b]
	2.706_{100}	3.14_{95}	8.43_{40}	20–1310[b] (synthetic)
	3.13_{100} ..	2.706_{60}	8.44_{40}	23–666 (synthetic mixture with richterite)

[a] This information is intended as a guide, only. Complete powder diffraction data, including mineral type and source, should be referred to, 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. Bureaus of Mines.[4]

[b] Fibrosity questionable.

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 is selected for quantitation of each asbestiform mineral. A ‘‘thin-layer'' method of analysis[5,6] is recommended in which, subsequent to comminution of the bulk material to ~10 µm 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] may be used for *semi-quantitative analysis*.

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.

2.2 Range and Sensitivity

The range of the method has not been determined.

The sensitivity of the method has not been determined. It will be variable and dependent upon many factors, including matrix effects (absoprtion and interferences), diagnostic reflections selected, and their relative intensities.

2.3 Limitations

2.3.1 Interferences

Since the fibrous and nonfibrous forms of the serpentine and amphibole minerals (Table 2–1) 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 2–3) and present more serious problems in identification and quantitation.[10] Potential interferences are summarized in Table 2–4 and include the following:

- *Chlorite* has major peaks at 7.19 Å and 3.58 Å That interfere with both the primary (7.36 Å) and secondary (3.66 Å) peaks for chrysotile. Resolution of the primary peak to give good quantitative results may be possible when a step-scanning mode of operation is employed.
- *Halloysite* has a peak at 3.63 Å that interferes with the secondary (3.66 Å) peak for chrysotile.
- *Kaolinite* has a major peak at 7.15 Å that may interfere with the primary peak of chrysotile at 7.36 Å when present at concentrations of >10 percent. However, the secondary chrysotile peak at 3.66 Å may be used for quantitation.
- *Gypsum* has a major peak at 7.5 Å that overlaps the 7.36 Å peak of chrysotile when present as a major sample constituent. This may be removed by careful washing with distilled water, or be heating to 300 °C to convert gypsum to plaster of paris.
- *Cellulose* has a broad peak that partially overlaps the secondary (3.66 Å) chrysotile peak.[8]
- Overlap of major diagnostic peaks of the amphibole asbestos minerals, amosite, anthophyllite, 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, adquate resolution may be attained by using step-scanning methods and/or by decreasing the collimator slit width at the X-ray port.

TABLE 2–3—COMMON CONSTITUENTS IN INSULATION AND WALL MATERIALS

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 fillers)
  Calcium silicates (synthetic)
  Opaques (chromite, magnetite inclusions in serpentine)
  Hematite (inclusions in "amosite")
  Magnesite
  *Diatomaceous earth

B. 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 ($CaSO_4 \cdot 2H_2O$)
  Quartz
  *Organic binders and thickeners
  Hyrdomagnesite
  Wollastonite
  Opaques (chromite, magnetite inclusions in serpentine)
  Hematite (inclusions in "amosite")

*Amorphous materials____contribute only to overall scattered radiation and increased background radiation.

TABLE 2–4—INTERFERENCES IN XRD ANALYSIS ASBESTIFORM MINERALS

Asbestiform mineral	Primary diagnostic peaks (approximate d-spacings, in Å)	Interference
Serpentine Chrysotile	7.4	Nonasbestiform serpentines (antigorite, lizardite) Chlorite Kaolinite Gypsum
	3.7	Chlorite Halloysite Cellulose
Amphibole "Amosite" Anthophyllite Crocidolite Tremolite	3.1	Nonasbestiform amphiboles (cummingtonite-grunerite, anthophyllite, riebeckite, tremolite) Mutual interferences Carbonates Talc
	8.3	Mutual interferences

- *Carbonates* may also interfere with quantitative analysis of the amphibole asbestos minerals, amosite, anthophyllite, crocidolite, and tremolite. 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, if present, chrysotile may be partially dissolved by this treatment.[11]
- A major *talc* peak at 3.12 Å interferes with the primary tremolite peak at this same position and with secondary peaks of crocidolite (3.10 Å), 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 interferences 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, with the result being that their diffraction patterns are chracterized by having major (110) reflections of the monoclinic amphiboles and (210) reflections of the orthorhombic anthophyllite separated by less than 0.2 Å.[12]

2.3.2 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 along with increased background intensity and an overall decrease in sensitivity. This situation may be corrected by choosing 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 raditation, 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]

2.3.3 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 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.

2.3.4 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] However, 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] (Further investigation into preferred orientation effects in both thin layer and bulk samples is required.)

2.3.5 Lack of Suitably Characterized Standard Materials

The problem of obtaining and characterizing suitable reference materials for asbestos analysis is clearly recognized. NIOSH has recently directed a major research effort toward the preparation and characterization of analytical reference materials, including asbestos standards;[16,17] however, these are not available in large quantities for routine analysis.

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 underestimated 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 Precision and Accuracy

Precision of the method has not been determined.

Accuracy of the method has not been determined.

2.5 Apparatus

2.5.1 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, and 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 Pipettes*
- *Pipette 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*

2.5.2 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*
- *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.

2.6 Reagents

2.6.1 Standard Reference Materials

The reference materials listed below are 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, or NIEHS Plastibest. (UICC reference materials available from: UICC, MRC Pneumoconiosis Unit, Llandough Hospital, Penarth, Glamorgan, CF61XW, UK).
- *Crocidolite:* UICC
- *Amosite:* UICC
- *Anthophyllite:* UICC
- *Tremolite Asbestos:* Wards Natural Science Establishment, Rochester, N.Y.; Cyprus Research Standard, Cyprus Research, 2435 Military Ave., Los Angeles, CA 90064 (washed with dilute HCl to remove small amount of calcite impurity); India tremolite, Rajasthan State, India.
- *Actinolite Asbestos*

2.6.2 Adhesive

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

2.6.3 Surfactant

1 percent aerosol OT aqueous solution or equivalent.

2.6.4 Isopropanol

ACS Reagent Grade.

2.7 Procedure

2.7.1 Sampling

Samples for analysis of asbestos content shall be collected as specified in EPA Guidance Document #C0090, *Asbestos-Containing Materials in School Buildings.*[10]

2.7.2 Analysis

All samples must be analyzed initially for asbestos content by PLM. XRD should be used as an auxiliary method when a second, independent analysis is requested.

NOTE: Asbestos is a toxic substance. All handling of dry materials should be performed in an operating fume hood.

2.7.2.1 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, quantitative, thin layer or bulk).

Bulk materials are usually received as inhomogeneous 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 2.7.2.2 and 2.7.2.3.

NOTE: All samples should be examined microscopically before and after each matrix reduction step to monitor changes in sample particle size, composition, and crystallinity, and to ensure sample representativeness and homogeneity for analysis.

2.7.2.1.1 *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.[19,22] 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 exposures.

For accurate, reproducible *quantitative analysis*, the particle size of both sample and standard materials should be reduced to ~10 µm (see Section 2.3.3). Dry ball milling at liquid nitrogen temperatures (e.g., Spex Freezer Mill, or equivalent) for a maximum time of 10 min. 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 µm.[8,16]

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

2.7.2.1.2 *Low temperature ashing*—For materials shown by PLM to contain large amounts of gypsum, cellulosic, or other organic materials, it may be desirable to ash the samples 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,[23,24] ashing temperatures should be kept below 500 °C. Use of a low temperature asher is recommended. In all cases, calibration of the oven is essential to ensure that a maximum ashing temperature of 500 °C is not exceeded.

2.7.2.1.3 *Acid leaching*—Because of the interference caused by gypsum and some carbonates in the detection of asbestiform minerals by XRD (see Section 2.3.1), it may be necessary to remove these interferents by a simple acid leaching procedure prior to analysis (see Section 1.7.2.2).

2.7.2.2 Qualitative Analysis

2.7.2.2.1 *Initial screening of bulk material*—Qualitative analysis should be performed on a representative, homogeneous portion of the sample with a minimum of sample treatment.

1. Grind and mix the sample with a mortar and pestle (or equivalent method, see Section 2.7.2.1.1.) to a final particle size sufficiently small (~100 µm) to allow adequate packing into the sample holder.
2. Pack the 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 a back-packing method[25] of 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 (~67.4 Å) and amphibole (8.2–8.5 Å) minerals (see Table 2–2). The X-ray diffraction equipment should be optimized for intensity. A slow scanning speed of 1° 2θ/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° 2θ; 1°2θ/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 2–2; common constituents of bulk insulation and wall materials are listed in Table 2–3.

2.7.2.2.2 *Detection of minor or trace constituents*— Routine screening of bulk materials by XRD may fail to detect small concentrations (<5 percent) 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 where 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 2.7.2.2.1) is in conflict with previous PLM results, it may be desirable to prepare the sample as described for quantitative analysis (see Section 2.7.2.3) and step-scan over appropriate 2θ ranges of selected diagnostic peaks (Table 2–2). Accurate transfer of the sample to the silver membrane filter is not necessary unless subsequent quantitative analysis is to be performed.

2.7.2.3 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.[5] A thick-layer or bulk method involving pelletizing the sample may be used for semiquantitative 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 2.7.2.1.1.

2. Dry at 100 °C for 2 hr; 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 2.7.2.1.2 and 2.7.2.1.3. 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 with approximately 200 mL isopropanol to which 3 to 4 drops of surfactant have been added.

6. Ultrasonicate for 10 min 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 a 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 resume 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 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 2–2).

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, $I_{\mathring{A}g}$. 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, $I_{\mathring{r}}$, of the reference specimen following the procedure in step 12. Determine the normalized intensities by dividing the peak intensities by $I_{\mathring{r}}$:

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

2.8 Calibration

2.8.1 Preparation of Calibration Standards

1. Mill and size standard asbestos materials according to the procedure outlined in Section 2.7.2.1.1. *Equivalent, standardized matrix reduction and sizing techniques should be used for both standard and sample materials.*

2. Dry at 100 °C for 2 hr; 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. Quantitatively transfer each to a 1–L volumetric flask with approximately 200 mL isopropanol to which a few drops of surfactant have been added.

4. Ultrasonicate for 10 min 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 and the following procedure.

Mount a silver membrane filter on the filtration apparatus. Place a few milliliters 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.

2.8.2 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 2.7.2.3, step 12, and the same conditions as those used for the samples.

2. Determine the normalized intensity for each peak measured, $\hat{I}_{\mathring{s}td}$, as outlined in Section 2.7.2.3, step 14.

2.9 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 $\hat{I}2_{\mathring{s}td}$ on w. Poor reproducibility (±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 $\hat{I}_{\mathring{s}td}$ 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, $\hat{I}_{\mathring{A}g}$, of the sample filter, calculate the transmittance, T, for each sample as follows:[26,27]

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

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

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

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 appropriate calibration data and 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 2.7.2.3).

2.10 References

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

2. L. V. Azaroff 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 File,* U.S. Department of Commerce, National Bureau of Standards, and Joint Committee on Powder Diffraction Studies, Swarthmore, PA.

4. W. J. Campbell, 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 RI8452, 1980.

5. B. A. Lange 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):520–525, 1979.

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

7. H. Dunn and J. H. Stewart, Jr., Quantitative determination of chrysotile in building materials, *The Microscope, 29*(1), 1981.

