SDMS Document ID
1000188

Libby Asbestos Project
Libby, Montana

Stimson Lumber Company

November 2001

Draft Sampling and Analysis Plan

Draft
Sampling and Analysis Plan
for
Stimson Lumber Company
Libby, Montana

EPA Region VIII

November 2001

Contract No. DTRS57-99-D-00017
Task Order No. C0016

Prepared for:

U.S. Environmental Protection Agency - Region VIII
Emergency Response Office
Denver, Colorado

Prepared by:

U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe Center National Transportation Systems Center
Environmental Engineering Division, DTS-33
55 Broadway, Kendall Square
Cambridge, Massachusetts 02142

and

CDM Federal Programs Corporation
One Cambridge Place
50 Hampshire Street
Cambridge, Massachusetts 02139

Draft
Sampling and Analysis Plan
for
Stimson Lumber Company
Libby, Montana

EPA Region VIII

November 2001

Contract No. DTRS57-99-D-00017
Task Order No. C0016

Prepared By: _____ Date: 5 NOV 01
Thomas E. Cook
CDM Federal Project Scientist

Approved By: _____ Date: _____
Tim Wall
CDM Federal Project Manager

Reviewed By: _____ Date: _____
RoseMary Gustin
CDM Federal QA Director

Approved By: _____ Date: _____
John McGuiggin
Volpe Center Project Manager

Approved By: _____ Date: _____
Paul Peronard
EPA On-Scene Coordinator

Contents

Section 1 Introduction

1.1 Project Objectives 1-1
1.2 Project Organization and Responsibilities 1-2

Section 2 Project Background

2.1 Source of the Vermiculite 2-1
2.2 Environmental Setting 2-1
2.2.1 Site Description/Known History 2-2
2.2.2 Previous Investigation 2-3
2.3 Contaminant of Concern 2-3

Section 3 Data Quality Objectives

3.1 Problem Statement 3-1
3.2 Identify the Decision 3-1
3.3 Inputs to the Decision 3-2
3.4 Boundaries for the Removal Assessment 3-2
3.5 Decision Rule 3-3
3.6 Specify Tolerable Limits on Decision Errors 3-3
3.7 Optimize the Decision for Obtaining Data 3-4

Section 4 Field Activities and Sampling Procedures

4.1 Site Information and Access Agreements 4-1
4.2 Site Investigation and Photographic Documentation 4-1
4.3 Soil Sampling 4-1
4.3.1 Selecting Soil Sampling Locations 4-1
4.3.2 Sample Identification 4-3
4.3.3 Collection and Analysis of Soil Samples 4-3
4.3.4 Sample Documentation 4-4
4.3.5 Sample Custody, Packaging, and Shipping 4-4
4.3.6 Quality Control Samples 4-5
4.3.7 Equipment Decontamination 4-6
4.3.8 Health and Safety 4-6
4.4 Waste / Product Sampling 4-7
4.4.1 Selecting Sample Locations 4-7
4.4.2 Sample Identification 4-7
4.4.3 Collection and Analysis of Waste/Product Samples 4-7
4.4.4 Sample Documentation 4-7
4.4.5 Sample Custody, Packaging, and Shipping 4-8
4.4.6 Quality Control Samples 4-8
4.4.7 Equipment Decontamination 4-9
4.4.8 Health and Safety 4-10
4.5 Personal Air Sampling 4-10
4.5.1 Selecting Sample Locations 4-10

4.5.2 Sample Identification 4-10
4.5.3 Collection and Analysis of Personal Air Samples 4-10
4.5.4 Sample Documentation 4-11
4.5.5 Sample Custody, Packaging, and Shipping 4-11
4.5.6 Quality Control Samples 4-12
4.5.7 Equipment Decontamination 4-12
4.5.8 Health and Safety 4-12
4.6 Ambient Air 4-13
4.6.1 Selecting Sample Locations 4-13
4.6.2 Sample Identification 4-13
4.6.3 Collection and Analysis of Ambient Air Samples 4-13
4.6.4 Sample Documentation 4-13
4.6.5 Sample Custody, Packaging, and Shipping 4-14
4.6.6 Quality Control Samples 4-14
4.6.7 Equipment Decontamination 4-15
4.6.8 Health and Safety 4-15
4.7 Microvacuum Dust Sampling 4-15
4.7.1 Selecting Sample Locations 4-15
4.7.2 Sample Identification 4-15
4.7.3 Collection and Analysis of Microvacuum Dest Samples 4-16
4.7.4 Sample Documentation 4-16
4.7.5 Sample Custody, Packaging, and Shipping 4-16
4.7.6 Quality Control Samples 4-16
4.7.7 Equipment Decontamination 4-17
4.7.8 Health and Safety 4-17

Section 5 Laboratory Analytical Methods 5-1

Section 6 Quality Assurance / Quality Control 6-1
6.1 Instrument Calibration and Frequency 6-1
6.2 Assessment and Response Actions 6-1
6.2.1 Audits / Self Assessments 6-1
6.2.2 Corrective Action Procedures 6-2

Section 7 Data Reporting and Deliverables 7-1

Section 8 References 8-1

Appendices

Appendix A - Previous Site Investigation Sample Results
Appendix B - Field Sample Data Sheets
Appendix C - Standard Operating Procedures
Appendix D - Site Health and Safety Plan
Appendix E - Laboratory Analytical Methods
Appendix F - Site Photographs

Figures

Figure 2-1 Site Location Map (Stimson Lumber Yard)
Figure 4-1 Former Popping Plant Sampling Locations
Figure 4-2 Railway Area Sampling Locations
Figure 4-3 Champion Nursery Conceptual Sampling Locations
Figure 6-1 Improvement Plan

Tables

Table 3-1 Summary of Available PCM and TEM Based Exposure Levels for Asbestos
Table 4-1 Sampling Supply and Equipment Checklist
Table 5-1 Summary of Analytical Methods

Plates

Plate 1 Stimson Lumber Company - Libby Operations Site Plan

Acronyms

ACM	asbestos-containing material
AIHA	American Industrial Hygiene Association
ASTM	American Society for Testing and Materials
CDM Federal	CDM Federal Programs Corporation
CDM Inc.	CDM Inc.
cm^2	square centimeter
COC	chain-of-custody
DI	deionized
DPT	direct-push technique
DQO	data quality objective
EDR	Environmental Data Resources
EPA	U.S. Environmental Protection Agency
IAG	interagency agreement
in.	inches
IR	infrared
L/min	liters per minute
µm	micron
MCE	mixed cellulose ester
MCS	MCS Environmental
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NPL	national priorities list
OSC	on-scene coordinator
OSHA	Occupational Safety and Health Administration
PCM	phase contrast microscopy
PES	Pacific Environmental Services, Inc.
PLM	polarized light microscopy
SAP	sampling and analysis plan
SDG	sample delivery group
SHSP	site health and safety plan
SOP	standard operating procedure
TEM	transmission electron microscopy
TO COTR	Volpe Center task order contracting officer's technical representative
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
Volpe Center	John A. Volpe National Transportation Systems Center
°F	degrees Fahrenheit

Section 1
Introduction

The U.S. Department of Transportation's John A. Volpe National Transportation Systems Center (Volpe Center) has an Interagency Agreement (IAG) with the U.S. Environmental Protection Agency (EPA) Region VIII for environmental engineering and related support.

Since November 1999, the Environmental Engineering Division (DTS-33) of the Volpe Center has been providing EPA Region VIII with immediate environmental engineering and site assessment support at Libby, Montana. The Volpe Center, its contractor CDM Federal Programs Corporation (CDM Federal), and CDM Federal's subcontractor Pacific Environmental Services, Inc. (PES), were requested by EPA Region VIII to conduct walk-through site visits and subsequent sampling activities to support emergency response activities at specified commercial and industrial facilities within the Libby, Montana vicinity where potential sources of tremolite/actinolite asbestos contamination exists.

This sampling and analysis plan (SAP) defines the sampling and analytical procedures that will be used for conducting soil, waste/product, air, and dust sampling at the Stimson Lumber facility in Libby, Montana.

1.1 Project Objectives

The objectives of the Stimson Lumber Company investigation are to:

1) Document any observed evidence of vermiculite product or other related waste with detailed notes and digital photographs.

2) Determine the vertical and horizontal extent of asbestos contamination in site soils.

3) Evaluate the ambient airborne asbestos fiber levels in site buildings to determine if there is a possible health hazard.

1.2 Project Organization and Responsibilities

Organization and responsibilities specific to this field investigation are listed in this section. For this data collection effort, key management personnel are as follows:

Individual	Role
Paul Peronard	EPA On-Scene Coordinator (OSC)
Duc Nguyen	EPA OSC
Chris Weis, Ph. D.	EPA Regional Toxicologist
John McGuiggin	Volpe Center Project Manager
Courtney Zamora	Volpe Center Field Team Leader
Tim Wall	CDM Federal Task Order Manager
David Schroder	CDM Federal Task Leader
Brian Stewart	PES Task Leader (dust/air/bulk product)
Greg Parana	PES Field Team Member (dust/air/bulk product)
Tommy Cook	CDM Federal Field Team Member (soil/waste)
Krista Lippoldt	CDM Federal Quality Assurance Coordinator

The entire field and data gathering effort will be conducted by a team consisting of two CDM Federal members who will be responsible for the soil and waste sampling and a PES member in charge of the dust, ambient air, and bulk product sampling.

Section 2
Project Background

2.1 Source of the Vermiculite

The Town of Libby is located in the extreme northwest corner of Montana. According to historical mining records, up to 80 percent of the world's vermiculite has come from the W.R. Grace Vermiculite Mine located on Zonolite Mountain, approximately seven miles northeast of Libby. Vermiculite is a mineral that is used in various building materials and textiles. Disseminated within the enormous deposit of vermiculite on Zonolite Mountain is the mineral tremolite, a rare and exceedingly toxic form of asbestos. Over the approximately 60-year life of the mine, tremolite asbestos was released into the environment as a by-product of the mining and ore-processing activities.

The Zonolite Mine began operation in 1924 by owner Edward Alley. In 1925, Great Northern Railroad shipped the first boxcar of "zonolite" from Libby to an Ohio company that used it to insulate bank vaults, office safes, and filing cabinets. Other firms used the material to make building boards and roofing materials. Processing the material was straightforward. The vermiculite ore was stripped from the mine and hauled in trucks to a mill, where it was separated into various commercial sizes through a screening system. Some of the ore was shipped untouched. Other material was sent to an expansion plant where it was run through ovens at about 2,000 degrees Fahrenheit (°F), causing the material to expand to 15 times its original size. In 1939, Alley's Zonolite Mine merged with another mining company that eventually became known as the Zonolite Co.

In 1963, the company was sold to W.R. Grace and Co. who expanded the operation and increased production. Through the '60s, '70s, and '80s, millions of tons of Libby vermiculite ore were shipped by rail to W.R. Grace plants and other companies in 30 states and six foreign countries. According to historical records, the property currently occupied by Stimson Lumber in Libby, Montana has been a recipient of vermiculite product for further processing, nursery amendments, and construction materials.

2.2 Environmental Setting

Mean annual precipitation in Libby is 19.4 inches (in.), with 37 percent of it occurring in the months of November through January, and 18 percent falling in the months of May and June. The month having the highest average precipitation is January, with 2.42 in. Average ambient temperature in Libby ranges from 22.4°F in January, to 67°F in July. Average annual precipitation at the W.R. Grace mine site is estimated at 20 in. per year (U. S. Department of Agriculture [USDA] 1977), and the temperature would

be expected to average 3 to 5 degrees cooler than at Libby. Climatological data was obtained from the Libby 1 N.E. Ranger station.

The Stimson Lumber facility is situated in the eastern section of Libby on U.S. Highway 2 South (Figure 2-1). Portions of the Stimson Lumber Company facilities are located on land formerly used in the production of ore into vermiculite insulation. Additionally, vermiculite insulation was installed in structures currently occupied by Stimson Lumber Company employees.

2.2.1 Site Description/Known History

The site is currently owned by Stimson Lumber Company and is used for the manufacturing of plywood (Plate 1). The site is approximately 200 acres in size and is occupied by various buildings, processing plants, and storage sheds.

A site visit (meeting) was conducted on September 28, 2001 by Mr. David Schroeder (CDM Federal Task Leader), Mr. Greg Parana (PES Field Team Member), and Dr. Chris Weis (EPA Regional Toxicologist). Stimson Lumber personnel present included Mr. Fred Sturgess (Libby Complex Manager), Ms. Veronica Bovee (Health and Safety Coordinator), Mr. John Chopot (Environmental Manager), and Mr. Barry Brown (Local Union #2581 President). The site visit included interviews with current employees and a walk-through of five areas of concern:

- Gravel parking lot (former popping plant)
- Railroad spur (north of gravel parking lot)
- Former landscaping nursery lot (Champion Nursery)
- Central Maintenance building
- Planer plant (plywood processing)

The unpaved parking area used by Stimson Lumber employees was once used as an aboveground storage area for uncontainerized vermiculite insulation. Vermiculite insulation was stockpiled directly on the native soil surface and may have contaminated the area with measurable amounts of asbestos mineral fibers. The area was converted to a parking lot in 1990.

A railroad spur exists near the former popping plant location. This siding was used for shipping raw and processed vermiculite material to and from the site. It is suspected that this section of the railroad is contaminated with tremolite asbestos from loading/unloading operations.

A landscaping nursery was previously located along the southern boundary of the lumber mill. It is believed that un-exfoliated, or raw vermiculite product, was introduced to the site for use as a growth media and fill material. Currently the area remains a vacant lot with sparse vegetation. The lot is currently used to stockpile wood chips (collected from 1991 through 1997).

The Central Maintenance building is currently insulated with vermiculite insulation. This structure is equipped with a large gantry crane that traverses the length of the building. Movement of this crane causes vibration within the structure and release of small amounts of vermiculite insulation from around seams and joints of the clapboard walls. Employees routinely inspect and seal leaking seams and joints with an expanding spray foam caulking compound.

The planer plant is currently used for processing plywood. According to historical records, vermiculite insulation was used as an insulator for the plywood dryers. The Big Dryer #1 is the dryer of concern. According to Stimson employees, the Big Dryer was modified in 1986-87 and it is believed that vermiculite material was added to the concrete as well as sandwiched between the top of the dryer and the concrete layer. The Little Dryer #2 was modified in 1996 and does not contain any vermiculite material.

2.2.2 Previous Investigation

At the request of Stimson Lumber Company, MCS Environmental (MCS) performed industrial hygiene sampling to determine the potential residual asbestos exposure of Stimson Lumber Company employees. In addition, soil and bulk samples were taken from various locations around the site including the Central Maintenance building, the former nursery, and the gravel parking lot. Air samples taken from employees working within the Central Maintenance building and the planer plant revealed concentrations of tremolite asbestos below Occupational Safety and Health Administration (OSHA) regulation. While analysis of soils collected from the parking lot were all non-detects, soil collected from the nursery area had concentrations of tremolite asbestos as high as 5%. Results of samples previously collected in areas of concern associated with this sampling plan are included in Appendix A.

2.3 Contaminant of Concern

The only potential contaminant of concern being investigated at this site is asbestos. Asbestos fibers are odorless and tasteless and vary in length, structure, and chemical composition. Fibers are microscopic and environmentally persistent. They do not evaporate, burn or dry out from heat, or erode in water. Toxicity of different type fibers varies, but exposure to any one of them can be fatal. Tremolite, the form found at Libby, is considered by many to be the most toxic.

The human health risks associated with asbestos fibers released in the environment include:

- Malignant mesothelioma, a cancer of the pleural or peritoneal cavity. In early stages of the disease, cancer is found in the lining of the chest cavity near the lung and heart or in the diaphragm. Mesothelioma may spread to tissue surrounding the lungs or other organs. Virtually all mesothelioma cases are attributable to asbestos exposure.

- Asbestosis, the scarring of the tissue of the lung itself from inhalation of fibers. It ranges in severity from mild impairment to disabling and eventually fatal.

Asbestos and smoking both cause lung cancer, but a history of smoking combined with exposure to asbestos creates a much higher risk of developing asbestos-related diseases.

0 600 1200 Feet

N

CDM Federal Programs Corporation

A Subsidiary of Camp Dresser & McKee Inc.

LEGEND

Stimson Lumber Yard

DRAFT

Figure 2-1
Site Location Map
Stimson Lumber Yard
Libby, Montana

Section 3
Data Quality Objectives

To ensure that data of sufficient quality and quantity are collected to meet project objectives, the data quality objective (DQO) process (EPA 2000) was utilized to develop DQOs for the soil, waste/product, dust, and air sampling tasks. The DQO process is a series of steps based on the scientific method that are designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended purpose. The DQO process consists of the following seven steps:

Step 1:	State the Problem
Step 2:	Identify the Decision
Step 3:	Identify Inputs to the Decision
Step 4:	Define the Study Boundaries
Step 5:	Develop a Decision Rule
Step 6:	Specify Limits on Decision Errors
Step 7:	Optimize the Design for Obtaining Data

During the first six steps of the process, the planning team develops decision performance criteria (i.e., DQOs) that are used to develop the data collection design. The final step of the process involves developing data collection design based on the previous six steps of the DQOs.

3.1 Problem Statement

The purpose of this step is to clearly define the problem so that the focus of the study is unambiguous. This plan was developed at the request of the EPA Region VIII through the Volpe Center to document the level of asbestos contamination in soil, waste/product, dust and air for the Stimson Lumber Company site at Libby, Montana. The planning team members for this investigation are listed in Section 1.2 of this SAP.

The purpose of this sampling event is to characterize the media to determine the onsite vertical and horizontal extent of the contamination where vermiculite product is suspected to have been introduced. Various materials within these onsite locations, including soil, dust, and waste/product may contain asbestos. Also, any material at the lumberyard that contains asbestos could potentially produce airborne asbestos within and around these source areas. Both the solid material and any airborne asbestos fibers could present a hazard to persons located in areas at or near these sites. Risk-based decisions for any future removal actions will be made by Paul Peronard (EPA OSC), Duc Nguyen (EPA OSC), and Chris Weis (EPA Regional Toxicologist). The budget and schedules associated with this work assignment are listed in the most current work plan.

3.2 Identify the Decision

This step identifies what questions the analysis will attempt to resolve and what actions may result. Data collected during this assessment will be used to determine what degree (if any) the sites have been impacted by asbestos. Specifically, the data will be used to answer the following principal study question:

- Is the media (i.e., soil, dust, product/waste, and air) at the site sufficiently characterized with respect to asbestos concentrations?

The alternative actions include either further investigation (i.e., additional sampling) or no further action. The decision statement is whether or not the media at the site is sufficiently characterized with respect to asbestos concentrations. If yes, then no further action is necessary. If no, then further investigation may be necessary or it may be determined that no further action is required.

3.3 Inputs to the Decision

The purpose of this step is to identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statements. The information required to resolve the decision statement consist of the following:

- The concentration of asbestos in each media within the areas of concern at the site

The sources of this information are data collected in the field and laboratory analysis of samples collected during this investigation. There are no action levels for this investigation; the only determination for alternative actions are if the site is sufficiently characterized with respect to asbestos contamination or not. The sampling methods are identified in Section 4 and the analytical methods are listed in Section 5.0 and Table 5-1 and detailed in Appendix E.

3.4 Boundaries for the Removal Assessment

This step defines the spatial and temporal boundaries to which this investigation will apply and determine when and where data should be collected.