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

9. L. Birks, 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. U.S. Environmental Protection Agency, *Asbestos-Containing Materials in School Buildings: A Guidance Document,* Parts 1 and 2, EPA/OPPT No. C00090, March 1979.

11. J. B. Krause and W. H. Ashton, Misidentification of asbestos in talc, pp. 339–353, 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).

12. H. D. Stanley, The detection and identification of asbestos and asbesti-form 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. A. L. Rickards, Estimation of trace amounts of chrysotile asbestos by X-ray diffraction, *Anal. Chem., 44*(11):1872–3, 1972.

14. P. M. Cook, 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. A. N. Rohl and A. M. Langer, Identification and quantitation of asbestos in talc, *Environ. Health Perspectives, 9:*95–109, 1974.

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

17. J. C. Haartz, 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, Environmental Sciences Laboratory, Mount

Sinai School of Medicine of the City University of New York, New York, New York.

19. A. M. Langer, 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.

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

21. E. Occella 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.

22. K. R. Spurny, W. Stöber, 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.

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

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

25. Reference 1, pp. 372–374.

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

27. J. A. Leroux, B. C. Davey, and A. Paillard, *Am. Ind. Hyg. Assoc. J., 34:*409, 1973.

[47 FR 23369, May 27, 1982; 47 FR 38535, Sept. 1, 1982; Redesignated at 60 FR 31922, June 19, 1995]

Subpart F [Reserved]

Subpart G—Asbestos Worker Protection

SOURCE: 65 FR 69216, Nov. 15, 2000, unless otherwise noted.

§ 763.120 What is the purpose of this subpart?

This subpart protects certain State and local government employees who are not protected by the Asbestos Standards of the Occupational Safety and Health Administration (OSHA). This subpart applies the OSHA Asbestos Standards in 29 CFR 1910.1001 and 29 CFR 1926.1101 to these employees.

§ 763.121 Does this subpart apply to me?

If you are a State or local government employer and you are not subject to a State asbestos standard that OSHA has approved under section 18 of the Occupational Safety and Health Act or a State asbestos plan that EPA has exempted from the requirements of this subpart under § 763.123, you must follow the requirements of this subpart to protect your employees from occupational exposure to asbestos.

§ 763.122 What does this subpart require me to do?

If you are a State or local government employer whose employees perform:

(a) Construction activities identified in 29 CFR 1926.1101(a), you must:

(1) Comply with the OSHA standards in 29 CFR 1926.1101.

(2) Submit notifications required for alternative control methods to the Director, National Program Chemicals Division (7404), Office of Pollution Prevention and Toxics, Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460.

(b) Custodial activities not associated with the construction activities identified in 29 CFR 1926.1101(a), you must comply with the OSHA standards in 29 CFR 1910.1001.

(c) Repair, cleaning, or replacement of asbestos-containing clutch plates and brake pads, shoes, and linings, or removal of asbestos-containing residue from brake drums or clutch housings, you must comply with the OSHA standards in 29 CFR 1910.1001.

§ 763.123 May a State implement its own asbestos worker protection plan?

This section describes the process under which a State may be exempted from the requirements of this subpart.

(a) *States seeking an exemption.* If your State wishes to implement its own asbestos worker protection plan, rather than complying with the requirements of this subpart, your State must apply for and receive an exemption from EPA.

(1) *What must my State do to apply for an exemption?* To apply for an exemption from the requirements of this subpart, your State must send to the Director of EPA's Office of Pollution Prevention and Toxics (OPPT) a copy of its asbestos worker protection regulations and a detailed explanation of how your State's asbestos worker protection plan meets the requirements of TSCA section 18 (15 U.S.C. 2617).

OSHA Standards Interpretation 1926.1101: Potential for Legal/Compliance Problems with OSHA's Asbestos Standards dated November 5, 1996

November 5, 1996

MEMORANDUM FOR: RUTH MCCULLY, DIRECTOR
HEALTH COMPLIANCE ASSISTANCE

FROM: GERARD RYAN
ASSISTANT REGIONAL ADMINISTRATOR
FOR TECHNICAL SUPPORT-VIII

SUBJECT: Potential for Legal/Compliance Problems with OSHA's Asbestos Standards

Questions continue to be raised in Region VIII regarding the issue of OSHA policy for separate layer sampling for determination of asbestos in building materials vs. the EPA rules regarding determination of percent asbestos. We continue to hold the position that OSHA's policy has been, and will continue to be that separate layer analysis must be done if an employer chooses to rebut presumption of asbestos in building materials older than 1981. Informal discussions with area consultants have revealed that they have seen employee over exposures to asbestos when wallboard systems with a topcoat of joint compound is sanded or wallboard systems are dismantled with no precautions.

However, further discussion with Region VIII EPA representatives indicate that misunderstandings regarding various nuances of OSHA, and both the AHERA and NESHAPS EPA asbestos rules are common. For example, although AHERA does not officially define their meaning of compositing, EPA uses this term in AHERA to mean mixing samples together that were obtained separately from a homogenous area for analysis. However, NESHAPS rules actually defines compositing in their 12/19/95 Federal Register notice to mean full depth sample. NESHAPS further defines compositing as it applies to wallboard systems, depending upon whether the joint compound is applied to cover seams and nail holes, or whether it has been applied as a skim coat on top of gypsum board.

NESHAPS requires each layer of a wallboard system to be treated separately and the results reported by layer (discrete stratum) when the wallboard system has a surface treatment, i.e., entire surface has a skim coat of a joint compound. If the joint compound is only applied to seams, corner bead, and or nails then EPA allows the composting of the various layers. Conversely, AHERA allows compositing of all layered bulk samples regardless of surface treatments. This seems to run contrary to OSHA's understanding and policy to require separate layer analysis for compliance with OSHA's asbestos regulation. Further confusing this issue is that OSHA allows employers/building owners to rebut presumed asbestos containing building materials if the employer follows the AHERA regulation.

Besides our discussions with EPA representatives here in Region VIII, we have also obtained copies of interpretation letters from EPA on these issues. These interpretations along with the Jan. 5, 1994 and the Aug. 1, 1994 EPA Federal Register Notices further clarify analysis of bulk samples obtained from multi-layered systems. The difficulty of these letters and the Notices is that they apply only to NESHAP.

OSHA may be legally weak if an employer following AHERA bulk sample analysis methods were cited by OSHA for not performing separate layer sampling and analysis. Under OSHA's regulation we allow the employer to rebut PACM if they follow AHERA rules on sampling and analysis. AHERA rules only required one-time sampling by schools, and have not been amended since the 1980's. NESHAPS asbestos rules which would apply to schools if they perform asbestos removal, require separate layer sampling and analysis, and have been amended several times since the 1980's. The amendments have embraced more state of the art sampling and analysis.

Region VIII will continue to uphold the OSHA position that separate layer analysis must be performed to determine asbestos content of building materials. However, we recognize, and bring forward to your attention and action, that we may be legally weak should a case proceed to trail. Any comments and or suggestions that you have would be appreciated.

Attachments

https://www.osha.gov/laws-regs/standardinterpretations/1997-02-07-0

January 17, 1995

Mr. Gerald Garrett
Garrett Laboratories, Inc.
8500 Stemmons Freeway, Suite 2020
Dallas, TX 75247-3804

Dear Mr. Garrett:

This is in response to your October 12, 1994 letter requesting an explanation of the scientific basis for differentiating the analysis of joint compounds from all other building materials. Additionally you state that the January 5, 1994 Federal Register appears to nullify the practice of compositing layered bulk samples to determine the asbestos content.

It has always been the policy of the asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP) program to have each layer of a multi-layered system analyzed for asbestos content when determining compliance with the asbestos NESHAP rules. Compositing layered bulk samples was only allowed for compliance with the Asbestos Hazard Emergency Act (AHERA) rule.

Joint compound when used as a skim coat on the entire wallboard system is treated as an add-on material. It is only when joint compound and/or tape is used specifically to cover the joints and nail holes in a wallboard system (not to cover the entire wallboard) that the materials may be averaged for a "composite" result. The decision to exempt joint compound and/or tape in this circumstance is based on practical enforcement issues and not epidemiological data. It would be difficult at best to find all the joints and nail holes in a wall system that are covered with asbestos-containing material, measure and add the surface areas together to determine if the 160 ft(2) threshold has been exceeded, and then abate only the regulated material. Essentially the whole wallboard system would have to be treated as regulated asbestos-containing material which would greatly increase the amount of material going to asbestos landfills unnecessarily.

This response was coordinated with the Office of Regulatory Enforcement and the Emissions Standards Division of the Office of Air Quality Planning and Standards. If you have any questions, please contact Tom Ripp of my staff at (202) 564-7003.

Sincerely,

John B. Rasnic

Manufacturing, Energy, and Transportation Division

Office of Compliance

https://www.osha.gov/laws-regs/standardinterpretations/1997-02-07-0

Texas Department of State Health Services: Analysis of Joint Compound for Asbestos Content

Texas Department of State Health Services

ASBESTOS REGULATORY CLARIFICATIONS

Environmental and Consumer Safety Section
Regulatory Services Division
ARC – 014
November 2001

Subject: Analysis of Joint Compound for Asbestos Content

BACKGROUND

The Texas Asbestos Health Protection Rules (TAHPR), National Emission Standards for Hazardous Air Pollutants (NESHAP), Occupational Health Safety and Health Administration (OSHA) rules, and Asbestos Hazard Emergency Response Act (AHERA) rules define ***asbestos-containing material (ACM)*** as material that contains greater than one percent asbestos. The EPA specified analytical methods for determining ***ACM*** for NESHAP and AHERA compliance in 1994, and thereby allowed composite analysis to be performed on multi-layered wall systems. Of these multi-layered wall systems, the EPA allowed joint compound, when used to fill cracks and voids in wall systems, to be considered non-ACM if the composite analytical result is equal to or less than one percent. By contrast, the TAHPR and OSHA rules do not recognize composite sample analysis for the purposes of defining ***ACM***. Since the NESHAP and AHERA often apply to projects that are also applicable to TAHPR and OSHA, there has been confusion as to the requirements for sampling and analyzing joint compound. This document clarifies how the Texas Department of State Health Services (DSHS) regulates demolition/renovation (D/R) projects involving asbestos-containing joint compound

RESPONSE

If more than one asbestos regulation applies to a project, the more stringent regulation prevails. The TAHPR does not allow composite sample analysis as part of an asbestos inspection performed inside a ***public building*** for a D/R project. Composite analysis is allowed when such inspections are performed in NESHAP facilities that are not ***public buildings***.

The OSHA rules do not allow material to be classified as non-ACM based on composite sample results. Therefore, when a private employer hires a crew to perform D/R work, composite analytical results may not be used to rebut the designation of presumed ACM. This regulation is focused to worker protection.

DISCUSSION

TAHPR

In 25 TAC §295.32, the TAHPR define ***ACM*** as follows:

> ***Asbestos-containing material (ACM)- Materials or products that contain more than 1.0 % of any kind or combination of asbestos, as defined by the Environmental Protection Agency (EPA) recommended methods as listed in EPA/600/R-93/116, July 1993 "Method for the Determination of Asbestos in Bulk Building Materials." This means any one material component of a structure or any layer of a material sample. Composite sample analysis is not allowed.***

In 25 TAC §295.32, the TAHPR define ***Asbestos-containing building material (ACBM)*** as follows:

> ***Asbestos-containing building material (ACBM) – Surfacing ACM, or miscellaneous ACM that is found in or on interior structural members or other parts of a public or commercial building.***

In 25 TAC §295.32, the TAHPR define ***inspection*** as follows:

Inspection – An activity undertaken in a school building, public building, or commercial building to determine the presence or location, or to assess the condition of, friable or non-friable asbestos-containing building material (ACBM) or suspected ACBM, whether by visual or physical examination, or by collecting samples of such material. This term includes reinspections of friable and non-friable known or assumed ACBM which has been previously identified. The term does not include the following:

> ***(A) periodic surveillance of the type described in 40 CFR §763.92(b) solely for the purpose of recording or reporting a change in the condition of known or assumed ACM.***
>
> ***(B) inspections performed by employees or agents of federal, state, or local government solely for the purpose of determining compliance with applicable statutes or regulations; or***

(C) visual inspections of the type described in 40 CFR §763.92(i) solely for the purpose of determining completion of response actions.

In the above definitions, the terms ***inspection***, ***ACBM***, and ***ACM*** are interrelated. The term ***inspection*** is focused to ***ACBM***, which in turn, is defined as types of ***ACM***. Since TAHPR does not allow composite analysis for determining ***ACM***, composite analysis may not be used when performing inspections of the interior space of ***public buildings*** for D/R projects.

NESHAP and AHERA

On September 30, 1994, the EPA published the *Asbestos Sampling Bulletin, Supplementary Guidance on Bulk Sample Collection and Analysis, U.S. EPA, OPPT/CMD (7404).* This document provides guidance for sampling and analysis of multi-layered wall systems, including wall systems that contain joint compound. With regard to joint compound, the guidance specifies that discrete layers be combined to produce a composite analytical result. If the composite result is less than or equal to one percent, the joint compound is not classified as ***ACM***, and no further analysis is required. If the composite result is greater than one percent, the joint compound is ***ACM***.

The EPA clarified in *Treatment of Layers of Wall*, January 13, 1994 (A960014) that joint compound is material used to fill nail holes, cracks and small spaces between sections of wallboard. Add-on material (e.g. troweled-on texture), not used as described above, is not considered joint compound, even if the substance is chemically similar to joint compound.

The EPA further clarified sampling requirements for multi-layered wall systems, not including joint compound, in the Federal Register, December 19, 1995 (*FRL-5399-3).* In this document, the EPA stated that, as an alternative to the standard PLM method, samples from multi-layered wall systems could be first analyzed gravimetrically as composite samples. If the results show the asbestos content to be greater than one percent, the material would be classified as ACM. If no asbestos were detected in the composite sample, the material would be classified as non-ACM. However, if the results indicate trace levels of asbestos up to one percent, the individual layers of the sample would then need to be reanalyzed. If the reanalysis showed that any layer within the sample contained greater than one percent, the layer would be classified as asbestos containing. According to this document multiple samples cannot be combined for composite analysis. The EPA stated that this alternative method is allowed to potentially reduce the time and cost of sampling analysis.

OSHA

OSHA issued a letter on July 10, 1996 (*TS/WEAVER/ws/July 3, 1996*), where the issue of composite analysis of ACM was addressed. The letter contains the following question and answer regarding wallboard systems (i.e. joint compound):

> ***In order to be in compliance with OSHA's "Communication of hazards" requirement as outlined in 29 CFR §1926.1101(k), does a completed inspection conducted pursuant to the requirements of AHERA 40 CFR Part 763, Subpart E fulfill OSHA requirements when wallboard systems are sampled as a composite material as allowed under AHERA and how can this conflict within the regulation be reconciled?***
>
> ***No, OSHA will not accept composite sampling even though the requirements of AHERA 40 CFR Part 763.86 were followed. If one is rebutting the designation of a material as PACM under §1926.1101(k)(5), each material must be analyzed separately to determine if it contains more than 1 % asbestos.***

FREQUENTLY ASKED QUESTIONS

1. When an asbestos inspection is performed inside a ***public building***, does DSHS allow joint compound to be analyzed as a composite sample?

   Answer: No. Composite sampling is not allowed under TAHPR for determining if a material is ACM.

2. When an asbestos inspection is performed on a facility that is not a ***public building***, does DSHS allow joint compound to be analyzed as a composite sample?

   Answer: Yes. The under the NESHAP, composite analysis of joint compound is allowed.

3. If an asbestos inspection is being done in a public building as part of a demolition does DSHS allow joint compound to be analyzed as a composite sample?

   Answer: No. Composite sampling is not allowed under TAHPR for determining if a material is ACM.

This Regulatory Clarification preempts any previous clarification/guidance/policy letters on this subject and remains in effect until superseded in writing by the Texas Department of State Health Services. Attributed use or reproduction of this information is freely granted.

US-EPA Applicability Determination Index Control No. C-112: Point Counting dated May 8, 1991

U.S. Environmental Protection Agency
Applicability Determination Index

Control Number: C112

Category:	Asbestos
EPA Office:	SSCD
Date:	05/08/1991
Title:	Point Counting
Recipient:	EPA Air Division Directors - Regions 1-10
Author:	Rasnic, John B.

Subparts: Part 61, M, Asbestos

References: 61.141

Abstract:

A sample in which no asbestos is detected by PLM does not have to be point counted; however, a minimum of at least three slide mounts should be prepared and examined in their entirety by PLM to determine if asbestos is present. If the amount by visual estimation appears to be less than 10 percent, the owner or operator may (1) assume the amount to be greater than 1 percent and treat the material as asbestos-containing material, or (2) require verification of the amount by point counting. If a result obtained by point count is different from a result obtained by visual estimation, the point count result will be used. A discussion of important considerations related to the quantitative analysis of asbestos in bulk samples is included.

Letter:

MEMORANDUM

SUBJECT: Clarification of Asbestos NESHAP Requirement to Perform Point Counting

FROM: John B. Rasnic, Acting Director
Stationary Source Compliance Division
Office of Air Quality Planning and Standards

TO: Air Management Division Directors
Regions III and IX

Air and Waste Management Division Director
Region II

Air Pesticides and Toxic Management Division Directors Region I, IV and VI

Air and Radiation Division Director
Region V

Air and Toxic Division Directors
Region VII, VIII and X

Revisions to the asbestos NESHAP were promulgated on November 20, 1990 and included a requirement to perform point counting to quantify asbestos in samples where the asbestos content is below ten percent. This requirement has been the subject of many questions, and the attached guidance document has been developed to clarify when point counting is required.

It should be understood that while the point count rule was published as a revision to the asbestos NESHAP, the intent of the revision is to improve the quantitative analysis of asbestos for all applications. Therefore, the revision is required for all NESHAP monitoring, under the conditions discussed in the attached clarification, and recommended for AHERA and other asbestos monitoring applications. This guidance document was prepared with the cooperation of the following parties: the National Institute of Standards and Technology, EPA's Office of Toxic Substances, Office of Research and Development, and the Emissions Standards Division and Stationary Source Compliance Division of the Office of Air Quality Planning and Standards. If you have any questions, please contact Scott Throwe of my staff at FTS 398-8699 or Michael Beard of the Office of Research and Development at FTS 629-2623.

Attachment

cc: Air Compliance Branch Chiefs
Asbestos NESHAP Coordinators
Sims Roy (MD-13)
David Kling (TS-799)

. CLARIFICATION OF NESHAP REQUIREMENT TO PERFORM POINT

COUNTING TO QUANTIFY ASBESTOS BELOW 10%

Since the amendment to the NESHAP for asbestos (Federal Register, Volume 55, Number 224, November 20, 1990) there have been several questions regarding the interpretation of the point count rule. Also, several recommendations for improving the quantitative analysis of asbestos in bulk samples have been made. This clarification notice addresses these questions and discusses the recommendations. A discussion of important considerations related to the quantitative analysis of asbestos in bulk samples follows the clarification statements. This clarification applies to all regulated asbestos-containing materials as defined in 40 CFR Section 61.141.

First, a sample in which no asbestos is detected by polarized light microscopy (PLM) does not have to be point counted. However, a minimum of three slide mounts should be prepared and examined in their entirety by PLM to determine if asbestos is present. This process should be carefully documented by the laboratory.

Second, if the analyst detects asbestos in the sample and estimates the amount by visual estimation to be less than 10%, the owner or operator of the building may (1) elect to assume the amount to be greater than one percent and treat the material as asbestos- containing material or (2) require verification of the amount by point counting.

Third, if a result obtained by point count is different from a result obtained by visual estimation, the point count result will be used.

DISCUSSION

The recently amended NESHAP for asbestos (Federal Register, V.55, N. 224, 11/20/90) requires that when the asbestos content of a bulk material is determined using procedures outlined in the interim method (40 CFR Part 763, Appendix A to Subpart F), and the asbestos content is estimated to be less than 10% by a method other than point counting, the quantitative analysis must be repeated using the point count technique. This action was taken after several reports of data from split samples analyzed by visual estimation by two or more laboratories produced conflicting results which made it difficult to determine if a sample should be classified as an asbestos-containing material. The materials were reanalyzed by point count and by interlaboratory exchange of prepared samples resulting in a consistent set of data.

A review of data from performance audits indicated an unacceptable number of false negatives (reporting the sample as containing less than 1% asbestos for asbestos-containing samples containing greater

than 1% asbestos) and an unacceptable number of false positives (reporting the sample as containing greater 1% asbestos for samples

containing less than 1% asbestos).

The Office of Research and Development (EPA/ORD) informally interviewed laboratories to determine the cause of these errors and learned that: (1) some laboratories did not view a sufficient amount of the sample to detect asbestos when present or failed to properly identify the asbestos component, resulting in false negatives and (2) some laboratories employed arbitrary rules for determining quantity, such as "one fiber detected is considered to be greater than 1%", resulting in false positives. Several round-robin studies and eighteen rounds of performance audit data indicate nearly all laboratories greatly overestimate the amount of asbestos using visual estimation techniques which are not related to standard materials of known composition. Because these false negatives and false positives result in either operations not being covered by NESHAP that should be, or unnecessary expenditure of funds for abatement, respectively, the Agency believes that additional effort on the part of the laboratory is warranted.

It should be noted that samples in which no asbestos is detected during analysis by polarized light microscopy (PLM) do not have to be point counted. However, a minimum of three slide mounts should be prepared and examined in their entirety by PLM to determine if asbestos is present. Point counting will not improve the probability of detection of asbestos where no asbestos has been detected by PLM unless the analyst has only made a very cursory examination of the sample. In fact, the detection limit for the point counting method would be higher (less likelihood of detection) than that expected by visual estimation due to the fact that the only asbestos fibers counted are those that fall directly under the reticle index (cross line or point array), whereas (in theory) all fibers are observed during visual estimation.