Spatial Boundaries

Concerning the soil and waste/product sampling, the horizontal boundaries for the assessment are approximately within the property boundaries associated with the Stimson Lumber Company facility. The vertical boundaries are from approximately four feet below the ground surface to the top of any onsite building or waste pile. The spatial boundaries for the air and dust sampling include the interior of onsite buildings. For the personal air monitoring, the boundary is the breathing zone of the affected person.

Temporal Boundaries
Temporal boundaries include the time frame from when the former site began operation (processing vermiculite or installed insulation) through the time of sampling.

The target population of interest is the asbestos contamination within the specified media. Possible constraints that may interfere with data collection may include, but are not limited to, rough terrain and inclement weather conditions (i.e., snow-covered soil, frozen soil, etc.). Sampling activities will commence once weather conditions permit. The decision whether or not the media is sufficiently characterized with respect to asbestos contamination will be based on the analytical results for each sample and the completeness of this investiation.

3.5 Decision Rule

The purpose of this step is to define the parameter of interest, specify the action level (if known), and integrate previous DQO outputs into a single statement/statements that describes a logical basis for determining whether the site has been impacted by asbestos. The parameters of interest are the concentrations of asbestos in soil, waste/product, dust, and air. While the primary form of asbestos at the Libby site is the tremolite-actinolite solution series, the combined concentration of all forms of asbestos may be used for decision-making. The actual results of the analyses and the completeness of the investigation will be used to determine if our objectives have been met.

If the characterization of asbestos contamination within the site areas of concern are concluded from this investigation, then no further investigation will be conducted. If the asbestos contamination is not completely characterized from this investigation, then either further investigation will be conducted or it may be decided that although not completely known, enough information has been collected to continue and no further investigation will be conducted.

Because this investigation is to collect information and not to make remedial decisions, the only alternative actions are either further investigation or consider the investigation complete.

3.6 Specify Tolerable Limits on Decision Errors

The purpose of this step is to specify the decision-maker's acceptable limits on decision errors. Decision-makers are interested in knowing the true value of the asbestos concentrations. There are several reasons why decision-makers may not know the true asbestos concentration in soil and waste/product:

1) There may be a high degree of variability of asbestos concentration within a sample. Although a sample may be thoroughly mixed, only a small portion of

the sample is used for the analysis. This could either result in an under- or over-estimate of the actual asbestos concentration.

2) Other fibers with optical properties similar to asbestos minerals may give false interferences. This could result in an over-estimate of the actual asbestos concentration.

3) The optical properties of asbestos may be obscured by a coating on the fibers. This could result in an under-estimate of the actual asbestos concentration.

4) Fibers finer than the resolving power of the microscope (about 0.3 μm) will not be detected. This could result in an under-estimate of the actual asbestos concentration.

5) Heat and acid may alter the index of refraction of asbestos and change its color. This could result in an under-estimate of the actual asbestos concentration.

The current null hypothesis for the assessment is that the media at the site is sufficiently characterized with respect to asbestos concentration. The alternative hypothesis is that the media at the site is not sufficiently characterized.

A false positive or "Type I" decision error refers to the type of error made when the null hypothesis is rejected when it is actually true and a false negative to "Type II" decision error refers to the type of error made when the null hypothesis is accepted when it is actually false. For this assessment, a Type I decision error would result in deciding that site media are not sufficiently characterized with respect to asbestos contamination when they are. A Type II decision error would result in deciding that the site media are sufficiently characterized with respect to asbestos contamination when they are not. A Type I decision error may cause spending money when it is not required whereas, a Type II decision error may cause a decision to be made based on incorrect or limited information. For this investigation, a Type II error is less acceptable. For this investigation, there are no action levels and, therefore, no gray area or tolerable decision error limits have been set.

3.7 Optimize the Decision for Obtaining Data

The purpose of this step is to identify the most resource-effective sampling design that generates data that satisfy the DQOs in the previous steps. The sampling program described in this SAP is consistent with the DQOs and project objectives for the assessment. However, if during the period of sample collection and/or evaluation, it becomes apparent that the quantity and/or distribution of samples is not sufficient for obtaining the data required to properly characterize soil, waste/product, or air for this assessment, the number, distribution, or methods may be modified to reflect the

specific needs of the project. Any changes to this SAP will be approved by EPA and the Volpe Center prior to implementation. In addition, any deviations to this SAP will be noted in the applicable field logbook and subsequent data summary reports.

Table 3-1 Summary of Available PCM and TEM Based Exposure Levels for Asbestos

Agency	Description	Required Analysis	Nominal Value	Reference
ACGIH	TLV-TWA	PCM	0.1 f/cc (0.1 f/ml)	American Conference of Governmental Industrial Hygienists, Inc. ACGIH, 1998
NIOSH	REL 100 minute TWA in a 400L sample (all forms)	PCM	0.1 f/cc (0.1 f/ml)	National Institute for Occupational Safety and Health NIOSH, 1999
OSHA	PEL (TWA) all forms	PCM	0.1 f/cc (0.1 f/ml)	Asbestos Standard for Industry, Occupational Safety and Health Administration Rules OSHA, 1998 29 CFR 1910.1001
OSHA	PEL (ceiling) 30 minute average (all forms)	PCM	1.0 f/cc (1.0 f/ml)	Asbestos Standard for Construction, Occupational Safety and Health Administration Rules OSHA, 1998 29 CFR 1926.1101
EPA (AHERA)	Level to determine the completion of a response action in Schools	TEM	70 structures per square millimeter (s/mm^2)	Asbestos Hazard Emergency Response Act of 1986 EPA, 1987 40 CFR 763
EPA (IRIS)	Inhalation unit risk	PCM	0.23 f/cc (f/ml)	On-line Database, Asbestos IRIS, 1999
EPA (EMSL)	Measure of work site cleanliness	PCM	Less than or equal to 0.01 f/cc (0.01 f/ml)	EMSL, 1985

Acronyms:
ACGIH - American Conference of Governmental Industrial Hygienists
NIOSH - National Institute for Occupational Safety and Health
OSHA - Occupational Safety and Health Administration
EPA - Environmental Protection Agency
AHERA - Asbestos Hazard Emergency Response Act
IRIS - Integrated Risk Information System
EMSL - EMSL Analytical, Inc.
TLV - threshold limit value
TWA - time waited average
REL - recommended exposure limit
PEL - permissible exposure limit
PCM - phase contrast microscopy
TEM - transmission electron microscopy
f/cc - fibers per cubic centimeter
f/ml - fibers per milliliter
L - liter

Section 4
Field Activities and Sampling Procedures

CDM Federal was tasked by the Volpe Center to provide all personnel, material, equipment, and supplies to complete the tasks identified below related to sampling and investigative support. This section describes the procedures that will be followed for information gathering, sample collection, handling, shipping, analysis, and documentation.

4.1 Site Information and Access Agreements

As part of the onsite investigation activities, CDM Federal will gather and verify current and historical information for the Stimson Lumber Company (if not previously done). Interviews with the current owner (contact) have been accomplished or arranged for by the EPA or the Volpe Center prior to arrival onsite. Signed access agreements and insurance documents will be required, and the Montana "One Call" or utilities underground location center will be contacted before any sampling activities commence.

4.2 Site Investigation and Photographic Documentation

CDM Federal will take detailed notes and digital photographs during the investigation and will document the existence of any suspected asbestos materials. Differential GPS locations and photographs will be taken and logged for each sampling area in accordance with CDM Federal Standard Operating Procedures (SOPs) 4-1 Field Logbook Content and Control and 4-2 Photographic Documentation of Field Activities.

4.3 Soil Sampling

4.3.1 Selecting Soil Sampling Locations

During the site visit, representatives from EPA, Volpe Center, CDM Federal, and Stimson Lumber Company visited areas of concern throughout the site. Areas were indentified based on historical records and employee interviews, where vermiculite product was potentially introduced. This information was used to develop this sampling plan, which includes specific sampling locations and protocol. Actual soil sampling locations may be modified in the field by the CDM Federal field team leader based on actual field conditions (i.e., limited access, additional sampling requirements, etc.).

Approximately 186 surface and subsurface soil samples are currently proposed as part of this field investigation. Soil samples will be collected from three areas of concern (gravel parking lot, railroad spur, and former nursery area) from within the Stimson Lumber Company property boundary.

Gravel Parking Lot

The gravel parking lot covers approximately ¾ of an acre. A total of three surface composite samples and 16 subsurface grab samples will be collected independently (i.e., not co-located).

For surface soil samples (0- to 2-in.), the area will be subdivided into three semi-equal sections (Figure 4-1). One five-point composite surface samples will be collected within each section. The first discrete sample will be taken from approximately the section midpoint while the following four samples will be taken approximately 20-ft from the four corner boundaries, completing each composite sample.

Subsurface samples will be collected from eight locations using direct-push methods (i.e., geoprobe), or equivalent, approximately 50-ft apart (Figure 4-1). An initial 4-ft core sample will be extracted to identify potential subsurface vermiculite seams. If vermiculite product is not visible, then two grab samples will be collected from the 0- to 1-ft and 1- to 2-ft depth (with "0" being the gravel/soil interface). These samples will be used to confirm that the subsoil is not contaminated. If vermiculite product is visible, the product-containing soil will be intentionally sampled. In addition, a separate grab sample will be obtained from 1-ft below the lowest visible contaminated layer. This sample will confirm the vertical extent of the contamination.

Additional surface and/or subsurface samples may be collected at the discretion of the CDM Federal field team leader. The type and location of each sample collected and profile characteristics (i.e., vermiculite layer) will be documented in the field logbook and on the field log sheets (Appendix B).

Railroad Spur

The railroad spur of interest extends approximately 200 linear feet just east of the gravel parking lot. Prior to sampling, the CDM field sampling team will coordinate with Stimson Lumber Company personnel to review necessary precautions for sampling on the designated railroad section. Samples will be obtained along two linear transects at 100-ft intervals (Figure 4-2). Three sampling midpoints will be established perpendicular to the tracks for each sampling area. Two points will be located outside each outer ballast boundary and one will be between the steel rails, if field conditions permit (i.e., sufficient soil-size material). Each midpoint will be the starting point (i.e., first discrete sample) for a 5-point linear composite sample. The four subsequent samples will be collected 25- and 50-ft from the midpoint in both directions along the track. A total of six surface composite samples will be collected.

Subsurface soil samples (2- to 6-in. and 6- to 12-in.) will be collected from each sample midpoint. These samples will be obtained using direct-push methods (i.e., geoprobe), or equivalent, as necessary. A minimum of 12 subsurface samples will be collected.

Additional surface and/or subsurface samples may be collected at the discretion of the CDM Federal field team leader. The type and location of each sample collected will be documented in the field logbook and on the field log sheets (Appendix B).

Former Nursery Area

The former landscaping nursery area is located along the southern property boundary adjacent to the log storage lot and encompasses approximately 16 acres. The sampling effort will be concentrated where known vermiculite material was introduced as fill and/or as a soil amendment. To date, the affected area has only been estimated, as interviews with the former owners of the nursery have not been conducted. The current sampling scheme has been developed based on historical documents and prior sampling that indicates areas of high levels of contamination. If an interview is conducted with the previous owners, the current sampling scheme will be re-evaluated and adjusted, as necessary.

A sampling grid will be established over the entire lot. Grid midpoints will be established on 50-ft centers on areas where known vermiculite product was introduced and at 100-ft centers throughout the remainder of the former nursery boundary (Figure 4-3). Five-point composite surface samples (0- to 2-in.) will be collected within each specific grid. The first discrete sample will be taken directly from the sampling grid midpoint while the following four will be taken within 25-ft from the midpoint at north, south, east, and west directions (within 50-ft from the midpoint for 100-ft center grids). In addition, two subsurface grab samples (2- to 6-in. and 6- to 12-in.) will be collected using direct-push methods (i.e., geoprobe), or equivalent, at the sampling grid midpoint.

The previous site visit revealed that two wood chip stockpiles (up to 20-ft high) exist on the lot. Where these stockpiles interrupt the grid-sampling scheme, soil samples (surface and subsurface) will be obtained at the edge (i.e., base) of the piles. The footprint of the piles will be accurately noted in the field logbook and on the field sample data sheet(s). Samples of the wood chip stockpiles will also be collected. Up to five grab samples of soil-sized materials will be taken from each stockpile. Specific sampling locations will be at the discretion of the CDM Federal field sampling team using professional judgment.

Approximately 157 samples (49 surface, 98 subsurface, and 10 stockpile) will be obtained. Additional surface and/or subsurface samples may be collected at the discretion of the CDM Federal field team leader. The type and location of each sample collected will be documented in the field logbook and on the field log sheets (Appendix B).

4.3.2 Sample Identification

Each media sample will be identified with a unique coding system for all sample media collected. This coding system (Index ID) is designed to prevent accidental duplication of sample identification numbers and ensures that all samples have a unique identification number assigned to them. These codes start at 1-0001 and are sequentially numbered so that thousands of unique codes are available, as necessary. To ensure that the laboratory is "blind" and does not receive certain specific information about a sample, only the index ID code will be used to label sample containers.

4.3.3 Collection and Analysis of Soil Samples

All soil samples will be analyzed in accordance with National Institute of Occupational Safety and Health (NIOSH) Method 9002, Asbestos (bulk) by PLM. At the direction of the EPA OSC or Volpe Center representative, transmission election microscopy (TEM) and/or Infrared (IR) analyses may be performed on a subset of those samples determined to be non-detect or trace (less than or equal to 1%) via PLM analysis. All soil samples will be collected in accordance with CDM Federal SOP 1-3 Surface Soil Sampling and SOP 1-4 Subsurface Soil Sampling (Appendix C), with modifications. The following modifications to SOP 1-3 and SOP 1-4 have been reviewed and approved.

Section 2.2, Discussion - Sample depth for surface soil will generally be 0- to 2-in. from the current ground surface. However, if a sample is required from an area with highly compacted soil (i.e., parking lot, railroad right-of-way), the depth from 0- to 1- in. will be acceptable assuming a sufficient amount of soil can be obtained. Subsurface soil samples using direct-push techniques (DPT) down to 4-ft will also be required. Composite samples will be composed of nearly equal portions of soil from five randomly discrete locations within a horizontal radius of the grid or transect unit including the grid midpoint. The actual composite sample for PLM analysis will be prepared at the CDM laboratory in Denver as an aliquot of the processed (i.e., dried and homogenized) volume of soil. If vermiculite is observed in the field, it will be included as at least one discrete biased portion of the sample. Generally, grid and/or segment size will be composed of 100- to 50-ft centers.

Section 4.0, Required Equipment - Neither ice bags nor blue ice will be used. Powder-free nitrile gloves will be used for sample collection. No pans, trays, or bowls are necessary, since samples will be placed directly into zipper-top bags. Since the sampling is for asbestos, rather than metals or organic compounds, the use of stainless steel or Teflon-lined sampling instruments is determined not to be necessary. The sampler may be a garden bulb planter, trowel, direct-push (geoprobe), or other similar sampling device. A list of equipment that may be used for sampling is included in Table 4-1.

Section 5.2.3, Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analysis – One-gallon zipper-top bags will be used as sample containers.

The one-gallon bags will be filled approximately half full. Sampling information will be written directly on the bags using a permanent marker. Sampling instruments do not need to be constructed of stainless steel or Teflon lined. Trays and bowls will not be used, as samples will be placed directly into zipper-top bags. Drying and homogenization will be performed in the CDM laboratory in Denver. All samples will be double bagged for shipment.

4.3.4 Sample Documentation

Sampling activities during this assessment will be documented in a field logbook (and on field sample data sheets, Appendix B) to be maintained by the field team in accordance with CDM Federal SOP 4-1 Field Logbook Content and Control (Appendix C). The field team leader will be responsible for maintenance and document control of the field logbook.

4.3.5 Sample Custody, Packaging, and Shipping

This section details the sample custody and the classifying, identifying, labeling, packaging, and transporting of soil samples collected during this investigation. Procedures will be in accordance with CDM Federal SOPs 1-2 Sample Custody and 2-1 Packaging and Shipping of environmental samples (Appendix C) as described below.

Sample classification is necessary to ensure the protection of personnel involved in the shipment of samples, and to maintain the integrity of each sample. Samples obtained at uncontrolled hazardous waste sites are classified as either environmental or hazardous samples. All samples collected during this investigation will be classified as environmental samples.

To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, chain-of-custody (COC) records will be used. The COC record is employed as physical evidence of sample custody and control, and provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting. COC procedures will follow the requirements set forth in CDM Federal SOP 1-2 Sample Custody (Appendix C). The following modifications to SOP 1-2 have been reviewed and approved:

Section 5.2, Sample Labels and Tags - Rather than using labels or tags, samples will be identified by writing the sample index ID directly on the one-gallon zipper-top bags using permanent markers.

Samples collected during this investigation will be packaged and shipped in accordance with CDM Federal SOP 2-1 Packaging and Shipping of Environmental Samples (Appendix C), with modification. The proposed modifications to SOP 2-1 are as follows:

Section 1.4, Required Equipment - No vermiculite or other absorbent material will be used. No bubble wrap or ice will be used.

Section 1.5, Procedures - Lining the cooler with a garbage bag is determined not to be necessary since the samples will already be double-bagged. No vermiculite or other absorbent material will be used to pack the samples. No ice will be used.

4.3.6 Quality Control Samples

Quality control (QC) data are necessary to determine precision and accuracy of sample collection techniques and to demonstrate the absence of interference and/or cross-contamination. For this investigation, a soil QC sample will consist of a duplicate taken from an environmental sample in the processing laboratory following drying and homogenization.

Soil duplicate samples will be analyzed at a rate of one per ten soil samples (i.e., 10 percent). For each group of ten samples (e.g., 1-0001 through 1-0010), any one of the samples may be duplicated. The duplicate sample will be prepared in the CDM Denver laboratory during processing, and it will receive a unique index identification code as described in Section 4.3.1.

Split samples may also be produced in the laboratory where one portion of the sample may be given to the property owner or submitted for additional analyses (i.e., IR or TEM), if requested. These split samples are processed in the same manner as the preliminary sample and the remainder of the sample will be archived at CDM's laboratory. If samples are submitted to the property owner, a separate COC form is completed without identifying any analyses and should identify the sample was split as noted in the comment section. The samples, signed copy of the COC, and corresponding field data sheet will be transferred to any property owner receiving split samples.

No other soil QC samples (e.g., field blanks, interlaboratory splits, etc.) are planned. Rinsate samples are used to evaluate the effectiveness of decontamination procedures. The soil analyses used for this project have a relatively high limit of detection and cross-contamination from sampling equipment would have to be extreme to be detectable in a sample. Decontamination of equipment to be visually clean will be sufficient to avoid cross-contamination and, therefore, no rinsate blanks will be collected.

4.3.7 Equipment Decontamination

Equipment used to collect, handle, or measure soil samples will be decontaminated in accordance with CDM Federal SOP 4-5 Field Equipment Decontamination at

Nonradioactive Sites, with modifications (Appendix C). The following modifications to SOP 4-5 have been reviewed and approved:

Section 5.0, Procedures - Decontamination water will not be captured and will be discharged to the ground at the site.

Section 5.3, Sampling Equipment Decontamination - ASTM Type II deionized (DI) water will not be used. Rather, locally available DI water will be used. Decontamination water will be discharged to the ground at the site.

Section 5.6, Waste Disposal - Decontamination water will not be captured and will not be packaged, labeled, or stored as investigation-derived waste.

The decontamination procedure for non-disposable equipment consists of a tap water and alconox wash with brush scrubbing, followed by a tap water rinse, and final DI water rinse. The equipment will then be allowed to air-dry before being wrapped in clean plastic or aluminum foil. All equipment will be decontaminated before coming into contact with any sample. Rinse water will be discharged to the ground at the site. Any other deviations from the decontamination procedures will be recorded in the appropriate field logbook.

4.3.8 Health and Safety

All sampling will be performed in accordance with applicable EPA, OSHA, corporate, and site health and safety requirements. CDM Federal has prepared a Site Health and Safety Plan (SHSP) for the site that is attached as Appendix D.

4.4 Waste/Product Sampling

4.4.1 Selecting Sample Locations

These samples will include biased collection of visible waste and/or product within the site boundaries. Waste/product sampling locations will be determined based on the size and number of buildings on the project site, current and historic uses of the buildings, current and historic site conditions, and the location of waste/product on-site.

Waste samples will be collected by the CDM sampling team and will include any solid media that contains visible un-exfoliated vermiculite and/or tremolite product, including stockpiles, fill material, and miscellaneous spill. Bulk product samples will be collected by the PES sampling team and will include exfoliated vermiculite, insulation, and other construction materials. Grab samples from each source identified will be collected.

4.4.2 Sample Identification

Each media sample will be identified with a unique coding system for all sample media collected. This coding system (Index ID) is designed to prevent accidental duplication of sample identification numbers and ensures that all samples have a unique identification number assigned to them. These codes start at 1-0001 and are sequentially numbered so that thousands of unique codes are available, as necessary. To ensure that the laboratory is "blind" and does not receive certain specific information about a sample, only the index ID code will be used to label sample containers.

4.4.3 Collection and Analysis of Waste/Product Samples

All waste/product samples will be analyzed in accordance with NIOSH Method 9002, Asbestos (bulk) by PLM. At the direction of the EPA OSC and Volpe Center representative, other analyses (i.e., TEM or IR) may be performed on a subset of those waste/product samples determined to be trace or non-detect via PLM analysis.

The samples will be collected by placing product or waste material into a one-gallon plastic zipper-top bag until it is approximately half full. This bag will then be placed into a second plastic zipper-top bag. All waste/product samples will be double bagged. Sampling personnel will wear disposable nitrile gloves while sampling. A new pair of gloves will be donned prior to each sample being collected. Sampling personnel will also wear an appropriate level respiratory protection at all times while collecting waste/product samples.

4.4.4 Sample Documentation

Sampling activities during this assessment will be documented in a field logbook and on field sample data sheets (Appendix B) to be maintained by the field team in accordance with CDM Federal SOP 4-1 Field Logbook Content and Control (Appendix C). The field team leader will be responsible for maintenance and document control of the field logbook.

4.4.5 Sample Custody, Packaging, and Shipping

This section details the sample custody and the classifying, identifying, labeling, packaging, and transporting of waste/product samples collected during this investigation. Procedures will be conducted in accordance with CDM Federal SOPs 1-2, 2-8, and 4-5 (Appendix C) as described below.

Sample classification is necessary to ensure the protection of personnel involved in the shipment of samples, and to maintain the integrity of each sample. Samples obtained at uncontrolled hazardous waste sites are classified as either environmental or hazardous samples. All samples collected during this investigation will be classified as environmental samples.

To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, COC records will be used. The COC record will be employed as physical evidence of sample custody and control, and provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting. COC procedures will follow the requirements set forth in CDM Federal SOP 1-2 Sample Custody (Appendix C). The following modifications to SOP 1-2 have been reviewed and approved:

Section 5.2, Sample Labels and Tags - Rather than using labels or tags, samples will be identified by writing the sample index ID directly on the one-gallon zipper-top bags using permanent markers. All samples will be double-bagged.

Samples collected during this investigation will be packaged and shipped in accordance with CDM Federal SOP 2-1 Packaging and Shipping of Environmental Samples (Appendix C), with modification. The following modifications to SOP 2-1 have been reviewed and approved.

Section 1.4, Required Equipment - No vermiculite or other absorbent material will be used. No bubble wrap or ice will be used.

Section 1.5, Procedures - Lining the cooler with a garbage bag is determined not to be necessary since the samples will already be double-bagged. Procedures related to the packaging of bottles do not apply. No vermiculite or other absorbent material will be used to pack the samples. No ice will be used.

4.4.6 Quality Control Samples

Quality control data are necessary to determine precision and accuracy of sample collection techniques and to demonstrate the absence of interference and/or cross-contamination. For this investigation, a waste/product QC sample will consist of a duplicate taken from an environmental sample in the field following homogenization in the zipper-top bag.

Waste/product duplicate samples will be lumped with soils and analyzed at a rate of one per ten waste/product samples per site (i.e., 10 percent). For each group of ten sequentially collected samples (e.g., 1-0001 through 1-0010), any one of the ten samples may be duplicated. The sample will receive a unique index ID code as described in Section 4.4.2.

Split samples may also be produced in the laboratory where one portion of the sample may be given to the property owner or submitted for additional analyses (i.e., IR or TEM), if requested. These split samples are processed in the same manner as the soil samples and the remainder of the sample will be archived at CDM's laboratory. If samples are submitted to the property owner, a separate COC form is completed without identifying any analyses and should identify the sample was split as noted in

the comment section. The samples, signed copy of the COC, and corresponding field data sheet will be transferred to any property owner receiving split samples.

No other waste/product QC samples (e.g., field blanks, interlaboratory splits, etc.) are planned. Rinsate samples are used to evaluate the effectiveness of decontamination procedures. The soil analyses used for this project have a relatively high limit of detection and cross-contamination from sampling equipment would have to be extreme to be detectable in a sample. Decontamination of equipment to be visually clean will be sufficient to avoid cross-contamination and, therefore, no rinsate blanks will be collected.

4.4.7 Equipment Decontamination

Equipment used to collect, handle, or measure waste/product samples will be decontaminated in accordance with CDM Federal SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites, with modification (Appendix C). The following modifications to SOP 4-5 have been reviewed and approved:

Section 5.0, Procedures - Decontamination water will not be captured and will be discharged to the ground at the site.

Section 5.3, Sampling Equipment Decontamination - ASTM Type II DI water will not be used. Rather, locally available DI water will be used. Decontamination water will be discharged to the ground at the site.

Section 5.6, Waste Disposal - Decontamination water will not be captured and will not be packaged, labeled, or stored as investigation-derived waste.

The decontamination procedure for non-disposable equipment will consist of a tap water and alconox wash with brush scrubbing, followed by a tap water rinse, and final DI water rinse. The equipment will then allowed to air-dry before being wrapped in clean plastic or aluminum foil. All equipment will be decontaminated before coming into contact with any sample. Rinse water will be discharged to the ground at the site. Any other deviations from the decontamination procedures will be recorded in the appropriate field logbook.

4.4.8 Health and Safety

All sampling will be performed in accordance with all applicable EPA, OSHA, corporate, and site health and safety requirements. CDM Federal has prepared a SHSP for the site that is attached as Appendix D.

4.5 Personal Air Sampling

4.5.1 Selecting Sample Locations

Personal air samples will be collected on a total of four Stimson Lumber Company employees. Eight-hour time weighted average (8-hr TWA) samples will be collected on two employees working in the Planer Plant (Plate 1, Plywood Plant), and two employees working in the Central Maintenance Building (Plate 1, Building Containing Zonolite Insulation). These four employees will be sampled for a period of three consecutive days. A total of 12 personal air samples will be collected (excluding blanks).

4.5.2 Sample Identification

Each personal air sample will be identified with a unique coding system for all sample media collected. This coding system (Index ID) is designed to prevent accidental duplication of sample identification numbers and ensures that all samples have a unique identification number assigned to them. These codes start at 1-0001 and are sequentially numbered so that thousands of unique codes are available, as necessary. To ensure that the laboratory is "blind" and does not receive certain specific information about a sample, only the index ID code will be used to label sample cassettes.

4.5.3 Collection and Analysis of Personal Air Samples

Personal air samples will be collected by drawing air through a mixed cellulose ester (MCE) filter (0.45 µm pore size) at a specified flow rate for a specified period of time. The details of the method are provided in EPA SOP 2015 Asbestos Sampling (Appendix C). Under normal circumstances, personal air samples will be collected at a flow rate of 2.5 liters per minute (L/min) over a 7- to 8-hour sampling period. This results in a total sampling volume 1200 liters.

All personal air samples will be analyzed in accordance with International Standard, Determination of Asbestos Fibers (ISO 13012), NIOSH Method 7400, Asbestos by PCM, and EPA Asbestos Hazard Emergency Response Act (AHERA) Method, Asbestos by TEM.

Depending on the sampling conditions, work activities, the level of asbestos in the air, and the level of interfering particles in the air, the flow rate, total sampling time, and/or sampling volume may require modifications. The decision to modify the flow rate, time, or volume will be made by PES in consultation with the EPA OSC and Volpe Center representative.

4.5.4 Sample Documentation

Sampling activities during this assessment will be documented in a field logbook and on field sample data sheets (Appendix B) to be maintained by the field team in accordance with CDM Federal SOP 4-1 Field Logbook Content and Control

(Appendix C). The field team leader will be responsible for maintenance and document control of the field logbook.

4.5.5 Sample Custody, Packaging, and Shipping

This section details the sample custody and the classifying, identifying, labeling, packaging, and transporting of personal air samples collected during this investigation.

Sample classification is necessary to ensure the protection of personnel involved in the shipment of samples, and to maintain the integrity of each sample. Personal air samples collected during this assessment will be classified as environmental samples.

To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, COC records will be used. The COC record will be employed as physical evidence of sample custody and control, and provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting. COC procedures will follow the requirements set forth in CDM Federal SOP 1-2 Sample Custody, with modifications (Appendix C). The following modifications to SOP 1-2 have been reviewed and approved:

Section 5.2, Sample Labels and Tags – A label will be affixed to each air-sampling cassette prior to being shipped to the appropriate laboratory. This number will correspond to the number assigned (i.e., Index ID) to that particular sample in the field data sheets.

Samples collected during this investigation will be packaged and shipped in accordance with CDM Federal SOP 2-8, Packaging and Shipping of Environmental Samples (Appendix C) and ASTM Standard D-5755-97 (Appendix C), with modification. The following modifications to SOP 2-8 are as follows:

Section 4.0, Required Equipment - No vermiculite or other absorbent material will be used. No bubble wrap or ice will be used.

4.5.6 Quality Control Samples

Field personnel will prepare one type of QC sample: field blanks.

Field Blanks

Field personnel will prepare blank samples for personal air samples by labeling unused filter cassettes and submitting them for analysis.

4.5.7 Equipment Decontamination

This project requires the decontamination of all personal air sampling equipment (e.g., pumps, cassette, tubing, etc) prior to sampling and prior to leaving the site.

Equipment used to collect, handle, or measure personal air samples will be decontaminated in accordance with CDM Federal SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites, with modification (Appendix C). The following modifications to SOP 4-5 have been reviewed and approved:

Section 5.0, Procedures - Decontamination water will not be captured and will be discharged to the ground at the site.

Section 5.3, Sampling Equipment Decontamination - ASTM Type II DI water will not be used. Rather, locally available DI water will be used. Decontamination water will be discharged to the ground at the site.

Section 5.6, Waste Disposal - Decontamination water will not be captured and will not be packaged, labeled, or stored as investigation-derived waste.

The decontamination procedure for non-disposable equipment will consist of a tap water and alconox wash with brush scrubbing, followed by a tap water rinse, and final DI water rinse. The equipment will then be allowed to air-dry before being wrapped in clean plastic or aluminum foil. All equipment will be decontaminated before coming into contact with any sample. Rinse water will be discharged to the ground at the site. Any other deviations from the decontamination procedures will be recorded in the appropriate field logbook.

4.5.8 Health and Safety

All sampling will be performed in accordance with all applicable EPA, OSHA, corporate, and site health and safety requirements. CDM Federal has prepared a SHSP for the project site that is attached as Appendix D.

4.6 Ambient Air

4.6.1 Selecting Sample Locations

Ambient air samples will be collected from two of the buildings at the Stimson facility, the Planer Plant and the Central Maintenance Facility. Approximately four ambient air samples will be collected from each of the buildings during normal daily operations and while equipment is running. A total of eight ambient air samples will be collected (excluding blanks). The specifics of the air sampling locations will be determined on site. The EPA OSC and Volpe Center representative working with the sampling team will determine the locations of ambient air samples to be collected in each building.

4.6.2 Sample Identification

Each ambient air sample will be identified with a unique coding system for all sample media collected. This coding system (Index ID) is designed to prevent accidental duplication of sample identification numbers and ensures that all samples have a unique identification number assigned to them. These codes start at 1-0001 and are sequentially numbered so that thousands of unique codes are available, as necessary. To ensure that the laboratory is "blind" and does not receive certain specific information about a sample, only the index ID code will be used to label sample cassettes.

4.6.3 Collection and Analysis of Ambient Air Samples

Ambient air samples will be collected by drawing air through a MCE filter (0.45 μm pore size) at a specified flow rate for a specified period of time. The details of the method are provided in EPA SOP 2015 Asbestos Sampling (Appendix C). Under normal circumstances, ambient air samples will be collected at a flow rate of 10 L/min over a 6 to 7-hour sampling period. This results in a total sampling volume of 4200 liters.

All ambient air samples will be analyzed in accordance with International Standard, Determination of Asbestos Fibers (ISO 13012), NIOSH Method 7400, Asbestos by PCM, and EPA AHERA Method, Asbestos by TEM.

Depending on the sampling conditions, work activities, the level of asbestos in the air, and the level of interfering particles in the air, the flow rate, total sampling time, and/or sampling volume may require modifications. The decision to modify the flow rate, time, or volume will be made by PES in consultation with the EPA OSC and Volpe Center representative.

4.6.4 Sample Documentation

Sampling activities during this assessment will be documented in a field logbook (and on field sample data sheets, see Appendix B) to be maintained by the field team in accordance with CDM Federal SOP 4-1 Field Logbook Content and Control (Appendix C). The field team leader will be responsible for maintenance and document control of the field logbook.

4.6.5 Sample Custody, Packaging, and Shipping

This section details the sample custody and the classifying, identifying, labeling, packaging, and transporting of air samples collected during this investigation.

Sample classification is necessary to ensure the protection of personnel involved in the shipment of samples, and to maintain the integrity of each sample. Air samples collected during this assessment will be classified as environmental samples.

To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, COC records will be used. The COC record will be employed as physical evidence of sample custody and control, and provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting. COC procedures will follow the requirements set forth in CDM Federal SOP 1-2 Sample Custody, with modifications (Appendix C). The following modifications to SOP 1-2 have been reviewed and approved:

Section 5.2, Sample Labels and Tags - A label will be affixed to each air-sampling cassette prior to being shipped to the appropriate laboratory. This number will correspond to the number assigned (i.e., index ID) to that particular sample in the field data sheets.

Samples collected during this investigation will be packaged and shipped in accordance with CDM Federal SOP 2-1 Packaging and Shipping of Environmental Samples (Appendix C) and ASTM Standard D-5755-97 (Appendix E), with modification. The following modifications to SOP 2-1 have been reviewed and approved:

Section 1.4, Required Equipment - No vermiculite or other absorbent material will be used. No bubble wrap or ice will be used.

4.6.6 Quality Control Samples

Field personnel will prepare one type of QC sample: field blanks.

Field Blanks

Field personnel will prepare blank samples for air by labeling unused filter cassettes and submitting them for analysis.

4.6.7 Equipment Decontamination

This project requires the decontamination of all air sampling equipment (e.g., pumps, cassette, tubing, etc) prior to sampling and prior to leaving the site.

Equipment used to collect, handle, or measure air samples will be decontaminated in accordance with CDM Federal SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites, with modification (Appendix C). The following modifications to SOP 4-5 have been reviewed and approved:

Section 5.0, Procedures - Decontamination water will not be captured and will be discharged to the ground at the site.

Section 5.6, Waste Disposal - Decontamination water will not be captured and will not be packaged, labeled, or stored as investigation-derived waste.

The decontamination procedure for non-disposable equipment consists of a tap water and alconox wash with brush scrubbing, followed by a tap water rinse, and final DI water rinse. The equipment will then be allowed to air-dry before being wrapped in clean plastic or aluminum foil. All equipment will be decontaminated before coming into contact with any sample. Rinse water will be discharged to the ground at the site. Any other deviations from the decontamination procedures will be recorded in the appropriate field logbook.

4.6.8 Health and Safety

All sampling will be performed in accordance with applicable EPA, OSHA, corporate, and site health and safety requirements. CDM Federal has prepared a SHSP that is specific to this project attached as Appendix D.

4.7 Microvacuum Dust Sampling

4.7.1 Selecting Sample Locations

Microvacuum dust samples will be collected within two of the buildings at the Stimson Lumber company facility, the Planer Plant and the Central Maintenance building. Approximately 15 dust samples will be collected from the Central Maintenance building and approximately 10 dust samples will be collected from the Planer Plant. A total of approximately 25 microvacuum dust samples will be collected by PES' field team during this assessment.

The specifics of the dust sampling locations will be determined on site. The EPA OSC and Volpe Center representative working with the sampling team will determine the location of microvacuum dust samples to be collected at in each building.

4.7.2 Sample Identification

Each dust sample will be identified with a unique coding system for all sample media collected. This coding system (Index ID) is designed to prevent accidental duplication of sample identification numbers and ensures that all samples have a unique identification number assigned to them. These codes start at 1-0001 and are sequentially numbered so that thousands of unique codes are available, as necessary. To ensure that the laboratory is "blind" and does not receive certain specific information about a sample, only the index ID code will be used to label sample cassettes.

4.7.3 Collection and Analysis of Microvacuum Dust Samples

Microvacuum dust samples will be collected by drawing air through a MCE filter (0.45 μm pore size) at a flow rate of 2.0 L/min for a minimum sampling time of two

minutes or until all visible dust or particulate matter has been removed from the sampling area, whichever comes first. The details of the method are provided in ASTM Standard D-5755-95, Microvacuum Sampling and Indirect Analysis Dust by Transmission Electron Microscopy for Asbestos Structure Number Concentrations (Appendix E). For the purposes of this project there will be one modification to the ASTM Method. The following modification to ASTM Method D-5755-95 is noted:

Section 8.7, Sample Area - The ASTM method indicates that a 100 square centimeters (cm^2) sampling area be vacuumed per cassette. In order to obtain a more representative dust sample from several areas within each building, PES will vacuum three separate 100 cm^2 sampling areas per sampling cassette. Therefore each cassette will represent the dust from a 300 cm^2 area.

All microvacuum samples will be analyzed in accordance with International Standard, Determination of Asbestos Fibers (ISO 13012.

4.7.4 Sample Documentation

Sampling activities during this assessment will be documented in a field logbook and on field sample data sheets (Appendix B) to be maintained by the field team in accordance with CDM Federal SOP 4-1 Field Logbook Content and Control (Appendix C). The field team leader will be responsible for maintenance and document control of the field logbook.

4.7.5 Sample Custody, Packaging, and Shipping

This section details the sample custody and the classifying, identifying, labeling, packaging, and transporting of dust samples collected during this investigation.

Sample classification is necessary to ensure the protection of personnel involved in the shipment of samples, and to maintain the integrity of each sample. Dust samples collected during this assessment will be classified as environmental samples.