When asbestos is observed to be above the laboratory blank level during PLM analysis, but less than 1% asbestos counts are recorded during point counting, the laboratory should report the sample contains trace asbestos. Also, false negatives that result from (1) misidentification of asbestos fibers as nonasbestos or (2) due to the inability of the microscopist to detect and confirm the presence of asbestos, will not be corrected by the point counting technique. Accurate results by point counting are obviously dependent on correct identification of fibers. A similar relationship is true for false positives, although it would be expected that point counting could improve quantitative results, given the pervasive tendency of laboratories to overestimate asbestos content, especially at the lower concentrations (less than 10%). However, the laboratory should take care to examine a sufficient amount of any sample to be sure that it does not contain asbestos. If the sample is not homogenous, some homogenization procedure should be performed to ensure that slide preparations made from small pinch samples are representative of the total sample. 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 to nonasbestos noted. It is suggested that the amount of asbestos compared to the amount of nonasbestos material be recorded in several fields on each slide and the results be compared to data derived from the analysis of calibration materials having similar textures and asbestos content.

The parties legally responsible for a building (owner or operator) may take a conservative approach to being regulated by the asbestos NESHAP. The responsible party may choose to act as though the building material is an asbestos containing material (greater than 1% asbestos) at any level of asbestos content (even less than 1% asbestos). Thus, if the analyst detects asbestos in the sample and estimates the amount to be less than 10% by visual estimation, the parties legally responsible (owner or operator) for the building may (1) elect to assume the amount to be greater than 1% and treat the material as regulated asbestos-containing material or (2) require verification of the amount by point counting.

The interim method states that asbestos shall be quantified using point counting or an equivalent estimation technique. The agency (ORD) has been conducting research to determine procedures for defining "equivalent estimation". Recent studies have suggested that the use of gravimetrically prepared standard materials, in conjunction with quantitative techniques, can be used to improve the analyst's ability to estimate asbestos quantity. A procedure for the formulation of calibration materials and quality assurance (QA) procedures for their use has been drafted and is being tested. The Agency believes that use of such materials and QA procedures, as well as other objective measurement techniques, have the potential to greatly improve quantitative estimates of asbestos, especially in the range below 10%. If the research proves these procedures to be worthy, the Agency will consider proposing a revised method. A draft of the proposed procedure will be circulated to all NVLAP labs for comment when it has been approved internally.

US-EPA: Report No. 15-P-0168: EPA Should Update Guidance to Address the Release of Potentially Harmful Quantities of Asbestos That Can Occur under EPA's Asbestos Demolition Standard

U.S. ENVIRONMENTAL PROTECTION

OFFICE OF INSPECTOR GENERAL

Pollution Prevention

EPA Should Update Guidance to Address the Release of Potentially Harmful Quantities of Asbestos That Can Occur Under EPA's Asbestos Demolition Standard

Report No. 15-P-0168 **June 16, 2015**

Scan this mobile
code to learn more
about the EPA OIG.

Report Contributors:

Michael Wilson
Eric Lewis
Christine El-Zoghbi
Ben Beeson
Wendy Wierzbicki
Hilda Canes Garduño

Abbreviations

AACM	Alternative Asbestos Control Method
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
EPA	U.S. Environmental Protection Agency
NESHAP	National Emission Standards for Hazardous Air Pollutants
OAR	Office of Air and Radiation
OECA	Office of Enforcement and Compliance Assurance
OIG	Office of Inspector General
ORD	Office of Research and Development
OSWER	Office of Solid Waste and Emergency Response
PCM	Phase Contrast Microscopy
RACM	Regulated asbestos-containing materials
TEM	Transmission Electron Microscopy

Cover photo: Demolition and wetting of the AACM2 building. (EPA photo)

Are you aware of fraud, waste or abuse in an EPA program?

EPA Inspector General Hotline
1200 Pennsylvania Avenue, NW (2431T)
Washington, DC 20460
(888) 546-8740
(202) 566-2599 (fax)
OIG_Hotline@epa.gov

More information at www.epa.gov/oig/hotline.html.

EPA Office of Inspector General
1200 Pennsylvania Avenue, NW (2410T)
Washington, DC 20460
(202) 566-2391
www.epa.gov/oig

Subscribe to our Email Updates
Follow us on Twitter @EPAoig
Send us your Project Suggestions

U.S. Environmental Protection Agency
Office of Inspector General

15-P-0168
June 16, 2015

At a Glance

EPA Should Update Guidance to Address the Release of Potentially Harmful Quantities of Asbestos That Can Occur Under EPA's Asbestos Demolition Standard

Why We Did This Review

The U.S. Environmental Protection Agency (EPA), Office of Inspector General (OIG), evaluated the EPA's Alternative Asbestos Control Method (AACM) experiments to assess the amount of asbestos released into the environment. During a separate OIG review, we found conditions that caused us to review the impact of a portion of the Asbestos National Emission Standards for Hazardous Air Pollutants (Asbestos NESHAP).

Since 1973, the EPA's Asbestos NESHAP regulation has allowed buildings that are structurally unsound and in imminent danger of collapse to be demolished without first removing regulated asbestos-containing materials. The demolition of these buildings resulted in the generation of highly contaminated asbestos runoff wastewater.

This report addresses the following EPA goal or cross-agency strategy:

- *Addressing climate change and improving air quality.*

Send all inquiries to our public affairs office at (202) 566-2391 or visit www.epa.gov/oig.

The full report is at: www.epa.gov/oig/reports/2015/20150616-15-P-0168.pdf

What We Found

The AACM experiments show that under the EPA's Asbestos NESHAP standard, the demolition of buildings that are structurally unsound and in imminent danger of collapse, and constructed with an asbestos-containing joint compound or Transite, can release significant amounts of asbestos into runoff wastewater.

Under the EPA's asbestos demolition standard, demolishing buildings that are structurally unsound and in imminent danger of collapse can release enough asbestos into the environment to pose a potential risk to human health.

The untreated discharge of runoff wastewater can contaminate the soil at the site or the water into which it is discharged. The AACM experiments demonstrate that the amount of asbestos released into runoff wastewater can often exceed the legally reportable quantity for asbestos, which is 1 pound in a 24-hour period. As a result, the Asbestos NESHAP demolitions under the Code of Federal Regulations (CFR) at 40 CFR § 61.145(a)(3) could require notification to the National Response Center in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) § 103 if a reportable quantity is released into the environment.

Upon a CERCLA § 103 notification, the EPA is tasked with determining the seriousness of the release and the need for an immediate response or cleanup. To be consistent with the CERCLA process where reportable quantity releases are occurring during Asbestos NESHAP demolitions, the EPA needs to assess the potential public health risk posed by these releases.

Planned Corrective Actions

The acting Assistant Administrator for Air and Radiation did not agree with our recommendations. However, the agency agreed that its guidance in the area reviewed was "dated and disparate" and proposed alternative corrective actions, which we accept. The actions include assembling a team of experienced asbestos experts to advise and assist the Office of Air and Radiation in producing an updated consolidated guidance document which has practical application to the regulated community. All recommendations are resolved.

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

THE INSPECTOR GENERAL

June 16, 2015

MEMORANDUM

SUBJECT: EPA Should Update Guidance to Address the Release of Potentially Harmful Quantities of Asbestos That Can Occur Under EPA's Asbestos Demolition Standard
Report No. 15-P-0168

FROM: Arthur A. Elkins Jr.

TO: Janet McCabe, Acting Assistant Administrator
Office of Air and Radiation

This is our report on the subject review conducted by the Office of Inspector General (OIG) of the U.S. Environmental Protection Agency (EPA). This report contains findings that describe the problems the OIG has identified and planned corrective actions. This report represents the opinion of the OIG and does not necessarily represent the final EPA position. EPA managers, in accordance with established audit resolution procedures, will make final determinations on matters in this report.

The EPA office with primary responsibility for the issues evaluated in this report is the Office of Air Quality Planning and Standards within the Office of Air and Radiation.

Action Required

You are not required to provide a written response to this final report because you provided agreed-to corrective actions and planned completion dates to address the issues noted. The OIG may make periodic inquiries on your progress in implementing these corrective actions. Should you choose to provide a final response, we will post your response on the OIG's public website, along with our memorandum commenting on your response. You should provide your response as an Adobe PDF file that complies with the accessibility requirements of Section 508 of the Rehabilitation Act of 1973, as amended.

We will post this report to our website at http://www.epa.gov/oig.

Table of Contents

Appendices

Purpose

Section 103(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires a person in charge of a facility to immediately notify the federal government, through the National Response Center,[1] of any release of a hazardous substance equal to or in excess of its reportable quantity. The Code of Federal Regulations (CFR) at 40 CFR § 302.4 sets the reportable quantity for asbestos[2] at 1 pound of asbestos fibers released into the environment in a 24-hour period. The Asbestos National Emission Standards for Hazardous Air Pollutants (Asbestos NESHAP) provision for the demolition of buildings that are structurally unsound and in imminent danger of collapse, which is under 40 CFR § 61.145(a)(3) (subsequently referred to as the "imminent collapse provision"), does not require facility managers to consider whether a demolition could require the notice of a CERCLA reportable quantity release.[3]

The U.S. Environmental Protection Agency (EPA) conducted Alternative Asbestos Control Method (AACM) experiments, which included the demolition procedures in the imminent collapse provision and collected data on the amount of asbestos released. The Office of Inspector General (OIG) evaluated data from the AACM experiments to determine whether contractor actions during demolitions under the imminent collapse provision could trigger the notice of a release as required by CERCLA § 103. The only similarity drawn between the AACM experiments and NESHAP demolitions, under the NESHAP imminent danger of collapse provision, is the potential asbestos contamination of runoff wastewater.

Background

According to the U.S. Department of Health and Human Services, asbestos is a human carcinogen with no safe level of exposure, and can lead to serious diseases such as asbestosis, lung cancer and mesothelioma. Asbestos is a mineral that readily forms thin fibers. Since the unaided human eye cannot see individual asbestos fibers, microscopes are used to test for asbestos. The EPA uses optical Phase Contrast Microscopy (PCM) or Transmission Electron Microscopy (TEM)

---

[1] The U.S. Coast Guard runs the National Response Center, which is the sole federal point of contact for reporting all hazardous substance releases and oil spills.

[2] The 1-pound reportable quantity for asbestos is a statutory limit set under CERCLA § 102(b).

[3] In addition to the asbestos-related requirement set out in CERCLA, the Clean Water Act makes it unlawful to discharge any pollutant from a point source into waters that have a significant nexus to navigable waters, unless a permit is obtained under the EPA's National Pollutant Discharge Elimination System. Point sources include industrial facilities, municipal governments and other government facilities, and discrete conveyances such as pipes and man-made ditches. Under the Clean Water Act (40 CFR Part 122(g)(7)(vii)), asbestos is a pollutant that requires a National Pollutant Discharge Elimination System permit. In this situation, it is highly plausible that runoff water from an Asbestos NESHAP demolition—which potentially contains a large amount of asbestos—may drain into a storm sewer and move into navigable waters.

to identify and count the number of asbestos fibers present in environmental samples. PCM can measure large asbestos fibers.[4] TEM can measure both large and small asbestos fibers.[5] Chrysotile is a specific type of asbestos that had been used in numerous building materials produced by manufacturers of floor tile, roof shingles, wall and attic insulation, drywall joint compound, “popcorn” ceiling coatings, and Transite cement boards.