To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, COC records will be used. The COC record will be employed as physical evidence of sample custody and control, and provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting. COC procedures will follow the requirements set forth in CDM Federal SOP 1-2 Sample Custody, with modifications (Appendix C). The following modifications to SOP 1-2 have been reviewed and approved:

Section 5.2, Sample Labels and Tags - A label will be affixed to each air sampling cassette prior to being shipped to the appropriate laboratory. This number will correspond to the number assigned (i.e., index ID) to that particular sample in the field data sheets.

Samples collected during this investigation will be packaged and shipped in accordance with CDM Federal SOP 2-1, Packaging and Shipping of Environmental Samples (Appendix C) and ASTM Standard D-5755-97 (Appendix E), with modification. The following modifications to SOP 2-1 are as follows:

Section 1.4, Required Equipment - No vermiculite or other absorbent material will be used. No bubble wrap or ice will be used.

4.7.6 Quality Control Samples

Quality control methods include both a field and laboratory component. Normally, field personnel will prepare two types of QC samples: duplicates and blanks. However, field duplicates will not be collected for microvacuum samples. In accordance with the ASTM standard, a microvacuum sample must be collected for two minutes or until all visible dust or particulate has been removed from a specified area. Therefore, it may be impossible to duplicate the sampling of dust.

Field Blanks

Field personnel will prepare blank samples for dust by labeling unused filter cassettes and submitting them for analysis.

4.7.7 Equipment Decontamination

This project requires the decontamination of all microvacuum sampling equipment (e.g., pumps, cassette, tubing, etc) prior to sampling and prior to leaving the site.

Equipment used to collect, handle, or measure dust samples will be decontaminated in accordance with CDM Federal SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites, with modification (Appendix C). The following modifications to SOP 4-5 have been reviewed and approved:

Section 5.0, Procedures - Decontamination water will not be captured and will be discharged to the ground at the site.

Section 5.3, Sampling Equipment Decontamination - ASTM Type II DI water will not be used. Rather, locally available DI water will be used. Decontamination water will be discharged to the ground at the site.

Section 5.6, Waste Disposal - Decontamination water will not be captured and will not be packaged, labeled, or stored as investigation-derived waste.

The decontamination procedure for non-disposable equipment will consist of a tap water and alconox wash with brush scrubbing, followed by a tap water rinse, and final DI water rinse. The equipment will then be allowed to air-dry before being wrapped in clean plastic or aluminum foil. All equipment will be decontaminated before coming into contact with any sample. Rinse water will be discharged to the

ground at the site. Any other deviations from the decontamination procedures will be recorded in the appropriate field logbook.

4.7.8 Health and Safety

All sampling will be performed in accordance with applicable EPA, OSHA, corporate, and site health and safety requirements. CDM Federal has prepared a SHSP that is specific to this project attached as Appendix D.

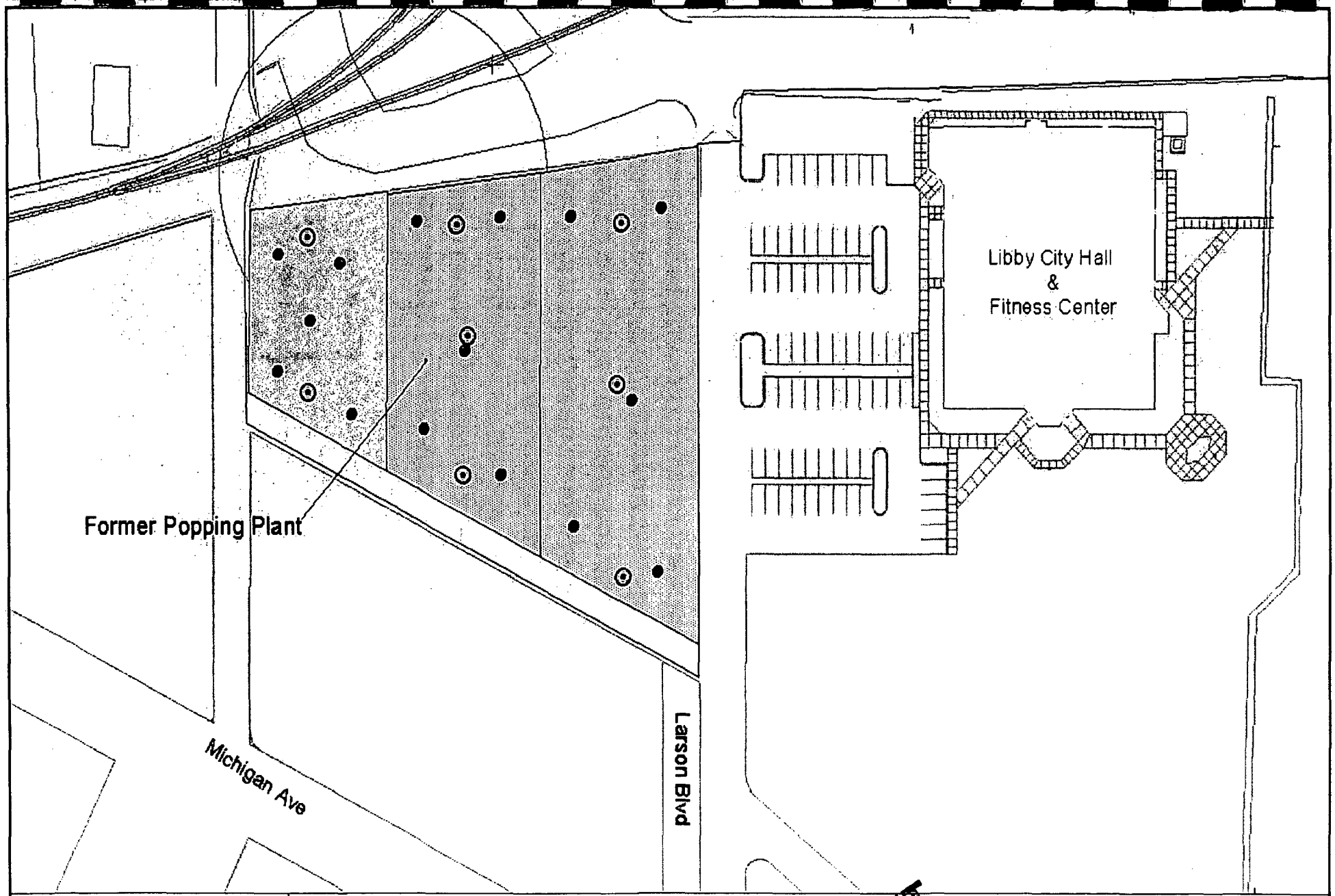
Table 4-1 Sampling Supply and Equipment Checklist

General
SAP
SOPs
HASP
access agreement
sample labels/tags/pens
permanent markers
field book
pin flags
digital camera
garbage bags
100-foot tape measure
GPS unit
cellular phone
file box
color pencils
Federal Express shipping labels
field forms (COCs and Data Sheets)
tool kit
1-gallon zipper-top bags

Equipment Decontamination/Personal Protective Equipment
rubber overboots
Tyvek coveralls
liquid soap
disposable gloves
respirators w/cartridges (see HASP)
duct tape
respirator cleaning kit
5-gallon water-boy
paper towels
safety glasses
eye wash kit
first aid kit
tap water
garden sprayer
long-handle brush
aluminum foil
tubs for decontamination

Soil and Waste/Product
bulb planting tool, trowel, or other sampling
sampling device
site maps
flagging stakes
300-ft measuring tape
flagging tape
plastic sheeting

Air and Dust Sampling
high-volume sample pumps (2-12L/min)
low-volume sample pumps
tygon tubing
sample stands
air-flow calibrator
tubing/cassett adaptors
shrink-wrap
extension cord
50 filter cassettes (0.45 um, MCE filter)
air sampling forms
filter cassettes
tyvek
metric ruler
filter paper
8 1/2 x 11 plastic sheets
masking tape
tape measure
flash light w/batteries
ear plugs
magnifying glass
disposable hand cleaning wipes
100 cm^2-template



1' = 42'

N

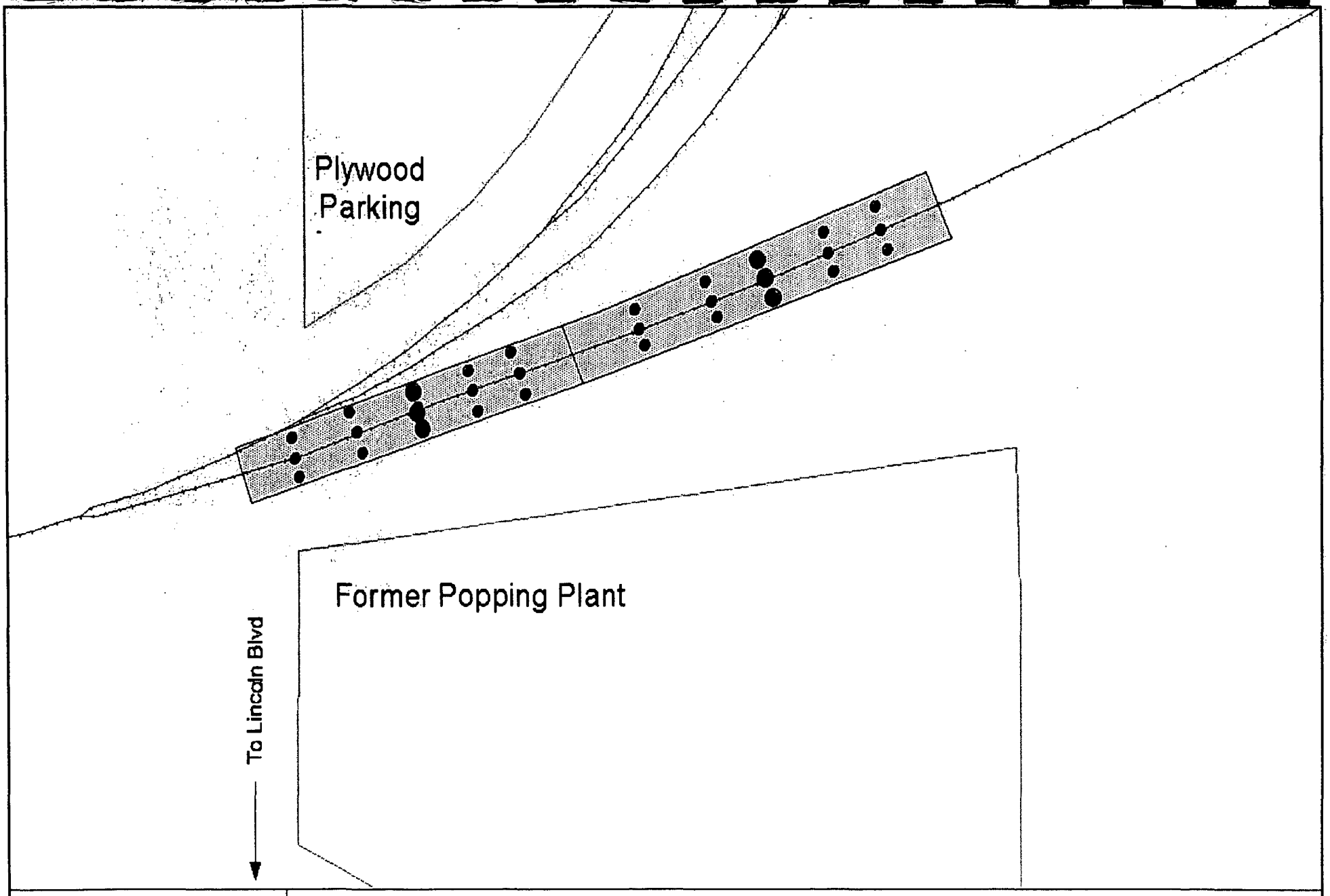
LEGEND

- Composite Surface Soil Location
- Subsurface Soil Location
- Railroad

DRAFT

CDM Federal Programs Corporation
A Subsidiary of Camp Dresser & McKee Inc.

Figure 4-1
Former Popping Plant
Stimson Lumber Yard
Libby, Montana



1" = 18.5'

N

LEGEND

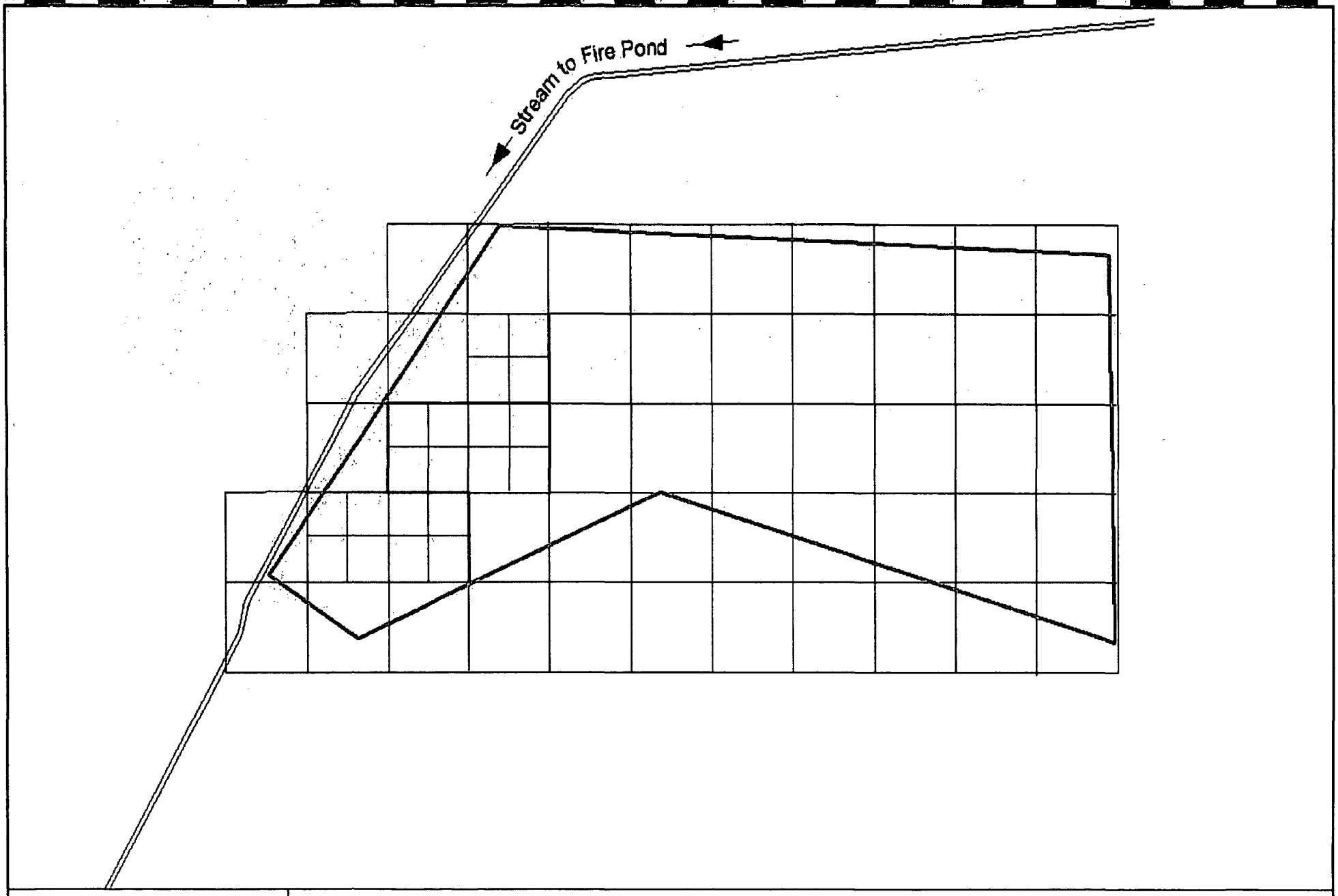
- Railroad
- Composite Sample Area 1
- Composite Sample Area 2
- Proposed Surface Sample
- Proposesd Subsurface Sample (taken from the midpoint of each composite)

DRAFT

CDM Federal Programs Corporation

A Subsidiary of Camp Dresser & McKee Inc.

Figure 4-2
Proposed Sampling Locations
Railway Area
Stimson Lumber Yard
Libby, Montana



1" = 171'

N

CDM Federal Programs Corporation

A Subsidiary of Camp Dresser & McKee Inc.

LEGEND

- Former Champion International Tree Nursery
- 100 Foot Standard Sampling Grid
- 50 Foot Sampling Grid (Areas of High Levels)

DRAFT

Figure 4-3
Conceptual Sampling Approach
Former Champion International Tree Nursery
Stimson Lumber Yard
Libby, Montana

Section 5
Laboratory Analytical Methods

All soil and waste/product samples will be processed prior to analysis. Therefore, these samples will be sent to the CDM Inc. laboratory for sample processing (i.e., drying, sieving, mass balances, etc.), preparation of duplicates, split samples for USGS infrared (or other) analyses, and archive requests. These samples will be sent directly from the field to the attention of Todd Burgesser at:

CDM Inc. Laboratory
2710 Walnut St.
Denver, Colorado 80202
(303) 295-3935

The air and dust samples will be sent directly to the analytical laboratory and will not require any processing at the CDM Inc. Laboratory.

Chain of custody procedures will be maintained through the processing phase and subsequent shipping to the analytical laboratory. Analytical services for all of the samples (i.e., soil, waste/product, dust, and air) will be conducted by one of the following laboratories:

EMSL Analytical Inc.
107 Haddon Avenue
Westmont, NJ 08108
Attn: Mr. Robert DeMalo
(800) 220-3675 ext. 1256

Reservoir Environmental Services Inc.
1827 Grant Street
Denver, Co 80203
Attn: Ms. Jeanne Orr
(303) 964-1986

The most appropriate analytical methods for each environmental medium will depend on the type and level of asbestos contamination and on the detection levels needed to assess hazard and/or nature and extent of contamination. Table 5-1 identifies the analytical methods that will be utilized during the assessment.

The laboratory used for all sample analysis will be accredited under the Laboratory Accreditation Program as sponsored by the American Industrial Hygiene Association (AIHA). The laboratory will also actively participate in the NIOSH Proficiency

Analytical Testing Program for Laboratory Quality Control for asbestos. Lastly, the laboratory will be fully accredited for TEM and PLM analysis under the National Voluntary Laboratory Accreditation Program as sponsored by the National Institute of Standards and Technology (NIST).

Table 5-1 Summary of Analytical Methods

Matrix	Analysis	Holding Time	Analytical Method*
Soil**	Asbestos (bulk) by PLM Asbestos (bulk) by TEM***	6 months	NIOSH Method 9002 EPA 600-R93-119
Waste/ Product	Asbestos (bulk) by PLM Asbestos (bulk) by TEM***	6 months	NIOSH Method 9002 EPA 600-R93-119
Dust	International Standard, Determination of asbestos fibers	6 months	ISO 10312
Personal Air	▪ International Standard, Determination of asbestos fibers ▪ PCM ▪ TEM	6 months	▪ ISO 10312 ▪ NIOSH Method 7400 ▪ EPA AHERA Method
Ambient Air	▪ International Standard, Determination of asbestos fibers ▪ PCM ▪ TEM	6 months	▪ ISO 10312 ▪ NIOSH Method 7400 ▪ EPA AHERA Method

* See Appendix E for methods.

** It may be determined based on the PLM results that the bulk samples will need to be further analyzed via Scanning Microscopy and Energy Dispersive X-ray Spectroscopy utilizing Method EPA-Libby-01.

*** TEM and/or USGS IR analyses may be performed on a subset of samples determined as trace or non-detect via PLM analysis.

Acronyms:
NIOSH - National Institute for Occupational Safety and Health
EPA - Environmental Protection Agency
PLM - polarized light microscopy
TEM - transmission electron microscopy
PCM - phase contrast microscopy
AHERA - Asbestos Hazard Emergency Response Act

sampling and analysis and to provide rapid feedback to the project staff and to facilitate corrective action and continuous improvement.

Laboratory audits/self assessments evaluate laboratory procedures to ensure that they follow Good Laboratory Practices (GLP) Guidelines and to ensure that they do not conflict with project requirements. If conflicts are noted, these must be addressed so that project requirements are met.

Other possible audits/self assessments that may be carried out over the course of the project including:

- Review and verification of procedures followed as part of real-time control charting of QC samples analyzed via field and contract laboratory procedures
- Evaluation of the flow of electronic data
- Review and verification of hardcopy data

Audits/self assessments may review the data flow, verify data entry procedures, and evaluate whether data management QC protocols will be observed. If audits/self assessments resulting from review of any of the procedures reveal that project requirements are not met, then an improvement plan (Figure 6-1) or immediate corrective action for the deficiency must be requested, reviewed, and reported. Results for all audits or self-assessments will be submitted to the corporate QA director identified on the signature page of this document. Information in the reports includes:

- Type of project audit/self assessment (field, office, laboratory, data management, etc.)
- Date of audit/self assessment
- Summary of situation or procedures reviewed
- Results of the audit/self assessment and plan of action describing any non-conformances noted
- Corrective action request(s) (CAR) or improvement plan, if non-conformance noted.
- Date by which CAR or improvement plan action must be received with response and any necessary documentation

If a CAR or improvement plan is required, a follow-up verification must be performed within 20 working days upon receipt of the CAR or improvement plan response to ensure that corrective actions were implemented. More detailed information regarding corrective action procedures is provided in the next section.

6.2.2 Corrective Action Procedures

Two types of corrective actions may result from project audits/self assessments: immediate and long-term. Immediate corrective actions include correcting

deficiencies or errors or correcting inadequate procedures. Long-term corrective actions are designed to eliminate the sources of deficiencies or errors. If either type of corrective action is deemed necessary following a project audit/self assessment, each step in the following procedures must be documented:

- Identify the deviation or deficiency
- Request a corrective action
- Report the problem through a CAR or through an improvement plan to the QA director
- Review the corrective action response
- Perform a follow-up verification to ensure the deviation is not recurring

Figure 6-1 Improvement Plan

CDM FEDERAL PROGRAMS CORPORATION
IMPROVEMENT PLAN

Project No./Title: _____

Client/Contract: _____

Project Manager: _____ QA Coordinator: _____

Situation (Attach Additional Pages as Required):

Situation Identified By: _____ Date: _

Plan of Action (Attach Additional Pages as Required):

Responsible for Action: _____

Scheduled Completion Date: _____

Actual Completion Date: _____

Project Manager Signature: _____ Date: _____

Section 7
Data Reporting and Deliverables

Following completion of analysis for each sample delivery group (SDG), the laboratory will prepare a report that will include a tabulation of all sample results, COC forms, and laboratory QA/QC analyses pertinent to that SDG. No evaluation or validation will be conducted on the data, which includes not evaluating the field QC samples. The laboratory will fax or deliver the report to the appropriate personnel (CDM Federal for soil and waste/product or PES for dust and air). The laboratory will also submit an electronic copy of the data results to CDM Federal. The results of the sampling will be entered into a database currently maintained by the Volpe Center.

Final laboratory reports will be provided to CDM Federal that include all sample results, necessary narratives, replicate analyses, continuing calibration results (if available), and any other QC results associated with the analyses.

Following completion of all field activities and receipt of all final SDGs, CDM Federal will prepare a draft report for the Stimson Lumber Company site. The draft report will include a brief description of the field program, laboratory test results, maps showing the locations and concentrations of the samples collected, assessment of the DQOs, and any deviations from the SAP. Copies of the laboratory results will be attached as an appendix. Three copies of each draft report will be submitted to the Volpe Center task order contracting officer's technical representative (TO COTR) for review and comment:

Project Manager
US/DOT/RSPA/Volpe Center
Attn: John McGuiggin, PE
55 Broadway, Kendall Square
Cambridge, MA 02142
Ph: (617)494-2574
Fax: (617)494-2789
Cell: (617)320-4164
Email: mcguiggin@volpe.dot.gov

Any comments received will be addressed and five copies of the final report will be issued to the TO COTR.

This page intentionally left blank.

Section 8
References

ACGIH 1998, 1998 TLVs® and BEIs®, American Conference of Governmental Industrial Hygienists, Inc., Publication 0098.

EPA 1987 Asbestos Hazard Emergency Response Act of 1986. 52 FR 41846, Codified at 40 CFR 763.

EPA 1990. Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance. EPA 340/1-90-018. December.

EPA 2000. Guidance for the Data Quality Objectives Process. EPA QA/G4. EPA/600/R-96/055. August.

IRIS 1999, IRIS On-line Database, Asbestos - CASRN 1332-21-4, Last Revised -- 09/26/1988.

NIOSH 1999, Pocket Guide to Chemical Hazards, National Institute for Occupational Safety and Health, Publication 99-115.

OSHA 1998a, Asbestos Standard for Industry, Occupational Safety and Health Administration Rules Codified at 29 CFR 1910.1001 et seq.

OSHA 1998b, Asbestos Standard for Construction, Occupational Safety and Health Administration Rules Codified at 29 CFR 1926.1101 et seq.

USDA 1977. Soil Survey of Lincoln County Area. U.S. Department of Agriculture National Resources Conservation Service Soil Survey Staff

Volpe Center 2000, Time-Critical Removal Action, Screening plant (Operable Unit 02), EPA Libby Asbestos Project, Libby, Montana. Prepared by Camp, Dresser and McKee, Inc. August.

This page intentionally left blank.

Appendix A

Previous Site Investigation Sample Results

ASBESTOS TEM LABORATORIES, INC.
FACSIMILE TRANSMISSION

Date: July 26, 2001 **Total Pages (including Cover Sheet):** 3

Attention: Veronica Bovee **FAX #:** [redacted]98
406-253-8858

Company:

CONCERNING ANALYTICAL RESULTS FOR:

Job Name:

Job #:

Comments: Polarized Light Microscopy Bulk Sample Analytical Results

Winchite & Arfvedsonite are not regulated asbestos minerals, but in this sample they occur in an asbestiform habit and both are amphiboles.

MAILED 8/13/01 LNW

1409 Fifth Street, Suite C · Berkeley, CA 94710 · Ph. (510) 528-0108 · FAX (510) 528-0109
With Branch Offices Located At: 952 GREG STREET, SPARKS, NV 89431

ASBESTOS TEM LABS FAX:510-528-0109 Jul 26 '01 10:55 P.01

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

Jul-26-01

Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 98-231
Polarized light microscopy analytical results for 1 bulk sample(s).
Job Site:
Job No.:

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 or 600/M4-82-020 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

MAILED
8/13/01 LNW

1409 FIFTH STREET, SUITE C • BERKELEY, CA 94710 • (510) 528-0108 • FAX (510) 528-0109
With Branch Offices Located At: 952 GREG STREET, SPARKS, NV 89431

POLARIZED LIGHT MICROSCOPY
ANALYTICAL REPORT

EPA Method 600/R-93/116 or 600/M4-82-020

Contact: Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Indicated: 1
Reg. Samples Analyzed: 1
Split Layers Analyzed: 0

Job Site / No.

Report No. 28145
Date Submitted: Jul-25-01
Date Reported: Jul-26-01

SAMPLE ID	ASBESTOS % TYPE	OTHER DATA 1) Non-Asbestos Fibers 2) Matrix Materials 3) Date/Time Collected 4) Date Analyzed	DESCRIPTION FIELD LAB
1. Lab ID # 98-231-001	None Detected	1) 45-60% Winchite,Arfvedsonite 2) 40-55% Mica, Other m.p. 3) 4) Jul-26-01	White. Fiberous Raw Ore Soil/Rock-Off-White
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	E-MAILED 8/13/01

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager _____ Analyst _____

ASBESTOS TEM LABORATORIES, INC. 1409 FIFTH STREET, BERKELEY, CA 94710 (510) 528-0108
With Branch Offices Located At: 952 GREG STREET, SPARKS, NV 89431

ASBESTOS TEM LABORATORIES, INC.
FACSIMILE TRANSMISSION

Date: Jul/20/2001 **Total Pages (including Cover Sheet):** 4

Attention: Veronica Bovee **FAX #:** (406) 293-9898

Company: Veronica Bovee

CONCERNING ANALYTICAL RESULTS FOR:

Job Name:

Job #:

Comments: Transmission Electron Microscopy Bulk Sample Analytical Results

@-MAILED 8/13/01 LNW

1409 Fifth Street, Suite C · Berkeley, CA 94710 · Ph. (510) 528-0108 · FAX (510) 528-0109

ASBESTOS TEM LABS FAX:510-528-0109 JUL 20 01 15:51 P.01

TRANSMISSION ELECTRON MICROSCOPY ANALYTICAL REPORT

Contact: Veronica Bovee

Address: Veronica Bovee
P.O. Box 439
Libby, MT 59923

Job Site / No.

REPORT NO. 27986

Date: Jul-20-01

Date Received: Jul-16-01

Total Samples Analyzed: 1

Client Sample # GM01-013-03.

Laboratory Sample # 98-212-001

SAMPLE DESCRIPTION

Roadway; south of building - East of Creek. Soil Sample.

SAMPLE PREPARATION PARAMETERS

Weight of Material Suspended (mg): 35.6

Volume of Suspension Water (ml): 500

Volume of Suspension Filtered (ml): 0.5

Filter Type & Pore Size: MCE 0.22um

Effective Filter Area (sq.mm): 201

ASBESTOS DETECTED IN SCAN AREA

CHRYSOTILE		AMPHIBOLE	
FIBERS	BUNDLES	FIBERS	BUNDLES
ND	ND	ND	ND

CALCULATED ASBESTOS CONCENTRATION (WEIGHT %)

CHRYSOTILE	AMPHIBOLE	TOTAL
ND	ND	ND

COMMENTS

NOTE: Approximately 50% of sample contained a highly fibrous asbestiform mineral called winchite/richterite that is not regulated by EPA. Over 100 fibers were observed and over 10 EDX spectra taken.

Filter Loading: Moderate

SAED Photo ID Nos. None Taken

TEM / ANALYTICAL PARAMETERS

Scanned For Bundles: 8 — Area (sq.mm): 0.0096 — Bundle Scan Area (sq.mm): 0.0768

Scanned For Fibers: 8 — Area (sq.mm): 0.0096 — Fiber Scan Area (sq.mm): 0.0768

Magnification: 18,000X

NOTATION KEY

Chrys. - Chrysotile Asbestos
Amph. - Amphibole Asbestos
ND - None Detected
Non-Asb. - Non-Asbestos

1 um = 1 micron = 0.001 mm
1 mm = 1 millimeter
1 sq.mm = 1 square millimeter
1 cc = 1 cubic centimeter

Analyst Signature

Lab Manager Signature

ASBESTOS TEM LABORATORIES, INC. 1409 FIFTH STREET, BERKELEY, CA 94710 (510) 528-0108

E-MAILED 8/13/01

HNU X-RAY System 5000
Spectrum Plotting Program
Printplot V3.000

Sample ID: Actinolite From L.A. #2

Energy Range: 0 -10 kev 10ev/ch

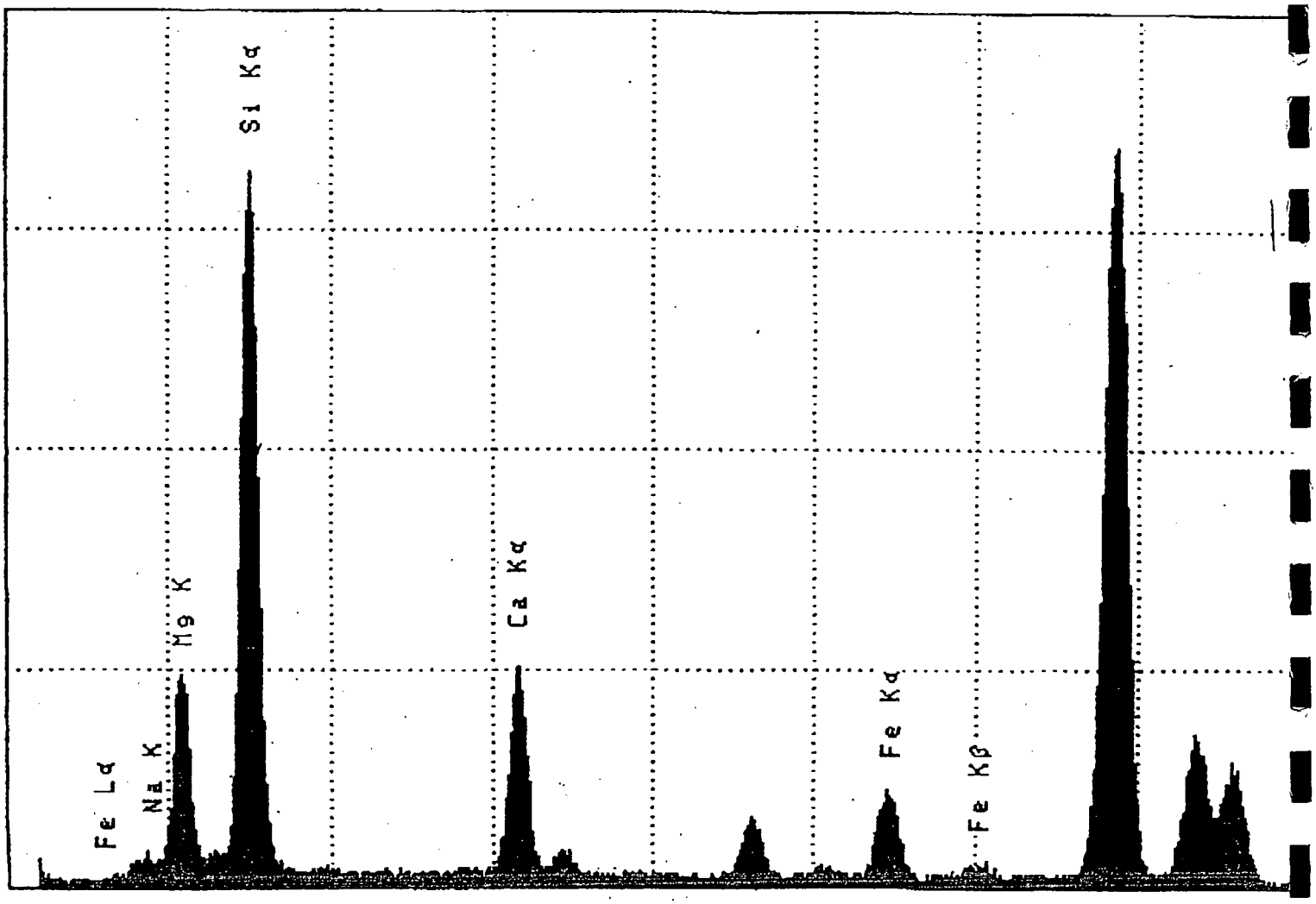
Preset: Off

Real Time: 256.66 Sec. Live Time: 243.24 Sec.

5% Deadtime 640 Counts/Second

Acquisition date: 02-Oct-92 Acquisition time: 10:35:06

Cfs 2K



<0.000 keV Cursor = 0 (0.000 keV) = 0 9.398 keV >

Actinolite Si/ =4 Fe/ =0.18

MAILED 8/13/01 LNW

HNU X-RAY System 5000
Spectrum Plotting Program
Printplot V3.000

Sample ID: 98-212-1

Energy Range: 0 - 10 keV 10 eV/ch

E-MAILED 6/13/01 cNW

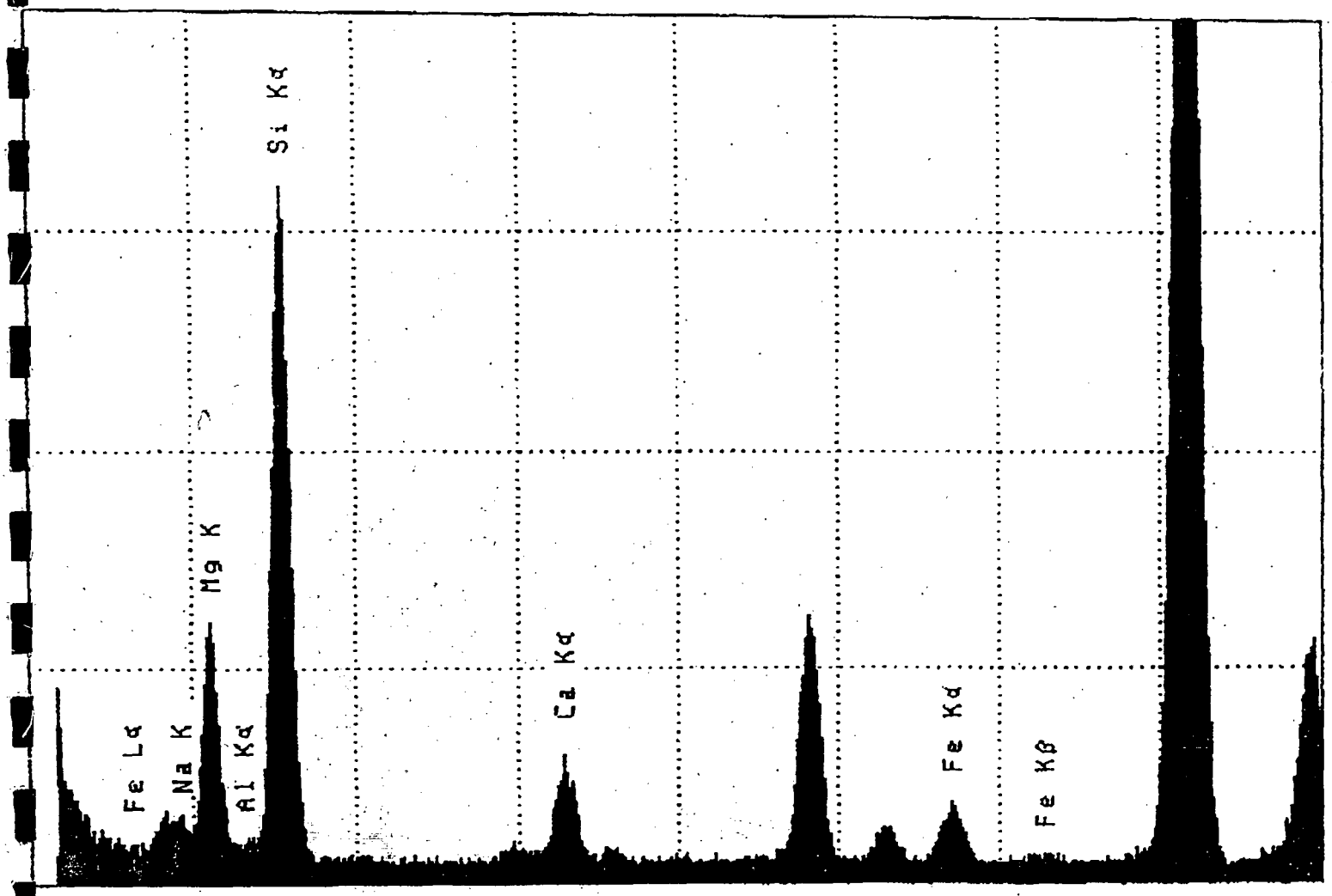
Preset: Off

Real Time: 164.06 Sec. Live Time: 143.05 Sec.