Asbestos NESHAP

The intent of the Asbestos NESHAP regulation is to protect the public by minimizing the release of asbestos fibers during activities that involve the processing, handling and disposal of asbestos-containing material. In 1973, the EPA issued the Asbestos NESHAP regulation (40 CFR Part 61–Subpart M) to protect human health by reducing asbestos exposure during building demolitions and other activities. The Asbestos NESHAP is a work practice standard which has no specific numerical limits on asbestos emissions; however, it requires zero visible emissions[6] to the outside air from activities relating to the processing, handling and disposal of asbestos-containing material.

Asbestos NESHAP Demolitions

Building demolitions take place all over the country. There is recognition of the significance of demolitions involving asbestos in buildings.

- The Maine Department of Environmental Protection states improper demolition activities may be the biggest source of asbestos exposure to the general public and trades people working on the project.[7]
- The Mississippi Department of Environmental Quality states that asbestos is a naturally occurring mineral that has been used extensively in building materials and products.[8]
- The South Dakota Department of Environment and Natural Resources state that building demolitions and renovations are a common occurrence in every town and city throughout the state and that many of these buildings contain asbestos.[9]
- A 2012 Department of Energy report stated: Many industrial structures built post-World War II up to the 1970s utilized siding and roofing materials containing asbestos fibers. Abatement has typically focused on manual removal techniques with necessary controls. However, due to their

---

[4] Larger asbestos fibers are those 5 µm or longer in length, with a diameter greater than or equal to 0.3 µm.

[5] Smaller asbestos fibers are those 5 µm or shorter in length, with a diameter less than 0.3 µm.

[6] See definition of “adequately wet” under Section 61.141 – Definitions; Section 61.145(c)(6)(i), and Section 61.150(a).

[7] http://www.maine.gov/dep/waste/asbestos/inspecreqdemo.html.

[8] http://www.deq.state.ms.us/mdeq.nsf/page/Air_AsbestosDemolitionandRenovationOperations.

[9] http://denr.sd.gov/des/wm/asb/asbdemolition.aspx.

> age, many structures clad with concrete asbestos board are no longer structurally sound, making manual removal difficult if not dangerous to perform.[10]

Demolition personnel must follow the Asbestos NESHAP regulation for the demolition of facilities with at least:

- 260 linear feet of regulated asbestos-containing materials (RACM) on pipes.
- 160 square feet of RACM on other facility components.
- 35 cubic feet of facility components where the amount of RACM could not be measured previously.

The Asbestos NESHAP and the Occupational Safety and Health Administration regulations require trained technicians to remove RACM intact in structurally sound buildings prior to their demolition. RACM contains more than 1 percent asbestos and is capable of becoming friable (when dry, crumbled, pulverized or reduced to powder by hand pressure). Removing RACM intact prior to the demolition reduces the release of asbestos fibers into the environment.

When RACM cannot be removed safely, the imminent collapse provision allows the RACM to remain in place during the demolition of "structurally unsound and in imminent danger of collapse" buildings. However, when the RACM is left in place, it must be "adequately wet" throughout the demolition to control asbestos air emissions. The Asbestos NESHAP defines "adequately wet" as to:

> 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.

The imminent collapse provision generates asbestos-contaminated runoff wastewater. The imminent collapse provision has no requirements to collect and treat the asbestos-contaminated runoff wastewater before its release into the environment.[11] The EPA explains that a release into the environment occurs when a hazardous substance is no longer contained or when waste drums are discarded

---

[10] http://tools.niehs.nih.gov/wetp/Public/DOE_Trainers/16_ABSTRACT_AACM_at_Hanford.pdf.

[11] The EPA's Asbestos NESHAP Demolition Decision Tree guidance recommends conducting a site assessment for all imminent collapse demolitions. This site assessment consists of visual inspection and comprehensive soil sampling. However, asbestos testing of soils can detect asbestos fiber content down to only 1 percent. In 2004, Office of Solid Waste and Emergency Response Directive 9345.4-05 explains that data from the Libby, Montana, Superfund site and other sites provide evidence that soil/debris containing significantly less than 1 percent asbestos can release unacceptable concentrations of asbestos fibers into the air.

or abandoned. In the case of Asbestos NESHAP demolitions, disposing of the runoff wastewater onto the ground or into a storm drain or sewer is a release into the environment.

Reportable Quantity of Asbestos Under CERCLA

CERCLA § 103(a) requires a person in charge of a facility to immediately notify the federal government (through the National Response Center) of any release of a hazardous substance equal to or in excess of its reportable quantity. CERCLA § 102(b) sets the reportable quantity for asbestos at 1 pound of asbestos fibers released into the environment in a 24-hour period. Since CERCLA § 103 has no requirements for monitoring or measuring releases, the amount of chemical released is to be estimated based on such information as past release data, engineering estimates, knowledge of the facility’s operations and release history, or best professional judgment. Specifically, the EPA requires the estimation of a reportable quantity to have a sound technical basis.

Use of CERCLA § 103 Notifications

The notification of a reportable quantity allows the EPA to focus resources on releases that are more likely to pose potential threats to public health and the environment. The EPA determines the seriousness of the release and the need for an immediate response or cleanup. The National Oil and Hazardous Substances Pollution Contingency Plan § 300.405 states that a CERCLA § 103 notification is one of eight ways the EPA discovers potential hazardous waste sites for further evaluation by the Superfund program.

CERCLA § 103 Enforcement

Failure to properly notify the National Response Center of a release of a reportable quantity can result in both civil and criminal penalties. The civil penalty under CERCLA is up to $25,000 per day for the first violation and up to $75,000 per day for a second violation. The criminal penalty upon conviction for failing to report, or for knowingly filing a false report, is a fine and/or up to 3 years imprisonment for the first offense and up to 5 years imprisonment for a repeat offense.

EPA’s Alternative Asbestos Control Method Project

Between 2005 and 2011, the EPA conducted research testing the effectiveness of an alternative demolition method to test the viability of amending the Asbestos NESHAP standard to include the AACM. During the AACM experiments, the EPA personnel and contractors wetted and demolished three buildings without removing all of the RACM prior to the demolition. The EPA personnel and contractors collected the runoff wastewater from the first two experiments and tested it for asbestos, before filtering and releasing it into the environment.[12]

The EPA's AACM research project demolished four separate buildings—each constructed with a commonly occurring source of RACM (e.g., drywall, Transite, and popcorn ceilings). The AACM research project consisted of the AACM1, AACM2 and AACM3 demolition experiments described below.

AACM1 Experiment

The AACM1 experiment demolished two nearly identical 1940s-era Fort Chaffee Redevelopment Authority buildings located in Fort Smith, Arkansas, and measuring about 30 feet by 150 feet. The AACM1 experiment conducted a side-by-side comparison of an Asbestos NESHAP-compliant demolition to the AACM demolition process. The building demolitions occurred in April and May 2006.

AACM1 building prior to demolition. (EPA photo)

The AACM demolition building contained 20,700 square feet of gypsum wallboard having a joint compound containing 4 to 10 percent asbestos. These buildings also contained some linoleum and floor tile. The AACM1 demolition compared the AACM and NESHAP processes on two architecturally identical buildings with asbestos-containing materials such as drywall, joint compound, tape and vinyl asbestos floor tile. Additionally, the experiment provided data regarding the amount of asbestos released to the air and runoff wastewater.

Interior of the AACM1 building shows the asbestos hazard (i.e., the asbestos-containing joint compound connecting the gypsum wallboard).[13] (EPA photo)

---

[12] The Asbestos NESHAP would not allow these demolitions unless the buildings were structurally unsound and in imminent danger of collapse.

[13] The room looks typical and requires a certified asbestos inspector to identify the hazard.

AACM2 Experiment

AACM2 building with added asbestos-containing Transite prior to demolition. (EPA photo)

The AACM2 experiment demolished a World War II-era, two-story Fort Chaffee Redevelopment Authority maintenance building located in Fort Smith, Arkansas, and measuring 32 feet by 48 feet by 14 feet. The building contained 2,778 square feet of Transite siding (i.e., asbestos-cement board). AACM2 evaluated the use of the AACM process on a Transite-covered building that was in danger of imminent collapse. The demolition occurred on July 28, 2007. Table 1 summarizes the AACM building descriptions, type of RACM, amount of RACM present, and the asbestos content of the RACM found in the AACM1 and AACM2 experiments.[14]

Table 1: Characteristics of the AACM1 and AACM2 buildings

Demolition	AACM building description and footprint size	Type of RACM	Amount of RACM	Asbestos content of RACM
AACM1	Single story, wood-frame construction 30′ x 150′ (4,500 sq. ft.)	Joint compound	Estimated 7,762 linear feet of drywall joints connecting 20,700 sq. ft. of wallboard	4–10 percent
AACM2	Maintenance building 32′ x 48′ x 14′ (1,536 sq. ft.)	Transite	2,778 sq. ft. of 3/8″-thick Transite cement board	30 percent

Source: The EPA's *Comparison of the Alternative Asbestos Control Method and the NESHAP Method for Demolition of Asbestos-Containing Buildings* (EPA/600/R-08/094: October 2008; revised December 2009). Also, the *Draft - Evaluation of the Alternative Asbestos Control Method at Site Two (AACM2) for Demolition of Asbestos-Containing Buildings* (EPA/600/R-09/006: October 22, 2009).

AACM3 Experiment

The AACM3 experiment demolished a 2,150-square-foot apartment building office at the former Oak Hollow Apartments in Fort Worth, Texas. The building contained 7,900 square feet of RACM in the form of popcorn ceilings and drywalls. The purpose of this experiment was to evaluate the environmental impacts of using the AACM to demolish a building that

---

[14] The patchwork material on the outside of the building is Transite, which the EPA added to increase the amount of asbestos released for testing purposes.

contained asbestos in the form of popcorn ceilings and wall coatings. The demolition occurred on December 17, 2007.

The AACM3 building with the asbestos-containing popcorn ceilings prior to demolition. (EPA photo)

Responsible Office

The Office of Air and Radiation (OAR), Office of Air Quality Planning and Standards, administers the Asbestos NESHAP regulation and is the responsible office.

Scope and Methodology

We conducted our work from March 2012 through December 2014. We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Our evaluation scope spanned the AACM experiments conducted from 2004 through 2011. We analyzed internal and external comments about alternative demolition methods, staff correspondence gathered through the 2004 Fort Worth Method, and 2010 AACM Freedom of Information Act requests. We also interviewed current and former personnel from the EPA’s Office of Policy (coordinator of the Fort Worth Method tests); OAR; Office of Enforcement and Compliance Assurance (OECA); Office of Research and Development (ORD); Office of General Counsel; Office of Solid Waste and Emergency Response (OSWER); and EPA Region 6.

We identified the following federal regulations, policies and guidance that document the requirements for reporting CERCLA § 103 releases:

Regulations. The EPA regulations addressing reportable quantities include 40 CFR Part 302 and the National Oil and Hazardous Substances Pollution Contingency Plan at § 300.170(c) and § 300.405(a).