13% Deadtime 1535 Counts/Second

Acquisition date: 04-Jul-:1 Acquisition time: 02:46:22

Cfs 2K



<0.015 keV Cursor = 0 (0.015 keV) = 0 8.991 keV >

American Mineralogist, Volume 85, pages 1540–1542, 2000

Amphibole asbestos from Libby, Montana: Aspects of nomenclature

ANN G. WYLIE[1] AND JENNIFER R. VERKOUTEREN[2,*]

[1]Laboratory for Mineral Deposits Research, Department of Geology, University of Maryland, College Park, Maryland, 20742, U.S.A.
[2]Chemical Science and Technology Laboratory, National Institute of Standards and Technology, Gaithersburg, Maryland, 20899, U.S.A.

E-MAILED 8/13/00 LNW

ABSTRACT

Richterite-asbestos and winchite-asbestos are not listed in the federal regulations governing asbestos. However, asbestiform winchite is found in the gangue at the Libby, Montana, vermiculite deposit, where asbestos-related diseases have been reported among the miners and millers. Changing amphibole nomenclature, uncertainties in Fe^{2+}/Fe^{3+}, and natural compositional variability result in samples of the asbestiform amphibole from Libby being variably classified as soda tremolite, richterite, sub-calcic actinolite, and winchite. A classification of winchite-asbestos is assigned for two samples of Libby asbestos analyzed for this report, consistent with the most recent International Mineralogical Association classification system. Although some of the unit-cell parameters and optical properties reported here are distinctive, others are very similar to the tremolite-actinolite series.

INTRODUCTION

The U.S. Occupational Safety and Health Administration (OSHA) and the U.S. Environmental Protection Agency (EPA) have regulated asbestos since the early 1970s (summarized by Vu 1993). The current regulations specify chrysotile and the asbestiform habit of five amphiboles: tremolite, actinolite, anthophyllite, riebeckite (listed as crocidolite) and cummingtonite-grunerite (listed as amosite) (Title 40, Code of Federal Regulations, Part 61 and Part 763; Title 29, Code of Federal Regulations, Part 1910 and Part 1926[1]). These minerals were known at the time the regulations were first written to have been mined commercially as asbestos. Although there have been modifications to the regulations since they were first promulgated, most notably to clarify that cleavage fragments are not asbestos (Federal Register 1992), the minerals that are regulated have not changed. In particular, the sodic-calcic amphiboles winchite and richterite are not regulated.

An asbestiform amphibole occurs as a gangue mineral in the Zonolite® vermiculite ore body in Libby, Montana, which was mined from 1923 to 1990. Estimates of the abundance of the amphibole in the unprocessed ore range from 0 to ≈ 5 wt% (Atkinson et al. 1982). An elevated incidence of mesothelioma, the hallmark of asbestos exposure, has been reported among the miners and millers of Zonolite® in several studies that were summarized by Ross et al. (1993). In late 1999 and early 2000, many deaths alleged to be due to asbestos exposure in Libby were reported in the popular press, stimulating Congressional oversight (106th Congress 2000). Of particular significance for the regulatory community is the identity of the asbestiform amphibole.

The asbestiform amphibole at Libby has been referred to under a variety of names, including tremolite, actinolite, soda tremolite, richterite, and winchite. The current nomenclature used in the popular press and by the residents of Libby is tremolite, or tremolite/actinolite. Deer et al. (1963) give an analysis of an amphibole from Libby (taken from Larson 1942) that they identify as "richterite (soda tremolite)."

In the amphibole classification system of Deer et al. (1963), Miyashiro's (1957) classification of the alkali amphiboles was generally adopted. However, of particular significance to the Libby amphibole, Deer et al. (1963) used the name richterite in place of soda tremolite, dividing tremolite from richterite at $NaCa_{1.5}$, (they considered winchite to be a subset of richterite). The International Mineralogical Association (IMA) classification (Leake 1978) continued the use of richterite in place of soda tremolite and added specific chemical parameters for distinguishing the actinolite series from richterite and for applying the name winchite. The parameters for richterite were $^{B}(Ca + Na) \geq 1.34$ atoms per formula unit (apfu) and $0.67 < {}^{B}Na < 1.34$ apfu (classifying the amphibole as a member of the sodic-calcic group) and $Si > 7.5$ apfu and $^{A}(Na+K) \geq 0.5$ apfu. By the IMA 1978 classification scheme, winchite is also a member of the sodic-calcic group and is distinguished from richterite by $^{A}(Na + K) < 0.5$ apfu. Members of the actinolite series belong to the calcic group and have $^{B}(Ca + Na) \geq 1.34$ apfu and $^{B}Na < 0.67$ apfu. Another relevant evolution in the nomenclature was the division between tremolite and actinolite; according to Deer et al. (1963), tremolite contained between 0 and 20% ferro–actinolite while according to the IMA, tremolite contained no more than 10% ferro–actinolite. The most recent nomenclature changes in Deer et al. (1997) and the revised IMA classification (Leake et al. 1997) changed the positions of the subdivisions to fit a 50% rule. Under these changes, $^{B}(Na +$

[1]Regulations dealing with asbestos can be obtained through the websites maintained by OSHA (www.osha.gov) and the EPA (www.epa.gov).

* E-mail: jennifer.verkouteren@nist.gov

Ca) ≥ 1.0 apfu is now used to define the calcic and sodic-calcic groups, and the calcic group has $^{B}Na < 0.50$ apfu.

RESULTS

Two samples of asbestiform amphibole from Libby were analyzed following the experimental procedures detailed in Verkouteren and Wylie (2000). Chemical compositions, cell parameters, and optical properties are given in Table 1. One of the samples had been in our collection for several years; the other was obtained recently. Sample 1 is relatively pure, loose fiber and sample 2 was collected from the mine dump and is composed primarily of asbestiform amphibole. In both cases, the fibers are light green and asbestiform. The wt% Fe (analyzed as FeO) was converted to formula proportions of cations assuming first all Fe^{2+} and then all Fe^{3+}. It seems likely that at least some portion of the iron is trivalent, as more than 8.0 apfu Si cannot be accommodated in the tetrahedral sites. Hence, the "true" formulae must lie somewhere between these two extremes.

Because $^{B}(Na + Ca) \geq 1.0$ apfu this amphibole is either a sodic-calcic or a calcic amphibole. If all the iron is Fe^{2+}, then $^{B}Na = 0.63$ or 0.61 apfu, and according to Miyashiro (1957) the amphibole should be called soda tremolite. According to Deer et al. (1963), it would probably be richterite. According to Leake (1978), it would be sub-calcic actinolite, and according to Deer et al. (1997) and Leake et al. (1997), it would be winchite. If all the iron is Fe^{3+}, ^{B}Na increases to 0.75 or 0.67 apfu and according to Leake (1978), Deer et al. (1997) and Leake et al. (1997), it would be winchite. The chemical composition of the Libby amphibole as reported by Larson (1942) corresponds to a current classification of richterite.

Deer et al. (1963) chose $NaCa_{1.5}$ as the dividing line between richterite and tremolite because it was consistent with a "relatively sudden" change in optical properties, specifically a decrease in birefringence, stronger pleochroism, lower indices of refraction, and smaller optic axial angle. The refractive indices given in Table 1 are different for the two samples, consistent with the change in 1 − Mg/(Mg + Fe + Mn). Comparison of the optical properties to those of the actinolite series (Verkouteren and Wylie 2000) indicates that, for both samples, n_α is high and n_γ is low, although not statistically outside the population of actinolite samples. The birefringence given in Table 1 is much lower than any actinolite sample in Verkouteren and Wylie (2000) and is a clear outlier; this is also true for the birefringence of the Libby amphibole given by Larson (1942). No difference exists between the optic axial angle given in Table 1 and the actinolite series; however, the optic axial angle for the Libby amphibole reported by Larson (1942) is distinctly smaller than that of corresponding actinolites.

Comparison of the lattice parameters to those of the actinolite series (Verkouteren and Wylie 2000) indicates that, for both samples, *a* and *c* are at or within the 95% prediction limits for actinolite, but *b* is outside the lower 95% prediction limit by more than 0.025 Å. The values of *a* are high given a Ca value of 1.3 apfu; these samples would fall into an anomalous region in the actinolite series where *a* and Ca are positively correlated (Verkouteren and Wylie 2000), and we would predict an *a* of 9.83 Å or lower. The values of β for the Libby samples are consistent with the actinolite series and the positive correlation of β and Ca. The potassian winchite-asbestos described by Wylie and Huggins (1980) has a larger *a* dimension, a smaller *b* dimension, and the same *c* dimension when compared with the actinolite series. Similarly, the three non-Ti bearing richterites in Oberti et al. (1992) have larger *a* dimensions, smaller *b* dimensions, and the same *c* dimensions when compared to the actinolite series.

TABLE 1. Chemical composition, optical properties, and cell parameters of 2 samples of winchite-asbestos, Libby, Montana. (1σ errors in parentheses)

Oxide	wt%			apfu§, all Fe^{2+}		apfu§, all Fe^{3+}	
	Sample 1*	Sample 2†		Sample 1	Sample 2	Sample 1	Sample 2
SiO_2	56.6(4)	56.1(2)	Si	8.04	8.01	7.92	7.92
TiO_2	n.d.	n.d.	^{IV}Al	–	–	0.08	0.07
Cr_2O_3	n.d.	n.d.	ΣT	8.04	8.01	8.00	8.00
Al_2O_3	0.5(1)	0.4(2)	^{VI}Al	0.09	0.07	0.01	–
FeO	6.0(6)	4.2(4)	Mg	4.28	4.45	4.21	4.41
MnO	0.1(0)	0.3(3)	Fe	0.72	0.50	0.71	0.50
MgO	20.2(5)	21.0(4)	Mn	0.01	0.03	0.01	0.03
CaO	8.3(10)	8.8(2)	ΣC	5.10	5.05	4.94	4.94
Na_2O	3.2(8)	3.4(2)	ex. C	0.10	0.05	–	–
K_2O	0.7(1)	0.8(2)	Ca	1.27	1.34	1.25	1.33
Total	95.6	95.0	^{B}Na	0.63	0.61	0.75	0.67
			ΣB	2.00	2.00	2.00	2.00
			^{A}Na	0.25	0.33	0.12	0.26
			^{A}K	0.13	0.15	0.13	0.15
			ΣA	0.38	0.48	0.25	0.41
		1-Mg/(Mg+Fe+Mn)		0.15	0.11		

Notes: optical properties: Sample 1: $n_\alpha = 1.621(1)$, $n_\beta = 1.631(1)$, $n_\gamma = 1.637(1)$, $c \wedge Z = 15.8(0.5)°$. Sample 2: $n_\alpha = 1.618(1)$, $n_\beta = 1.628(1)$, $n_\gamma = 1.634(1)$, $c \wedge Z = 15.8(0.5)°$ $\delta\ddagger = 0.016$, $2V_\gamma\ddagger = 104.9$.
Cell dimensions: Sample 1: $a = 9.855(1)$ Å, $b = 18.032(1)$ Å, $c = 5.288(3)$ Å, $\beta = 104.54(2)°$. Sample 2: $a = 9.861(2)$ Å, $b = 18.003(5)$ Å, $c = 5.276(6)$ Å, $\beta = 104.37(4)°$.
* Average of 6 analyses.
† Average of 3 analyses.
§ Calculated on the basis of 23 O atoms.
‡ Calculated from the measured refractive indices.

Q-MAILED 8/13/01 LNW

DISCUSSION

The composition of the Libby asbestiform amphibole as given in Table 1 is consistent with an identification of winchite-asbestos, based on Leake et al. (1997). The samples can be identified as winchites despite the uncertainty in site occupancies resulting from the unknown oxidation state of Fe. The *b* lattice dimension and the birefringence are consistent with what is known about winchite (and richterite) and are distinct from actinolite. Ross et al. (1993) report that both tremolite and richterite asbestos fibers were found in a specimen of Libby vermiculite. Our two samples were collected approximately ten years apart, and probably from different areas in the mine, and both are winchites, although our sample 2 is close to richterite in composition (ΣA = 0.48 to 0.41 apfu). Given the fact that the Libby amphibole reported by Larson (1942) is a richterite, it is possible that the amphibole composition ranges from winchite to richterite, and possibly to actinolite, throughout the vermiculite deposit. Asbestiform winchite and richterite are also known from other localities, where they are similarly associated with the alteration of alkali igneous rocks (Wylie and Huggins 1980; Deer et al. 1997).

It is unfortunate that a regulatory decision could hinge on such details as the amount of ^{B}Na and the choice of classification scheme. While the distinctions among amphiboles are important from a scientific standpoint, they do not add significantly to the regulatory terminology unless they are correlated with risk assessment. There are data that show differences in disease potential among different minerals with similar morphology, such as between talc and tremolite (Guthrie and Mossman 1993), but it is clear that the asbestiform winchite in Libby, Montana poses a health threat (106th Congress 2000). From an analytical standpoint, the identification of the specific asbestiform mineral is necessary for complete characterization of the asbestos component in any sample. The regulatory requirement to identify the mineral can be addressed by providing reference values for known asbestiform amphiboles, which was, in part, the impetus behind the study described in Verkouteren and Wylie (2000) and the current note. It would be reasonable for the regulations to be revised to provide a broader description of asbestiform amphiboles to avoid similar hair-splitting problems in the future.

ACKNOWLEDGEMENTS

We thank Laura Kuzel and Robert Nolan for providing samples.

REFERENCES CITED

106th Congress (2000) Federal, State, and Local Response to Public Health and Environmental Conditions from Asbestos Contamination in Libby, Montana (Full committee field hearing). Statements From Hearings Held 106th Congress, Second Session, U.S. Senate Committee on Environment and Public Works, February 16, 2000. http://www.senate.gov/~epw/stml_106.htm#02-16-00

Atkinson, G.R., Rose, D., Thomas, K., Jones, D., Chatfield, E., and Going, J. (1982) Collection, analysis and characterization of vermiculite samples for fiber content and asbestos contamination. Midwest Research Institute report for the U. S. Environmental Protection Agency, Project 4901-A32 under EPA Contract 68-01-5915, Washington, D.C.

Deer, W.A., Howie, R.A., and Zussman, J. (1963) Rock-forming minerals, volume 2, Chain silicates, 377 p. Longmans, London.

——— (1997) Rock-forming minerals, volume B, Double chain silicates, 2nd Ed., 764 p. The Geological Society, London.

Federal Register (1992) Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite. FR 57:24310, June 8, 1992.

Guthrie, Jr. G.D. and Mossman, B.T. (1993) Merging the geological and biological sciences: An integrated approach to the study of mineral-induced pulmonary diseases. In Mineralogical Society of America Reviews in Mineralogy, 28, 1-5.

Larson, E.S. (1942) Alkalic rocks of Iron Hill, Gunnison County, Colorado. U.S. Geological Survey, Prof. Paper No. 197A.

Leake, B.E. (1978) Nomenclature of amphiboles. American Mineralogist, 63, 1023–1052.

Leake, B.E., Woolley, A.R., Arps, C.E.S., Birch, W.D., Gilbert, M.C., Grice, J.D., Hawthorne, F.C., Kato, A., Kisch, H.J., Krivovichev, V.G., Linthout, K., Laird, J., Mandarino, J.A., Maresch, W.V., Nickel, E.H., Rock, N.M.S., Schumacher, J.C., Smith, D.C., Stephenson, N.C.N., Ungaretti, L., Whittaker, E.J.W., and Youshi, G. (1997) Nomenclature of amphiboles: Report of the subcommittee on amphiboles of the International Mineralogical Association, Commission on new minerals and mineral names. American Mineralogist, 82, 1019–1037.

Miyashiro, A. (1957) The chemistry, optics and genesis of the alkali-amphiboles. Journal of the Faculty of Science University Tokyo, Section 2, 11, 57–83.

Oberti, R., Ungaretti, L., Cannillo, E. and Hawthorne, F.C. (1992) The behavior of Ti in amphiboles: I. Four- and six-coordinate Ti in richterite. European Journal of Mineralogy, 4, 425–439.

Ross, M., Nolan, R.P., Langer, A.M., and Cooper, W.C. (1993) Health effects of mineral dusts other than asbestos. In Mineralogical Society of America Reviews in Mineralogy, 28, 361–407.

Verkouteren, J.R. and Wylie, A.G. (2000) The tremolite-actinolite-ferro-actinolite series: Systematic relationships among cell parameters, composition, optical properties, and habit, and evidence of discontinuities. American Mineralogist, 85, 1239–1254.

Vu, V.T. (1993) Regulatory approaches to reduce human health risks associated with exposure to mineral fibers. In Mineralogical Society of America Reviews in Mineralogy, 28, 545–554.

Wylie, A.G. and Huggins, C.W. (1980) Characteristics of a potassian winchite-asbestos from the Allamoore Talc District, Texas. Canadian Mineralogist, 18, 101–107.

MANUSCRIPT RECEIVED JUNE 13, 2000
MANUSCRIPT ACCEPTED JUNE 13, 2000
PAPER HANDLED BY ROBERT F. DYMEK

E-MAILED 8/13/01 CNW

ASBESTOS TEM LABORATORIES, INC.
FACSIMILE TRANSMISSION

Date: 7/20/01 **Total Pages (including Cover Sheet):** 3

Attention: Ms. Veronica Bovee **FAX #:** 406-293-9898

Company: Stimson Lumber Company

CONCERNING ANALYTICAL RESULTS FOR:

Job Name: Stimson Nursery Site

Job #: 01-014

Report #: 96113

8/13/01 LNW

Comments: Polarized Light Microscopy Bulk Sample Analytical Results

Veronica: You can be certain that the mineral reported as tremolite in this report is the same mineral that has caused lung diseases in Libby. However, it is ~~[illegible]~~ not currently classified as asbestos by EPA. The mineral is actually richterite. It is very similar to tremolite. If you want to know more about this phase call [illegible]

1016 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovec

Address: Stimson Lumber Company
875 Highway 2 South
Libby, MT 59923

Samples Submitted: 20
Reg. Samples Analyzed: 20
Split Layers Analyzed: 0

Job Site / No. Stimson Nursery Site 01-014

Report No. 96113
Date Submitted: Jul-18-01
Date Reported: Jul-20-01

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM101-014-001. Lab ID # 850-002-001		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	50' From Corner Fence, 1-3" Deep, Soil Sample Soil-Brown
GM101-014-002. Lab ID # 850-002-002		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	100' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-003. Lab ID # 850-002-003		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	150' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-004. Lab ID # 850-002-004	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-005. Lab ID # 850-002-005	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 6" Deep, Soil Soil-Brown
GM101-014-006. Lab ID # 850-002-006		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	250' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-007. Lab ID # 850-002-007		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	300' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-008. Lab ID # 850-002-008	<1%	Tremolite	Fibers: None Detected Matrix: 100-100% Qtz, Mica, Other m.p.	300' From Corner Fence, 5' to North 1-3" Deep, Soil Soil-Brown
GM101-014-009. Lab ID # 850-002-009		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to North 1-3" Deep, Soil Soil-Brown
GM101-014-010. Lab ID # 850-002-010	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 5' to South 1-3" Deep, Soil Soil-Brown

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch

Analyst C. Neil Upchurch

E-MAILED

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address: Stimson Lumber Company
875 Highway 2 South
Libby, MT 59923

Samples Submitted: 20
Reg. Samples Analyzed: 20
Split Layers Analyzed: 0

Job Site / No. Stimson Nursery Site 01-014

Report No. 96113
Date Submitted: Jul-18-01
Date Reported: Jul-20-01

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM101-014-011. Lab ID # 850-002-011	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to South 1-3" Deep, Soil Soil-Brown
GM101-014-012. Lab ID # 850-002-012	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to West 1-3" Deep, Soil Soil-Brown
GM101-014-013. Lab ID # 850-002-013		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 5' to East 1-3" Deep, Soil Soil-Brown
GM101-014-014. Lab ID # 850-002-014		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to East 1-3" Deep, Soil Soil-Brown
GM101-014-015. Lab ID # 850-002-015		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 50' to North, Soil Soil-Brown
GM101-014-016. Lab ID # 850-002-016		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 90' to North, Soil Soil-Brown
GM101-014-017. Lab ID # 850-002-017		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 120' to North, Soil Soil-Brown
GM101-014-018. Lab ID # 850-002-018		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	270' From Corner Fence, 15' From Little Fence, Soil Soil-Brown
GM101-014-019. Lab ID # 850-002-019		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	180' From Corner Fence, 15' From Little Fence, Soil Soil-Brown
GM101-014-020. Lab ID # 850-002-020		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	150' From Corner Fence, 15' From Little Fence, Soil Soil-Brown

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

E-MAIL 9/13/01

Lab Manager C. Neil Upchurch

Analyst C. Neil Upchurch

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address: Stimson Lumber Company
875 Highway 2 South
Libby, MT 59923

Samples Submitted: 20
Reg. Samples Analyzed: 20
Split Layers Analyzed: 0

Job Site / No. Stimson Nursery Site 01-014

Report No. 96113
Date Submitted: Jul-18-01
Date Reported: Jul-20-01

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM101-014-011. Lab ID # 850-002-011	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to South 1-3" Deep, Soil Soil-Brown
GM101-014-012. Lab ID # 850-002-012	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to West 1-3" Deep, Soil Soil-Brown
GM101-014-013. Lab ID # 850-002-013		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 5' to East 1-3" Deep, Soil Soil-Brown
GM101-014-014. Lab ID # 850-002-014		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to East 1-3" Deep, Soil Soil-Brown
GM101-014-015. Lab ID # 850-002-015		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 50' to North, Soil Soil-Brown
GM101-014-016. Lab ID # 850-002-016		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 90' to North, Soil Soil-Brown
GM101-014-017. Lab ID # 850-002-017		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 120' to North, Soil Soil-Brown
GM101-014-018. Lab ID # 850-002-018		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	270' From Corner Fence, 15' From Little Fence, Soil Soil-Brown
GM101-014-019. Lab ID # 850-002-019		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	180' From Corner Fence, 15' From Little Fence, Soil Soil-Brown
GM101-014-020. Lab ID # 850-002-020		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	150' From Corner Fence, 15' From Little Fence, Soil Soil-Brown

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

E-MAIL 9/3/01

Lab Manager C. Neil Upchurch

Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC.
FACSIMILE TRANSMISSION

Date: July 26, 2001 **Total Pages (including Cover Sheet):** 3

Attention: Veronica Bovee **FAX #:** [redacted] 98
406-253-8858

Company:

CONCERNING ANALYTICAL RESULTS FOR:

Job Name:

Job #:

Comments: Polarized Light Microscopy Bulk Sample Analytical Results

Winchite & Arfvedsonite are not regulated asbestos minerals, but in this sample they occur in an asbestiform habit and both are amphiboles.

MAILED 8/13/01 LNW

1409 Fifth Street, Suite C · Berkeley, CA 94710 · Ph. (510) 528-0108 · FAX (510) 528-0109
With Branch Offices Located At: 952 GREG STREET, SPARKS, NV 89431

ASBESTOS TEM LABS FAX:510-528-0109 JUL 26 '01 10:55 P.01

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

Jul-26-01

Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 98-231
Polarized light microscopy analytical results for 1 bulk sample(s).
Job Site:
Job No.:

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 or 600/M4-82-020 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

MAILED
8/13/01 LMW

1409 FIFTH STREET, SUITE C • BERKELEY, CA 94710 • (510) 528-0108 • FAX (510) 528-0109
With Branch Offices Located At: 952 GREG STREET, SPARKS, NV 89431

POLARIZED LIGHT MICROSCOPY
ANALYTICAL REPORT

EPA Method 600/R-93/116 or 600/M4-82-020

Contact: Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Indicated: 1
Reg. Samples Analyzed: 1
Split Layers Analyzed: 0

Job Site / No.

Report No. 28145
Date Submitted: Jul-25-01
Date Reported: Jul-26-01

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	OTHER DATA 1) Non-Asbestos Fibers 2) Matrix Materials 3) Date/Time Collected 4) Date Analyzed	DESCRIPTION FIELD / LAB
1.		None Detected	1) 45-60% Winchite,Arfvedsonite 2) 40-55% Mica, Other m.p. 3) 4) Jul-26-01	White. Fiberous Raw Ore Soil/Rock-Off-White
Lab ID # 98-231-001				
Lab ID #			1) 2) 3) 4)	
Lab ID #			1) 2) 3) 4)	
Lab ID #			1) 2) 3) 4)	
Lab ID #			1) 2) 3) 4)	
Lab ID #			1) 2) 3) 4)	
Lab ID #			1) 2) 3) 4)	
Lab ID #			1) 2) 3) 4)	
Lab ID #			1) 2) 3) 4)	
Lab ID #			1) 2) 3) 4)	E-MAILED 8/13/01

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager [signature] Analyst [signature]

ASBESTOS TEM LABORATORIES, INC. 1409 FIFTH STREET, BERKELEY, CA 94710 (510) 528-0108
With Branch Offices Located At: 952 GREG STREET, SPARKS, NV 89431

ASBESTOS TEM LABS FAX:510-526-0109 JUL 26 '01 10:36 P.03

ASBESTOS TEM LABORATORIES, INC.
FACSIMILE TRANSMISSION

Date: Jul/20/2001 **Total Pages (including Cover Sheet):** 4

Attention: Veronica Bovee **FAX #:** (406) 293-9898

Company: Veronica Bovee

CONCERNING ANALYTICAL RESULTS FOR:

Job Name:

Job #:

Comments: Transmission Electron Microscopy Bulk Sample Analytical Results

E-MAILED 8/13/01 LNW

1409 Fifth Street, Suite C · Berkeley, CA 94710 · Ph. (510) 528-0108 · FAX (510) 528-0109

TRANSMISSION ELECTRON MICROSCOPY ANALYTICAL REPORT

Contact:	Veronica Bovee	REPORT NO.	27986
Address:	Veronica Bovee P.O. Box 439 Libby, MT 59923	Date:	Jul-20-01
		Date Received:	Jul-16-01
Job Site / No.		Total Samples Analyzed:	1

Client Sample # GM01-013-03.

Laboratory Sample # 98-212-001

SAMPLE DESCRIPTION

Roadway; south of building - East of Creek. Soil Sample.

SAMPLE PREPARATION PARAMETERS

Weight of Material Suspended (mg):	35.6	Filter Type & Pore Size	MCE 0.22um
Volume of Suspension Water (ml):	500	Effective Filter Area (sq.mm)	201
Volume of Suspension Filtered (ml):	0.5		

ASBESTOS DETECTED IN SCAN AREA

CHRYSOTILE		AMPHIBOLE	
FIBERS	BUNDLES	FIBERS	BUNDLES
ND	ND	ND	ND

CALCULATED ASBESTOS CONCENTRATION (WEIGHT %)

CHRYSOTILE	AMPHIBOLE	TOTAL
ND	ND	ND

COMMENTS

NOTE: Approximately 50% of sample contained a highly fibrous asbestiform mineral called winchite/richterite that is not regulated by EPA. Over 100 fibers were observed and over 10 EDX spectra taken.

Filter Loading: Moderate

SAED Photo ID Nos. None Taken

TEM / ANALYTICAL PARAMETERS

# Scanned For Bundles	8	Area (sq.mm)	0.0096	Bundle Scan Area (sq.mm)	0.0768
# Scanned For Fibers	8	Area (sq.mm)	0.0096	Fiber Scan Area (sq.mm)	0.0768

Magnification: 18,000X

NOTATION KEY

Chrys. - Chrysotile Asbestos
Amph. - Amphibole Asbestos
ND - None Detected
Non-Asb. - Non-Asbestos

1 um = 1 micron = 0.001 mm
1 mm = 1 millimeter
1 sq.mm = 1 square millimeter
1 cc = 1 cubic centimeter

Analyst Signature

Lab Manager Signature

ASBESTOS TEM LABORATORIES, INC. 1409 FIFTH STREET, BERKELEY, CA 94710 (510) 528-0108

MAILED 8/13/01

HNU X-RAY System 5000
Spectrum Plotting Program
Printplot V3.000

Sample ID: Actinolite From L.A. #2

Energy Range: 0 -10 kev 10ev/ch

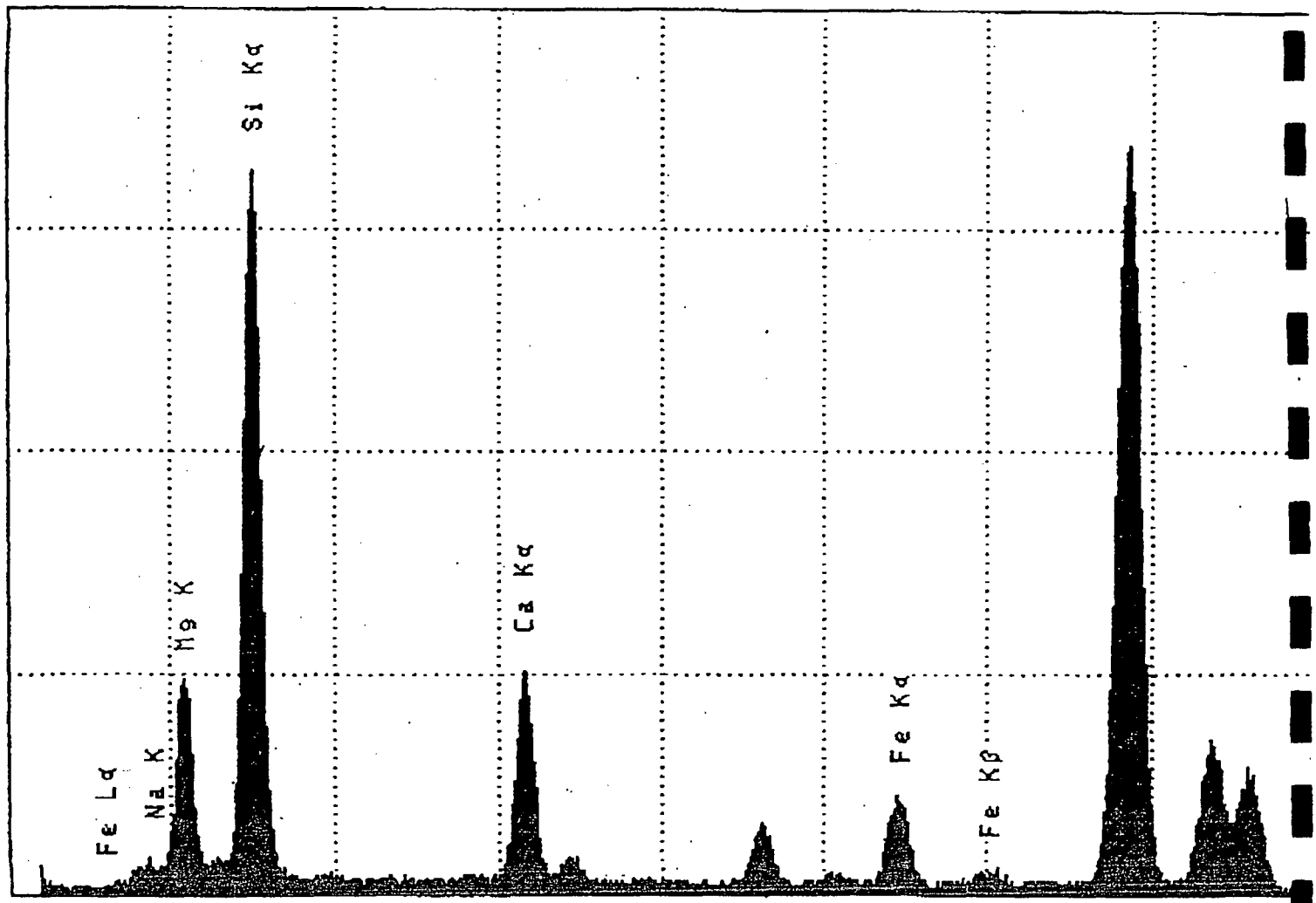
Preset: Off

Real Time: 256.66 Sec. Live Time: 243.24 Sec.

5% Deadtime 640 Counts/Second

Acquisition date: 02-Oct-92 Acquisition time: 10:35:06

Cfs 2K



<0.000 keV Cursor = 0 (0.000 keV) = 0 9.398 keV

Actinolite Si/ =4 Fe/ =0.18

E-MAILED 8/13/01 LNW

HNU X-RAY System 5000
Spectrum Plotting Program
Printplot V3.000

Sample ID: 98-212-1

Energy Range: 0 - 10 keV 10 eV/ch

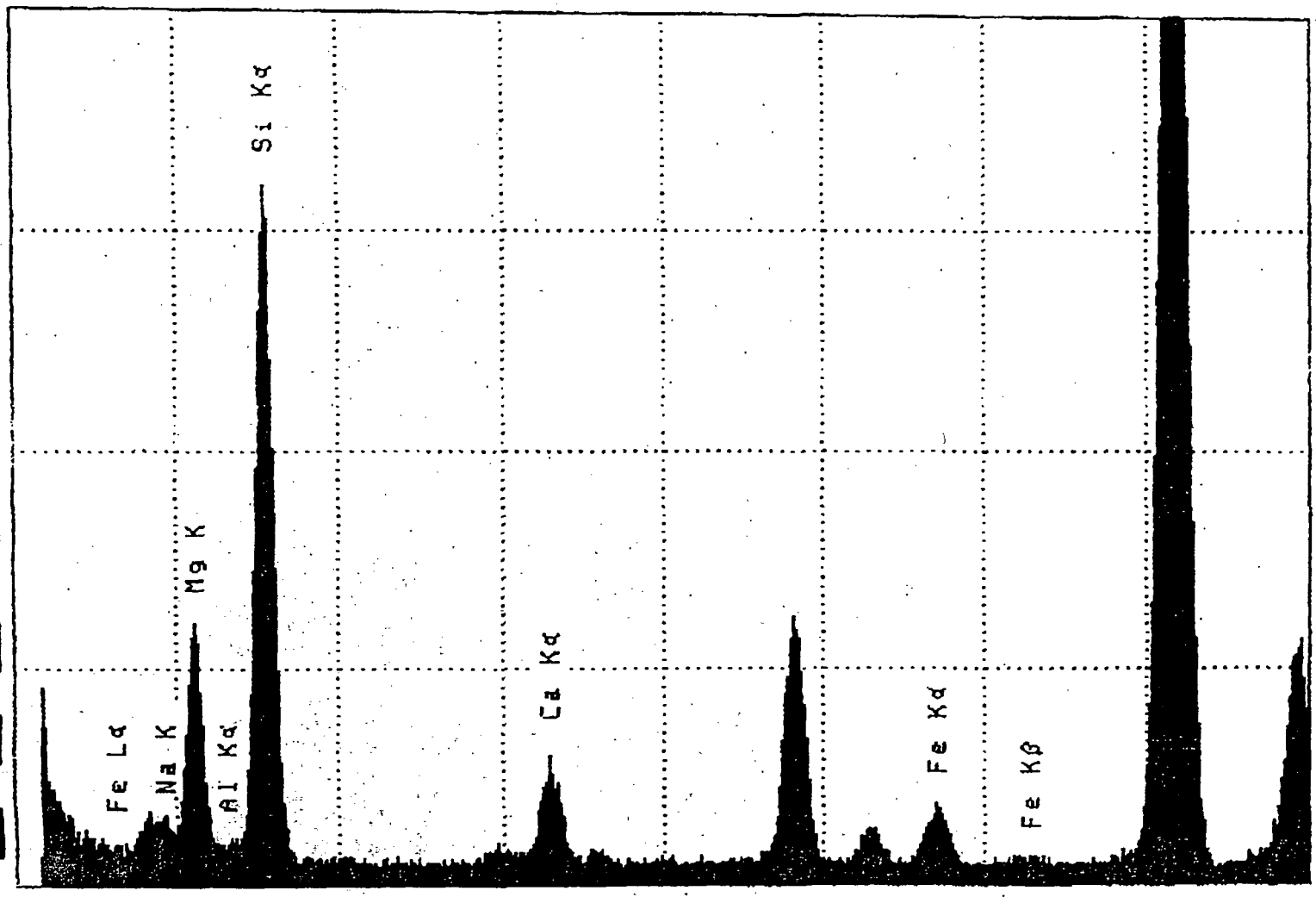
Preset: Off

Real Time: 164.06 Sec. Live Time: 143.05 Sec.

13% Deadtime 1535 Counts/Second

Acquisition date: 04-Jul-:1 Acquisition time: 02:46:22

Cfs 2K



<0.015 keV Cursor = 0 (0.015 keV) = 0 8.991 keV >

E-MAILED 8/13/01 cNW

American Mineralogist, Volume 85, pages 1540–1542, 2000

Amphibole asbestos from Libby, Montana: Aspects of nomenclature

ANN G. WYLIE[1] AND JENNIFER R. VERKOUTEREN[2,*]

[1]Laboratory for Mineral Deposits Research, Department of Geology, University of Maryland, College Park, Maryland, 20742, U.S.A.
[2]Chemical Science and Technology Laboratory, National Institute of Standards and Technology, Gaithersburg, Maryland, 20899, U.S.A.

E-MAILED 8/13/01 LNW

ABSTRACT

Richterite-asbestos and winchite-asbestos are not listed in the federal regulations governing asbestos. However, asbestiform winchite is found in the gangue at the Libby, Montana, vermiculite deposit, where asbestos-related diseases have been reported among the miners and millers. Changing amphibole nomenclature, uncertainties in Fe^{3+}/Fe^{2+}, and natural compositional variability result in samples of the asbestiform amphibole from Libby being variably classified as soda tremolite, richterite, sub-calcic actinolite, and winchite. A classification of winchite-asbestos is assigned for two samples of Libby asbestos analyzed for this report, consistent with the most recent International Mineralogical Association classification system. Although some of the unit-cell parameters and optical properties reported here are distinctive, others are very similar to the tremolite-actinolite series.

INTRODUCTION

The U.S. Occupational Safety and Health Administration (OSHA) and the U.S. Environmental Protection Agency (EPA) have regulated asbestos since the early 1970s (summarized by Vu 1993). The current regulations specify chrysotile and the asbestiform habit of five amphiboles: tremolite, actinolite, anthophyllite, riebeckite (listed as crocidolite) and cummingtonite-grunerite (listed as amosite) (Title 40, Code of Federal Regulations, Part 61 and Part 763; Title 29, Code of Federal Regulations, Part 1910 and Part 1926[1]). These minerals were known at the time the regulations were first written to have been mined commercially as asbestos. Although there have been modifications to the regulations since they were first promulgated, most notably to clarify that cleavage fragments are not asbestos (Federal Register 1992), the minerals that are regulated have not changed. In particular, the sodic-calcic amphiboles winchite and richterite are not regulated.