Policies. OECA issued the EPA's CERCLA § 103 enforcement policy on September 30, 1999. The policy is titled *Enforcement Response Policy for Sections 304, 311, and 312 of the Emergency Planning and Community Right-to-Know Act and Section 103 of the Comprehensive Environmental Response, Compensation and Liability Act*. OECA's enforcement policy supersedes OSWER's June 1990 penalty policy (OSWER Directive 9841.2).

Guidance. Federal guidance addressing reportable quantities includes:

- The EPA's *Guidance for Federal Facilities on Release Notification Requirements Under CERCLA and SARA Title III* (EPA 9360.7-06: Nov. 1990).
- The Department of Energy's *CERCLA § 103 and EPCRA § 304 Release Notification Requirements Update* (DOE/EH-0447: Jan. 1995).
- OECA's 1990 memorandum titled *Inclusion of CERCLA Section 103(a) Counts in Asbestos NESHAP Cases*, which identifies the elements necessary to establish a CERCLA § 103(a) claim and provides a legal analysis of relevant statutes and regulations.

We applied the requirements for reporting CERCLA releases to our evaluation of whether Asbestos NESHAP demolitions using the imminent collapse provision can result in a release of a "reportable quantity" of asbestos. We used the EPA's AACM experimental data to calculate whether the unfiltered runoff wastewater in the AACM experiments would have exceeded the reportable quantity for asbestos, if released untreated. We did not evaluate the potential amount of asbestos released into the air.

Results of Review

The OIG evaluated data from the AACM experiments to determine whether contractor compliance during NESHAP demolitions under the imminent collapse provision could trigger the notice of a release as required by CERCLA § 103. The OIG's only source of performance data on the imminent collapse provision is from the AACM experiments, and the OIG's evaluation of these demolitions is limited to buildings constructed with either an asbestos-containing joint compound or Transite.

Imminent Collapse Provision Can Result in the Release of Reportable Quantities of Asbestos

The AACM and the Asbestos NESHAP imminent collapse provision establish similar demolition techniques. Both techniques do not require all of the RACM to be removed prior to demolition, but require the RACM to be wetted throughout the demolition to control asbestos air emissions. Both also generate asbestos-contaminated runoff wastewater. During the first two AACM experiments, the researchers determined the concentration of asbestos in the runoff wastewater. The AACM demolitions filtered the contaminated runoff wastewater and removed the contaminated soil to limit the release of asbestos into the environment.

Demolitions under the imminent collapse provision have no requirement to collect, test or treat contaminated runoff wastewater or to remove any contaminated soil. However, for the same type of building construction and RACM content, the amount of asbestos in the unfiltered runoff wastewater observed during the AACM demolitions provides an estimate of the amount of asbestos released in contaminated runoff wastewater generated during a demolition using the imminent collapse provision. The exact amount of asbestos released into the environment during an Asbestos NESHAP demolition is not directly known, because the Asbestos NESHAP regulation is a work practice standard and does not require any monitoring or testing for asbestos emissions.

Number of Asbestos Fibers in AACM1 and AACM2 Runoff Wastewater

In both of the AACM1 and AACM2 experiments, ORD directly measured the asbestos concentrations in the unfiltered runoff wastewater and found the water to be highly contaminated with asbestos. ORD determined the amount of asbestos fibers[15] released into the runoff wastewater through direct sampling and analytical testing of the runoff wastewater. AACM1 runoff wastewater contained 2.485 billion TEM structures per liter (TEM s/L). Since the AACM1 demolition generated 18,059 gallons of runoff wastewater, the unfiltered AACM1 runoff wastewater contained 170 trillion TEM structures. AACM2 runoff wastewater contained 42 billion TEM s/L. Since the AACM2 demolition generated

---

[15] In the AACM experiments, ORD measured the amount of asbestos in the unfiltered runoff wastewater as the concentration of asbestos structures per liter (the “s/L”). The EPA’s *Asbestos-Containing Materials in Schools* regulation, implementing the Asbestos Hazard Emergency Response Act of 1986 (40 CFR Part 763, Subpart E, Appendix A(II)(A)), defines asbestos structures as asbestos in the form of bundles, clusters, fibers or matrix. Therefore, the term asbestos structures is inclusive of asbestos fibers, but also counts bundles of asbestos fibers, clusters of asbestos fibers, and asbestos sticking fibers out of matrix particles. A bundle of multiple asbestos fibers and clusters of asbestos fibers are expected to weigh more than the typical individual fiber. Since the OIG estimated the weight of asbestos fibers, the OIG’s estimation generated a lower weight than what may be actually present if the increased weight of bundles and clusters could be incorporated into the estimation. Therefore, for the OIG’s purpose of estimating a reportable quantity, the number of asbestos structures is synonymous with the number of asbestos fibers.

12,186 gallons of runoff wastewater, the unfiltered AACM2 runoff wastewater contained 1,900 trillion TEM structures. Table 2 summarizes this information.

Table 2: Calculation of TEM structures released into unfiltered runoff wastewater

Demolition	Average asbestos concentration in unfiltered runoff wastewater (TEM structures/L)	Volume of unfiltered runoff wastewater generated in a 24-hour period (gallons)	TEM structures released into unfiltered runoff wastewater (TEM structures)[16]
AACM1	2,485,000,000	18,059[a]	1.7×10^{14}
AACM2	42,000,000,000	12,186	1.9×10^{15}

Source: OIG analysis of the EPA's *Comparison of the Alternative Asbestos Control Method and the NESHAP Method for Demolition of Asbestos-Containing Buildings* (EPA/600/R-08/094: October 2008; revised December 2009). Also, the *Draft - Evaluation of the Alternative Asbestos Control Method at Site Two (AACM2) for Demolition of Asbestos-Containing Buildings* (EPA/600/R-09/006: October 22, 2009).

Note: [a] On day one of demolition (May 1, 2006).

Weight of Asbestos in AACM1 and AACM2 Runoff Wastewater

To assess the potential for a reportable release of asbestos, the amount of asbestos fibers released during AACM1 and AACM2 experiments needs to be converted to weight in pounds. CERCLA § 103 does not require direct sampling and testing to determine whether a reportable quantity of asbestos has been released. Rather, CERCLA § 103 allows for a reasoned estimate of the size of the release. The EPA requires the estimation of a reportable quantity to have a sound technical basis.

Our estimate for the weight of asbestos exceeds the EPA requirement. We used ORD's direct measurement of the amount of asbestos fibers in AACM1 and AACM2 runoff wastewater. We converted the amount of asbestos fibers into weight by using the EPA's standard conversion factor for PCM fibers, the National Research Council's published conversion factor for TEM fibers, and the Agency for Toxic Substances and Disease Registry's published PCM fiber content of end-use commercial products.

We determined that the weight of asbestos in both of the AACM1 and AACM2 unfiltered runoff wastewater exceeded the reportable quantity for asbestos. We estimated the weight of asbestos in AACM1 and AACM2 unfiltered runoff wastewater to be 1.4 and 16 pounds, respectively. Table 3 summarizes the amount of asbestos in AACM1 and AACM2 unfiltered runoff wastewaters.

---

[16] Calculated as follows: TEM Asbestos Structures Released into the Unfiltered Runoff Wastewater (TEM s) = Avg. Asbestos concentration (TEM s/L) x Volume of Runoff Wastewater (gallons) x 3.785 liters/gallons.

Table 3: Weight of asbestos in unfiltered runoff wastewater above the reportable quantity

Demolition	Estimated asbestos weight released into unfiltered runoff wastewater (lbs.)	Reportable quantity for asbestos (lbs. released over 24 hours)	Amount of asbestos in unfiltered runoff wastewater above the reportable quantity (lbs.)
AACM1	1.4	1.0	0.4
AACM2	16	1.0	15

Source: OIG analysis of the EPA's *Comparison of the Alternative Asbestos Control Method and the NESHAP Method for Demolition of Asbestos-Containing Buildings* (EPA/600/R-08/094: October 2008; revised December 2009). Also, the *Draft - Evaluation of the Alternative Asbestos Control Method at Site Two (AACM2) for Demolition of Asbestos-Containing Buildings* (EPA/600/R-09/006: October 22, 2009).

Our results show that if either the AACM1 or AACM2 buildings had been demolished following the Asbestos NESHAP imminent collapse provision where the same amount of RACM was left in place (i.e., where no collection or filtration of the runoff wastewater is required), the amount of asbestos released into the runoff wastewater would have exceeded the reportable quantity for asbestos and would have required the National Response Center to be notified.

Minimum Building Size That Can Release a Reportable Quantity of Asbestos

The AACM demolitions provide data to estimate when a reportable quantity of asbestos is released during Asbestos NESHAP demolitions using the imminent collapse provision. Although the amount of asbestos released into runoff wastewater depends on many variables,[17] determining when a reportable quantity of asbestos could be released is helpful for understanding the scale of this issue. The AACM1 and AACM2 demolitions generated a reportable quantity of asbestos in the unfiltered runoff wastewater from: (1) buildings constructed with asbestos-containing drywall joint compound; and (2) buildings constructed with Transite.

Buildings Constructed With Asbestos-Containing Drywall Joint Compound

In a building constructed similar to the AACM1 building (i.e., 4 to 10 percent asbestos-containing joint compound being the principal asbestos fiber source), the AACM1 demolition shows that 1 pound of asbestos can be released into runoff wastewater after 3.6 hours of active demolition time.[18] This is enough time to demolish 5,545 linear feet of drywall joints connecting 14,786 square feet of wallboard. In terms of building size, the AACM1 demolition shows

---

[17] Variables include the type of RACM(s) present, the amount of each type of RACM present in the building, the asbestos content of each type of RACM, the level of wear or damage to the RACM, the friability of the RACM, the volume of water and force of the water spray used during the demolition, the type and frequency of mechanical forces used to demolish the building, and the length of the demolition.

[18] "Active demolition time" is used to characterize the actual time spent performing the mechanical crushing of the building, and transferring and loading building debris into waste trucks where the spraying of amended water is used to control asbestos air emissions during the demolition.

that 1 pound of asbestos can be released into runoff wastewater after only 3,214 square feet of a building is demolished. To put this building size into perspective, the U.S. Census Bureau identified the average single-family home in 2010 as being 2,392 square feet. Therefore, the demolition of a similarly constructed building, just 1.34 times larger than the average single-family home, could be sufficient to release a reportable quantity of asbestos into runoff wastewater.

Although the demolition of single-family homes is not required to follow the Asbestos NESHAP,[19] the AACM 1 experiment shows that the demolition of a large single-family home constructed with 4 to 10 percent asbestos-containing joint compound can release a reportable quantity of asbestos. Furthermore, if additional sources of RACM (e.g., popcorn ceilings or insulation) were present in the building, the minimum building size that can release a reportable quantity of asbestos upon demolition would be smaller.

Buildings Constructed With Transite

In a building constructed similar to the AACM2 building (i.e., Transite is the principal asbestos fiber source), the AACM2 demolition shows that 1 pound of asbestos can be released into runoff wastewater after just 25.4 minutes of demolition time. This is enough time to only demolish about 174 square feet of 3/8-inch thick Transite (the equivalent of 5.4 Transite wallboards measuring 4 feet by 8 feet). Since only 160 square feet of RACM present in a building invokes the requirement to follow the Asbestos NESHAP regulation, the AACM2 demolition indicates that virtually all buildings that are constructed with Transite—and are required to follow the Asbestos NESHAP—would release a reportable quantity of asbestos into the runoff wastewater upon demolition using the imminent collapse provision.

Table 4 summarizes when AACM1 and AACM2 demolitions generated a reportable quantity of asbestos into unfiltered runoff wastewater.

---

[19] The Asbestos NESHAP regulation specifically excludes residential buildings having four or fewer dwelling units (see 40 CFR § 61.141–Definition of facility).

Table 4: AACM1 and AACM2 buildings generating a reportable quantity of asbestos upon demolition

Demolition	Type of RACM	Length of active demolition time before runoff wastewater exceeded the reportable quantity	Amount of RACM demolished before the reportable quantity for asbestos was exceeded	Minimum size of the building demolished resulting in release of a reportable quantity of asbestos
AACM1	Joint compound	3.6 hours[a]	Estimated 5,545 linear feet of joints connecting 14,786 sq. ft. of wallboard	3214 sq. ft.
AACM2	Transite	25.4 minutes[b]	174 sq. ft. of 3/8″-thick Transite; or the equivalent of 5.4 Transite wallboards measuring 4′ x 8′ x 3/8″	96 sq. ft.

Source: OIG analysis of the EPA's *Comparison of the Alternative Asbestos Control Method and the NESHAP Method for Demolition of Asbestos-Containing Buildings* (EPA/600/R-08/094: October 2008; revised December 2009). Also, the *Draft - Evaluation of the Alternative Asbestos Control Method at Site Two (AACM2) for Demolition of Asbestos-Containing Buildings* (EPA/600/R-09/006: October 22, 2009).

Notes: [a] At a water spray rate of 60 gallons per minute.
[b] At a water spray rate of 30 gallons per minute.

Conclusion

Analysis of data collected by the EPA during the AACM experiments shows that under specific conditions Asbestos NESHAP demolitions (conducted under the "imminent danger of collapse" provision) can release significant amounts of wetted asbestos into the environment. Further, the AACM experiments demonstrate that the amount of wetted asbestos can exceed the legal standard for a reportable quantity of asbestos. As a result, Asbestos NESHAP demolitions using the imminent collapse provision could be noncompliant with CERCLA § 103 if a reportable quantity is released into the environment and not reported, or improperly reported. Because Asbestos NESHAP "imminent collapse" demolitions are allowed to occur and may be releasing harmful amounts of asbestos into the environment, the EPA needs to assess the potential public health risk posed by the release of reportable quantities of asbestos and inform the regulated community of the potential CERCLA § 103 reporting requirements.

Recommendations

We recommended that the Assistant Administrator for Air and Radiation:

1. Conduct an evaluation of the potential public health risk posed by the release of asbestos fibers through the untreated discharge of runoff wastewater during Asbestos NESHAP 40 CFR § 61.145(a)(3) demolitions of structurally unsound buildings in imminent danger of collapse.

2. Issue a technical report that is available to the public and details the findings of the evaluation done in response to Recommendation 1.

3. Implement actions needed as a result of the technical report in a timely manner, and include regulatory reviews or reviews that respond to the report's findings.

4. Consult and communicate with other EPA offices to share and discuss information about the outcomes of the OAR evaluation; and share any process, enforcement or regulatory changes.

Agency Response and OIG Evaluation

Comments received from the acting Assistant Administrator for Air and Radiation disagreed with the recommendations. In its comments, the agency asserts that the AACM experiments were not equivalent to imminent collapse Asbestos NESHAP demolitions and, as such, do not provide an appropriate basis for comparison. After review and consideration of the agency's comments, we maintain that the AACM experiments provide an appropriate basis for comparison in order to estimate the amount of asbestos released in the runoff wastewater during imminent collapse Asbestos NESHAP demolitions.

We met with the agency to discuss our findings and recommendations. The agency proposed to review, revise and consolidate what it agreed was "dated and disparate" Asbestos NESHAP guidance to include, but not limited to, addressing the issue of mitigating future releases of asbestos-contaminated runoff wastewater into the environment during subsequent Asbestos NESHAP demolitions, under the imminent danger of collapse provision. We accept the proposed alternative corrective actions, which are listed below. We believe the new guidance should address how it applies to former imminent collapse Asbestos NESHAP demolition sites.

Agency Corrective Actions: To mitigate the potential risk associated with asbestos demolitions under the NESHAP imminent danger of collapse provision, the EPA agreed to:

1. Assemble a team of experienced asbestos experts from the Technical Review Workgroup, OECA, OSWER, Office of General Counsel, on-scene coordinators, and asbestos inspectors to advise and assist OAR in producing an updated consolidated guidance document which has practical application to the regulated community.
2. Review rule applicability regarding containment of asbestos-contaminated waste materials at demolition sites (including, but not limited to, asbestos in demolition water).
3. Identify, review and revise, as appropriate, the pertinent existing guidance documents.

4. Collect, review and compile existing work practices into a set of implementation guidelines for containment of asbestos-contaminated waste materials, and materials contaminated by asbestos during the demolition process.
5. Collect and review existing applicability determinations issued by regional offices and headquarters that have a bearing on this issue.
6. Identify and review existing sampling and analysis methods that are applicable to asbestos in various media, and incorporate into the guidance as appropriate.
7. Consolidate relevant materials into a single set of guidance materials.
8. Implement guidance via outreach to local and state agencies and regional offices through team meetings, monthly Regional Asbestos Coordinator/ National Asbestos Council group meetings, technical conferences and symposia, and/or Web-based platforms.

The agency’s complete response and our comments are in Appendix A.

Status of Agreed-To Corrective Actions and Potential Monetary Benefits

ACTIONS						POTENTIAL MONETARY BENEFITS (in $000s)	
Action No.	Page No.	Action	Status[1]	Action Official	Planned Completion Date	Claimed Amount	Agreed-To Amount
1	14	Assemble a team of experienced asbestos experts from the Technical Review Workgroup, OECA, OSWER, Office of General Counsel, on-scene coordinators, and asbestos inspectors to advise and assist OAR in producing an updated consolidated guidance document which has practical application to the regulated community.	O	Assistant Administrator for Air and Radiation	4/30/16		
2	14	Review rule applicability regarding containment of asbestos-contaminated waste materials at demolition sites (including, but not limited to, asbestos in demolition water).	O	Assistant Administrator for Air and Radiation	4/30/16		
3	14	Identify, review and revise, as appropriate, the pertinent existing guidance documents.	O	Assistant Administrator for Air and Radiation	4/30/16		
4	15	Collect, review and compile existing work practices into a set of implementation guidelines for containment of asbestos-contaminated waste materials, and materials contaminated by asbestos during the demolition process.	O	Assistant Administrator for Air and Radiation	4/30/16		
5	15	Collect and review existing applicability determinations issued by regional offices and headquarters that have a bearing on this issue.	O	Assistant Administrator for Air and Radiation	4/30/16		
6	15	Identify and review existing sampling and analysis methods that are applicable to asbestos in various media, and incorporate into the guidance as appropriate.	O	Assistant Administrator for Air and Radiation	4/30/16		
7	15	Consolidate relevant materials into a single set of guidance materials.	O	Assistant Administrator for Air and Radiation	4/30/16		
8	15	Implement guidance via outreach to local and state agencies and regional offices through team meetings, monthly Regional Asbestos Coordinator/ National Asbestos Council group meetings, technical conferences and symposia, and/or Web-based platforms.	O	Assistant Administrator for Air and Radiation	4/30/16		

---

[1] O = Action is open with agreed-to corrective actions pending.
C = Action is closed with all agreed-to actions completed.
U = Action is unresolved with resolution efforts in progress.

Appendix A

Agency Response to Draft Report and OIG Comments

(Received February 27, 2015)

MEMORANDUM

SUBJECT: Response to Office of Inspector General (OIG) Draft Report No. OPE-FY13-0025 "Release of Potentially Harmful Quantities of Asbestos Can Occur Under EPA's Asbestos Demolition Standard", dated December 29, 2014

From: Janet G. McCabe
Acting Assistant Administrator

To: Carolyn Copper
Assistant Inspector General
Office of Inspector General

Thank you for the opportunity to review and comment on the Office of Inspector General's (OIG's) draft report titled, "Release of Potentially Harmful Quantities of Asbestos Can Occur Under EPA's Asbestos Demolition Standard", (Project No. OPE-FY13-0025), December 29, 2014. Using the data from earlier Alternative Asbestos Control Method (AACM) experiments, the OIG raises a concern that there is a potential for release of asbestos to water resulting when buildings, in danger of imminent collapse,[1] are demolished under the Asbestos National Emission Standards for Hazardous Air Pollutant (NESHAP) provisions and we respond to this concern in this memo.

The draft report recommends that the Assistant Administrator for OAR take the following actions:

1) Conduct an evaluation of the potential public health risk posed by the release of asbestos fibers through the untreated discharge of runoff wastewater during Asbestos NESHAP 40 CFR § 61.145(a)(3) demolitions of structurally unsound buildings in imminent danger of collapse.

2) Issue a technical report that is made available to the public and details the findings of the evaluation done in response to Recommendation 1.

---

[1] Under the asbestos NESHAP, if the facility is being demolished under an order of a State or local government agency, issued because the facility is structurally unsound and in danger of imminent collapse, the requirements of 61.145(b)(1), (b)(2), (b)(3)(iii), (b)(4) (except (b)(4)(viii)), (b)(5), and (c)(4) through (c)(9) of section 61.145 apply.

3) Implement actions needed as a result of the technical report in a timely manner, and include regulatory reviews or reviews that respond to the report's findings.

4) Consult and communicate with other EPA offices to share and discuss information about the outcomes of the OAR evaluation; and share any process, enforcement or regulatory changes.

After our meeting with the OIG on January 21 and February 19, 2015, to discuss the findings of this draft report, and after conducting discussions with other EPA offices, we disagree with the recommendations in this draft report for the following reasons:

- The AACM experiments were not the equivalent of Asbestos NESHAP demolitions performed under the imminent collapse provisions and, as such, do not provide an appropriate basis for the concern raised by the OIG or the recommendations in the draft report.

OIG Response: Comments received from the acting Assistant Administrator for Air and Radiation disagreed with the recommendations. In its comments, the agency asserts that the AACM experiments were not equivalent to imminent collapse Asbestos NESHAP demolitions and, as such, do not provide an appropriate basis for comparison. After review and consideration of the agency's comments, we maintain that the AACM experiments provide an appropriate basis for comparison in order to estimate the amount of asbestos released in the runoff wastewater during imminent collapse Asbestos NESHAP demolitions.

- The current Asbestos NESHAP work practice requirements and guidance already address the issue of potential site contamination from water runoff. In addition, action may be taken now under the Comprehensive Environmental Response, Compensation, and Liability Act **(**CERCLA**)** to address releases of asbestos.

OIG Response: We agree that guidance exists and we note that the OAR corrective actions will update that guidance.[2]

Further discussion of each of these points is provided in the attachment.

However, we share the OIG's concern regarding the potential for asbestos exposure. We recognize asbestos as a known human carcinogen, and note that there is no known safe level of exposure to asbestos. As we investigated the existing information to better understand and comment on the IG's findings, we identified several items where we could enhance implementation of the existing NESHAP.

The asbestos NESHAP was last amended in 1990, and around the early 1990's EPA developed guidance documents to assist in implementing the rule, including demolition work practices, containment of asbestos waste at a demolition site, applicability determinations for specific inquiries regarding application of the rule, and enforcement memoranda regarding prevention of site contamination during demolition activities. A variety of work practices in the field have been

---

[2] The guidance is not a part of the NESHAP regulation.

developed to prevent off-site migration of water and contamination of nearby properties, and the science and available technology (i.e., sampling and analysis methods) in some instances may have improved since these documents were last revised. However, these documents are disparate and dated and we believe could be reviewed, revised and consolidated into a single guidance document. We note however that the Administrator, through OAR, has the authority and the responsibility to determine the level of guidance appropriate to accompany existing regulatory actions.

Therefore, we intend to take the following actions, which also address the OIG's concerns raised in this draft report:

1- Assemble a team of experienced asbestos experts from the TRW, OECA, OSWER, OGC, on scene coordinators (OSC) and asbestos inspectors (AI) to advise and assist OAR in producing an updated consolidated guidance document which has practical application to the regulated community.
2- Review rule applicability regarding containment of asbestos-contaminated waste materials at demolition sites (including, but not limited to, asbestos in demolition water).
3- Identify, review and revise as appropriate, the pertinent existing guidance documents.
4- Collect, review, and compile existing work practices into a set of implementation guidelines for containment of asbestos-contaminated waste materials, and materials contaminated by asbestos during the demolition process.
5- Collect and review existing applicability determinations issued by regional offices and headquarters that have a bearing on this issue.
6- Identify and review existing sampling and analysis methods that are applicable to asbestos in various media, and incorporate into the guidance as appropriate.
7- Consolidate relevant materials into a single set of guidance materials.
8- Implement guidance via outreach to local and state agencies and regional offices through team meetings, monthly RAC/NAC group meetings, technical conferences and symposia, and / or web-based platforms.

Our anticipated milestones are to initiate the above in March 2015 and finish within a year (or by April 2016).

OIG Response: We accept these proposed alternatives and agree that the agency's proposed actions to review, revise and consolidate its existing Asbestos NESHAP guidance may address the issue of mitigating future releases of asbestos-contaminated runoff wastewater into the environment during subsequent Asbestos NESHAP demolitions. In addition, we believe the new guidance should address how it applies to former imminent collapse Asbestos NESHAP demolition sites.

ATTACHMENT

The AACM experiments are not the Equivalent of Imminent Collapse NESHAP demolitions.

According to the Asbestos NESHAP, an ordered demolition may be issued when a building, or portion of the building, is found to be both structurally unsound *and* in danger of imminent collapse. Because inhalation is the route of asbestos exposure, the work practices of the Asbestos NESHAP address this type of exposure. Use of water during ordered demolitions to maintain "adequately wet"[3] conditions minimizes release of asbestos to air from asbestos containing materials (ACM). However, to minimize the release of asbestos, the agency previously issued guidance[4] for demolition contractors and regulatory agencies to use while implementing the requirements of the NESHAP (see References 1 and 2).

We note here, as we did in our meeting with the OIG on January 21, 2015, that the AACM experiments were not the equivalent of imminent collapse NESHAP demolitions because the following provisions required by the NESHAP for a demolition under imminent collapse were not followed.

(1) 61.145 (c)(6)(ii) requires all RACM, including material that has been removed or stripped, to be carefully lowered to the ground and floor, not dropping, throwing, sliding, or otherwise damaging or disturbing the material. However, photographs taken during the AACM experiments showed heavy demolition equipment being driven over the regulated asbestos-containing materials (RACM).

OIG Response: This Asbestos NESHAP requirement concerns how to handle removed RACM (i.e., carefully lowering removed RACM to the ground). Since Asbestos NESHAP demolitions of structurally unsound and in imminent danger of collapse buildings are not required to remove RACM, this Asbestos NESHAP requirement is immaterial.

(2) Section 61.150(a) requires no visible emissions to the outside air during the collection, processing packaging, or transporting of any asbestos-containing waste material. However, visible emissions were observed during the demolition(s) and waste collection activities, which is inconsistent with these requirements.

---

[3] 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. 61.141 Definitions.

[4] Demolition Practices Under The Asbestos NESHAP (EPA 340-1-92-013 and Decision Tree Guidelines (U.S. Environmental Protection Agency, Manufacturing, Energy, and Transportation Division, Office of Compliance. June 1994, were issued shortly after promulgation of the Asbestos NESHAP in 1990 and are used extensively by states and local agencies to whom delegation status has been approved. These materials are also used for training asbestos inspectors and are available on our website (http://www2.epa.gov/asbestos/building-owners-and-managers#renovation), which provides further assistance to owners/operators and state and local agencies conducting ordered demolitions.

OIG Response: We do not assert that the AACM experiments followed NESHAP requirements or were equivalent in all respects to NESHAP demolitions. As we have stated, the issue of concern is asbestos contaminating the wastewater when the buildings are demolished with the RACM intact. That occurs under the NESHAP imminent collapse provision and occurred with the AACM experiments.

> (3) Sections 61.145 (c)(6)(i) and 61.150(a)(1) require that materials be adequately wet and kept wet until collected or contained or treated in preparation for disposal. Section 61.150(a)(3), which applies specifically to facilities demolished where the RACM is not removed prior to demolition, requires owners/operators to adequately wet asbestos-containing waste material at all times after demolition and keep wet during handling and loading for transport to a disposal site. However, as noted above, visible emissions were observed during the demolition(s) and waste collection activities, which is inconsistent with these requirements.

OIG Response: We do not assert that the AACM experiments followed NESHAP requirements or were equivalent in all respects to NESHAP demolitions. As we have stated the issue of concern is asbestos contaminating the wastewater when the buildings are demolished with the RACM intact. That occurs under the NESHAP imminent collapse provision and occurred with the AACM experiments.

Based on these inconsistencies with the work practice requirements of the asbestos NESHAP, the AACM experiments were not equivalent to demolitions typically conducted under the asbestos NESHAP. We also note that a previous OIG report on these experiments came to the same conclusion.[5]

OIG Response: This quote (see footnote 5) does not appear in the OIG report. Our previous report identified that the AACM is not an approved demolition technique and cannot be used for the demolition of structurally sound buildings where it is safe for contractors to remove the asbestos prior to demolition. Our previous report did not compare or evaluate the AACM experiments against the imminent collapse Asbestos NESHAP demolitions.

The current Asbestos NESHAP rule and guidance address the issue of potential site contamination from water runoff.

The guidance for demolition contractors has several sections devoted to imminent collapse demolitions. The rule includes isolation and proper disposal of RACM contaminated debris, and a post demolition site assessment. The site assessment would include visual evaluations and a comprehensive soil sampling scheme to detect any asbestos remaining in the soil. If asbestos is detected, the guidance states the site should be decontaminated.

---

[5] In an OIG early warning report dated December 14, 2011, the OIG stated "it is clear that the AACM demolitions are not representative of Asbestos NESHAP-compliant demolitions."

OIG Response: EPA's Asbestos NESHAP Demolition Decision Tree Guidance (dated June 29, 1994) recommends any NESHAP demolitions occurring without first removing all of the RACM should undergo a post-demolition site assessment. A site assessment, according to this guidance, is comprised of a visual evaluation and a comprehensive soil sampling. However, since asbestos fibers are too small to be seen by the unaided eye, asbestos soil contamination cannot be identified by a visual inspection. Therefore, we do not believe a visual inspection is health protective.

Soil testing for asbestos contamination can detect asbestos fiber content down to only 1 percent. However, OSWER Directive 9345.4-05 (issued August 10, 2004) identified that the use of the 1 percent threshold for asbestos in soil is not a risk-based site clean-up standard and may not be protective of human health. Therefore, we do not believe the current NESHAP soil testing guidance is health protective.

EPA's Asbestos NESHAP Demolition Decision Tree Guidance (dated June 29, 1994) recommends that imminent collapse Asbestos NESHAP demolition sites "must be cleaned up to background levels of asbestos contamination." This guidance also states that "to clean up the site to background levels, it will probably be necessary to remove all the asbestos contaminated soil." We believe this language acknowledges that imminent collapse Asbestos NESHAP demolitions contaminate the soil and may require it to be removed and disposed of as asbestos-containing waste.

The EPA corrective actions should address these issues.

Regulatory Actions Under CERCLA Also Address Releases of Asbestos

In addition to the work practices of the Asbestos NESHAP, action may be taken under CERCLA to address releases of asbestos. In such enforcement actions, all that must be shown is a failure to adhere to the work practices of the Asbestos NESHAP. If that is the case, then enforcement may proceed under CERCLA's definition of a release and/or failure to notify and report, and the asbestos NESHAP's provisions (61.150(a)) for failure to contain asbestos waste. CERCLA has pursued such cases since the 1980's, and these include instances in which wind blew asbestos off site, leaching of asbestos into the soil, and releases of asbestos into public and private sewer systems. EPA has previously issued guidance on the inclusion of CERCLA counts when an asbestos release has occurred (See Reference 3).

OIG Response: We agree that a failure of demolition contractors to adhere to the Asbestos NESHAP work practices may result in an enforcement action. However, we restate our concern that even fully compliant imminent collapse Asbestos NESHAP demolitions can still release reportable quantities of asbestos through the uncontrolled discharge or unfiltered discharge of the contaminated runoff wastewater. Therefore, even fully compliant imminent collapse Asbestos NESHAP demolitions could be noncompliant with CERCLA's reportable quantity requirements.

The EPA's 1990 guidance on the inclusion of CERCLA 103(a) counts in asbestos NESHAP cases (see reference 3) identifies that regardless of whether a demolition contractor knew of the reportable release of asbestos, the demolition contractor is still liable for any resulting harm from the release. The EPA should consider this in any updated NESHAP guidance issued in response to our report.

REFERENCES

1. Demolition Practices Under The Asbestos NESHAP (EPA 340-1-92-013) - http://www2.epa.gov/asbestos/building-owners-and-managers#renovation

2. Decision Tree Guidelines (U.S. Environmental Protection Agency, Manufacturing, Energy, and Transportation Division, Office of Compliance), June 1994 - http://www2.epa.gov/asbestos/building-owners-and-managers#renovation

3. Enforcement: Inclusion of CERCLA Section 103(a) Counts in Asbestos NESHAP Cases, Memorandum, June 1990 - http://www2.epa.gov/asbestos/building-owners-and-managers#renovation

Distribution

Office of the Administrator
Assistant Administrator for Air and Radiation
Agency Follow-Up Official (the CFO)
Agency Follow-Up Coordinator
General Counsel
Associate Administrator for Congressional and Intergovernmental Relations
Associate Administrator for Public Affairs
Deputy Assistant Administrator for Air and Radiation
Director, Office of Air Quality Planning and Standards, Office of Air and Radiation
Audit Follow-Up Coordinator, Office of Air and Radiation
Audit Follow-Up Coordinator, Office of Air Quality Planning and Standards,
    Office of Air and Radiation