An asbestiform amphibole occurs as a gangue mineral in the Zonolite® vermiculite ore body in Libby, Montana, which was mined from 1923 to 1990. Estimates of the abundance of the amphibole in the unprocessed ore range from 0 to ≈ 5 wt% (Atkinson et al. 1982). An elevated incidence of mesothelioma, the hallmark of asbestos exposure, has been reported among the miners and millers of Zonolite® in several studies that were summarized by Ross et al. (1993). In late 1999 and early 2000, many deaths alleged to be due to asbestos exposure in Libby were reported in the popular press, stimulating Congressional oversight (106th Congress 2000). Of particular significance for the regulatory community is the identity of the asbestiform amphibole.

The asbestiform amphibole at Libby has been referred to under a variety of names, including tremolite, actinolite, soda tremolite, richterite, and winchite. The current nomenclature used in the popular press and by the residents of Libby is tremolite, or tremolite/actinolite. Deer et al. (1963) give an analysis of an amphibole from Libby (taken from Larson 1942) that they identify as "richterite (soda tremolite)."

In the amphibole classification system of Deer et al. (1963), Miyashiro's (1957) classification of the alkali amphiboles was generally adopted. However, of particular significance to the Libby amphibole, Deer et al. (1963) used the name richterite in place of soda tremolite, dividing tremolite from richterite at $NaCa_{1.5}$, (they considered winchite to be a subset of richterite). The International Mineralogical Association (IMA) classification (Leake 1978) continued the use of richterite in place of soda tremolite and added specific chemical parameters for distinguishing the actinolite series from richterite and for applying the name winchite. The parameters for richterite were $^{B}(Ca + Na) \geq 1.34$ atoms per formula unit (apfu) and $0.67 < {}^{B}Na < 1.34$ apfu (classifying the amphibole as a member of the sodic-calcic group) and $Si > 7.5$ apfu and $^{A}(Na+K) \geq 0.5$ apfu. By the IMA 1978 classification scheme, winchite is also a member of the sodic-calcic group and is distinguished from richterite by $^{A}(Na + K) < 0.5$ apfu. Members of the actinolite series belong to the calcic group and have $^{B}(Ca + Na) \geq 1.34$ apfu and $^{B}Na < 0.67$ apfu. Another relevant evolution in the nomenclature was the division between tremolite and actinolite; according to Deer et al. (1963), tremolite contained between 0 and 20% ferro-actinolite while according to the IMA, tremolite contained no more than 10% ferro-actinolite. The most recent nomenclature changes in Deer et al. (1997) and the revised IMA classification (Leake et al. 1997) changed the positions of the subdivisions to fit a 50% rule. Under these changes, $^{B}(Na +$

[1]Regulations dealing with asbestos can be obtained through the websites maintained by OSHA (www.osha.gov) and the EPA (www.epa.gov).

* E-mail: jennifer.verkouteren@nist.gov

FAX:310-526-0109 Jul 20 '01 13:59 P.01

Ca) ≥ 1.0 apfu is now used to define the calcic and sodic-calcic groups, and the calcic group has $^{B}Na < 0.50$ apfu.

RESULTS

Two samples of asbestiform amphibole from Libby were analyzed following the experimental procedures detailed in Verkouteren and Wylie (2000). Chemical compositions, cell parameters, and optical properties are given in Table 1. One of the samples had been in our collection for several years; the other was obtained recently. Sample 1 is relatively pure, loose fiber and sample 2 was collected from the mine dump and is composed primarily of asbestiform amphibole. In both cases, the fibers are light green and asbestiform. The wt% Fe (analyzed as FeO) was converted to formula proportions of cations assuming first all Fe^{2+} and then all Fe^{3+}. It seems likely that at least some portion of the iron is trivalent, as more than 8.0 apfu Si cannot be accommodated in the tetrahedral sites. Hence, the "true" formulae must lie somewhere between these two extremes.

Because $^{B}(Na + Ca) \geq 1.0$ apfu this amphibole is either a sodic-calcic or a calcic amphibole. If all the iron is Fe^{2+}, then $^{B}Na = 0.63$ or 0.61 apfu, and according to Miyashiro (1957) the amphibole should be called soda tremolite. According to Deer et al. (1963), it would probably be richterite. According to Leake (1978), it would be sub-calcic actinolite, and according to Deer et al. (1997) and Leake et al. (1997), it would be winchite. If all the iron is Fe^{3+}, ^{B}Na increases to 0.75 or 0.67 apfu and according to Leake (1978), Deer et al. (1997) and Leake et al. (1997), it would be winchite. The chemical composition of the Libby amphibole as reported by Larson (1942) corresponds to a current classification of richterite.

Deer et al. (1963) chose $NaCa_{1.5}$ as the dividing line between richterite and tremolite because it was consistent with a "relatively sudden" change in optical properties, specifically a decrease in birefringence, stronger pleochroism, lower indices of refraction, and smaller optic axial angle. The refractive indices given in Table 1 are different for the two samples, consistent with the change in 1 – Mg/(Mg + Fe + Mn). Comparison of the optical properties to those of the actinolite series (Verkouteren and Wylie 2000) indicates that, for both samples, n_α is high and n_γ is low, although not statistically outside the population of actinolite samples. The birefringence given in Table 1 is much lower than any actinolite sample in Verkouteren and Wylie (2000) and is a clear outlier; this is also true for the birefringence of the Libby amphibole given by Larson (1942). No difference exists between the optic axial angle given in Table 1 and the actinolite series; however, the optic axial angle for the Libby amphibole reported by Larson (1942) is distinctly smaller than that of corresponding actinolites.

Comparison of the lattice parameters to those of the actinolite series (Verkouteren and Wylie 2000) indicates that, for both samples, a and c are at or within the 95% prediction limits for actinolite, but b is outside the lower 95% prediction limit by more than 0.025 Å. The values of a are high given a Ca value of 1.3 apfu; these samples would fall into an anomalous region in the actinolite series where a and Ca are positively correlated (Verkouteren and Wylie 2000), and we would predict an a of 9.83 Å or lower. The values of β for the Libby samples are consistent with the actinolite series and the positive correlation of β and Ca. The potassian winchite-asbestos described by Wylie and Huggins (1980) has a larger a dimension, a smaller b dimension, and the same c dimension when compared with the actinolite series. Similarly, the three non-Ti bearing richterites in Oberti et al. (1992) have larger a dimensions, smaller b dimensions, and the same c dimensions when compared to the actinolite series.

TABLE 1. Chemical composition, optical properties, and cell parameters of 2 samples of winchite-asbestos, Libby, Montana. (1σ errors in parentheses)

Oxide	wt%			apfu§, all Fe^{3+}		apfu§, all Fe^{2+}	
	Sample 1*	Sample 2†		Sample 1	Sample 2	Sample 1	Sample 2
SiO_2	56.6(4)	56.1(2)	Si	8.04	8.01	7.92	7.92
TiO_2	n.d.	n.d.	^{IV}Al	–	–	0.08	0.07
Cr_2O_3	n.d.	n.d.	ΣT	8.04	8.01	8.00	8.00
Al_2O_3	0.5(1)	0.4(2)	^{VI}Al	0.09	0.07	0.01	–
FeO	6.0(6)	4.2(4)	Mg	4.28	4.45	4.21	4.41
MnO	0.1(0)	0.3(3)	Fe	0.72	0.50	0.71	0.50
MgO	20.2(5)	21.0(4)	Mn	0.01	0.03	0.01	0.03
CaO	8.3(10)	8.8(2)	ΣC	5.10	5.05	4.94	4.94
Na_2O	3.2(8)	3.4(2)	ex. C	0.10	0.05	–	–
K_2O	0.7(1)	0.8(2)	Ca	1.27	1.34	1.25	1.33
Total	95.6	95.0	^{B}Na	0.63	0.61	0.75	0.67
			ΣB	2.00	2.00	2.00	2.00
			^{A}Na	0.25	0.33	0.12	0.26
			^{A}K	0.13	0.15	0.13	0.15
			ΣA	0.38	0.48	0.25	0.41
		1-Mg/(Mg+Fe+Mn)		0.15	0.11		

Notes: optical properties: Sample 1: $n_\alpha = 1.621(1)$, $n_\beta = 1.631(1)$, $n_\gamma = 1.637(1)$, $c \wedge Z = 15.8(0.5)°$. Sample 2: $n_\alpha = 1.618(1)$, $n_\beta = 1.628(1)$, $n_\gamma = 1.634(1)$, $c \wedge Z = 15.8(0.5)°$ & ‡ = 0.016, $2V_z$‡ = 104.9.
Cell dimensions: Sample 1: $a = 9.855(1)$ Å, $b = 18.032(1)$ Å, $c = 5.288(3)$ Å, $\beta = 104.54(2)°$. Sample 2: $a = 9.861(2)$ Å, $b = 18.003(5)$ Å, $c = 5.276(6)$ Å, $\beta = 104.37(4)°$.
* Average of 6 analyses.
† Average of 3 analyses.
§ Calculated on the basis of 23 O atoms.
‡ Calculated from the measured refractive indices.

E-MAILED 8/13/01 LNW

Discussion

The composition of the Libby asbestiform amphibole as given in Table 1 is consistent with an identification of winchite-asbestos, based on Leake et al. (1997). The samples can be identified as winchites despite the uncertainty in site occupancies resulting from the unknown oxidation state of Fe. The *b* lattice dimension and the birefringence are consistent with what is known about winchite (and richterite) and are distinct from actinolite. Ross et al. (1993) report that both tremolite and richterite asbestos fibers were found in a specimen of Libby vermiculite. Our two samples were collected approximately ten years apart, and probably from different areas in the mine, and both are winchites, although our sample 2 is close to richterite in composition (ΣA = 0.48 to 0.41 apfu). Given the fact that the Libby amphibole reported by Larson (1942) is a richterite, it is possible that the amphibole composition ranges from winchite to richterite, and possibly to actinolite, throughout the vermiculite deposit. Asbestiform winchite and richterite are also known from other localities, where they are similarly associated with the alteration of alkali igneous rocks (Wylie and Huggins 1980; Deer et al. 1997).

It is unfortunate that a regulatory decision could hinge on such details as the amount of ^{B}Na and the choice of classification scheme. While the distinctions among amphiboles are important from a scientific standpoint, they do not add significantly to the regulatory terminology unless they are correlated with risk assessment. There are data that show differences in disease potential among different minerals with similar morphology, such as between talc and tremolite (Guthrie and Mossman 1993), but it is clear that the asbestiform winchite in Libby, Montana poses a health threat (106th Congress 2000). From an analytical standpoint, the identification of the specific asbestiform mineral is necessary for complete characterization of the asbestos component in any sample. The regulatory requirement to identify the mineral can be addressed by providing reference values for known asbestiform amphiboles, which was, in part, the impetus behind the study described in Verkouteren and Wylie (2000) and the current note. It would be reasonable for the regulations to be revised to provide a broader description of asbestiform amphiboles to avoid similar hair-splitting problems in the future.

Acknowledgements

We thank Laura Kuzel and Robert Nolan for providing samples.

References cited

106th Congress (2000) Federal, State, and Local Response to Public Health and Environmental Conditions from Asbestos Contamination in Libby, Montana (Full committee field hearing). Statements From Hearings Held 106th Congress, Second Session, U.S. Senate Committee on Environment and Public Works, February 16, 2000. http://www.senate.gov/~epw/stml_106.htm#02-16-00

Atkinson, G.R., Rose, D., Thomas, K., Jones, D., Chatfield, E., and Going, J. (1982) Collection, analysis and characterization of vermiculite samples for fiber content and asbestos contamination. Midwest Research Institute report for the U. S. Environmental Protection Agency, Project 4901-A32 under EPA Contract 68-01-5915, Washington, D.C.

Deer, W.A., Howie, R.A., and Zussman, J. (1963) Rock-forming minerals, volume 2, Chain silicates, 377 p. Longmans, London.

——— (1997) Rock-forming minerals, volume B, Double chain silicates, 2nd Ed., 764 p. The Geological Society, London.

Federal Register (1992) Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite. FR 57:24310, June 8, 1992.

Guthrie, Jr. G.D. and Mossman, B.T. (1993) Merging the geological and biological sciences: An integrated approach to the study of mineral-induced pulmonary diseases. In Mineralogical Society of America Reviews in Mineralogy, 28, 1–5.

Larson, E.S. (1942) Alkalic rocks of Iron Hill, Gunnison County, Colorado. U.S. Geological Survey, Prof. Paper No. 197A.

Leake, B.E. (1978) Nomenclature of amphiboles. American Mineralogist, 63, 1023–1052.

Leake, B.E., Woolley, A.R., Arps, C.E.S., Birch, W.D., Gilbert, M.C., Grice, J.D., Hawthorne, F.C., Kato, A., Kisch, H.J., Krivovichev, V.G., Linthout, K., Laird, J., Mandarino, J.A., Maresch, W.V., Nickel, E.H., Rock, N.M.S., Schumacher, J.C., Smith, D.C., Stephenson, N.C.N., Ungaretti, L., Whittaker, E.J.W., and Youshi, G. (1997) Nomenclature of amphiboles: Report of the subcommittee on amphiboles of the International Mineralogical Association, Commission on new minerals and mineral names. American Mineralogist, 82, 1019–1037.

Miyashiro, A. (1957) The chemistry, optics and genesis of the alkali-amphiboles. Journal of the Faculty of Science University Tokyo, Section 2, 11, 57–83.

Oberti, R., Ungaretti, L., Cannillo, E. and Hawthorne, F.C. (1992) The behavior of Ti in amphiboles: I. Four- and six-coordinate Ti in richterite. European Journal of Mineralogy, 4, 425–439.

Ross, M., Nolan, R.P., Langer, A.M., and Cooper, W.C. (1993) Health effects of mineral dusts other than asbestos. In Mineralogical Society of America Reviews in Mineralogy, 28, 361–407.

Verkouteren, J.R. and Wylie, A.G. (2000) The tremolite-actinolite-ferro-actinolite series: Systematic relationships among cell parameters, composition, optical properties, and habit, and evidence of discontinuities. American Mineralogist, 85, 1239–1254.

Vu, V.T. (1993) Regulatory approaches to reduce human health risks associated with exposure to mineral fibers. In Mineralogical Society of America Reviews in Mineralogy, 28, 545–554.

Wylie, A.G. and Huggins, C.W. (1980) Characteristics of a potassian winchite-asbestos from the Allamoore Talc District, Texas. Canadian Mineralogist, 18, 101–107.

Manuscript received June 13, 2000
Manuscript accepted June 13, 2000
Paper handled by Robert F. Dymek

E-MAILED 8/13/01 CNW

ASBESTOS TEM LABS Fax:510-528-0109 Jul 20 '01 14:01 P.03

ASBESTOS TEM LABORATORIES, INC.
FACSIMILE TRANSMISSION

Date: 7/20/01 **Total Pages (including Cover Sheet):** 3

Attention: Ms. Veronica Bovee **FAX #:** 406-293-9898

Company: Stimson Lumber Company

CONCERNING ANALYTICAL RESULTS FOR:

Job Name: Stimson Nursery Site

Job #: 01-014

Report #: 96113

8/13/01 LNW

Comments: Polarized Light Microscopy Bulk Sample Analytical Results

Veronica: You can be certain that the mineral reported as tremolite in this report is the same mineral that has caused lung disease in Libby. However, it is ~~technically~~ not currently classified as asbestos by EPA. The mineral is actually richterite. It is very similar to tremolite. If you want to know more about this please call Jeff

1016 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address: Stimson Lumber Company
875 Highway 2 South
Libby, MT 59923

Samples Submitted: 20
Reg. Samples Analyzed: 20
Split Layers Analyzed: 0

Job Site / No. Stimson Nursery Site 01-014

Report No. 96113
Date Submitted: Jul-18-01
Date Reported: Jul-20-01

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM101-014-001. Lab ID # 850-002-001		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	50' From Corner Fence, 1-3" Deep, Soil Sample Soil-Brown
GM101-014-002. Lab ID # 850-002-002		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	100' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-003. Lab ID # 850-002-003		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	150' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-004. Lab ID # 850-002-004	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-005. Lab ID # 850-002-005	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 6" Deep, Soil Soil-Brown
GM101-014-006. Lab ID # 850-002-006		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	250' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-007. Lab ID # 850-002-007		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	300' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-008. Lab ID # 850-002-008	<1%	Tremolite	Fibers: None Detected Matrix: 100-100% Qtz, Mica, Other m.p.	300' From Corner Fence, 5' to North 1-3" Deep, Soil Soil-Brown
GM101-014-009. Lab ID # 850-002-009		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to North 1-3" Deep, Soil Soil-Brown
GM101-014-010. Lab ID # 850-002-010	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 5' to South 1-3" Deep, Soil Soil-Brown

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch

Analyst C. Neil Upchurch

E-MAILED 8/12/01

THE MINERAL RICHTERITE

- **Chemistry:** $Na_2Ca(Mg, Fe)_5 Si_8O_{22}(OH)_2$, **Sodium Calcium Magnesium Iron Silicate Hydroxide.**
- **Class: Silicates**
- **Subclass: Inosilicates**
- **Group: Amphibole**
- **Uses: Only as mineral specimens**
- **Specimens**

Richterite, which is sometimes called *soda tremolite*, is closely related to **tremolite**. It basically is the sodium rich version of tremolite which is calcium rich. Another closely related mineral is **ferrorichterite**, which has replaced richterite's magnesium with iron. Yet another related mineral is **fluororichterite** and it is enriched in fluorine by replacing some or all of the hydroxides in richterite. Fluororichterite is also spelled fluorrichterite.

Richterite, ferrorichterite, fluororichterite and tremolite belong to the **Amphibole Group** of minerals. This is a large group of double chained silicates where chains of silicates are held together by the metal ions sodium, calcium, iron, magnesium, aluminum and sometimes other metals such as manganese, titanium, potassium and lithium. Richterite often contains some manganese, fluorine and potassium and these are sometimes included in its formula or referred to as a variety such as K-richterite or fluor-magnesio richterite. All these similar sounding variety names and related species make for some confusion.

Ricterite is not a common mineral, but is found world wide as a small constituent in unusual rocks. Richterite is found in contact metamorphosed limestones, ultramafic igneous extrusives, metasomatic deposits and alkaline igneous rocks. Its type locality of Langban Mine and Pajsberg, Varmland, Sweden and Kipawa, Quebec, Canada are richterite's only consistent sources of good crystals. When crystals are seen they usually are slender and prismatic with typical amphibole diamond-shaped cross sections. Some richterite has been found in the meteorite debris at Canyon Diablo in **Arizona**.

PHYSICAL CHARACTERISTICS:

- **Color** is brown, reddish brown, yellow and light to dark green.
- **Luster** is vitreous to dull.
- **Transparency:** Crystals are generally translucent, but some specimens are translucent.
- **Crystal System** is Monoclinic; 2/m
- **Crystal Habits** include long prismatic crystals. Crystals can have a diamond-shaped cross-section although rarely symmetrical. Also found granular, massive and occasionally in radial aggregates.
- **Cleavage** is imperfect in two directions at 56 and 124 degrees.

E-MAILED 7/20/01
8/13/01 LMW

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address: Stimson Lumber Company
875 Highway 2 South
Libby, MT 59923

Samples Submitted: 20
Reg. Samples Analyzed: 20
Split Layers Analyzed: 0

Job Site / No. Stimson Nursery Site 01-014

Report No. 96113
Date Submitted: Jul-18-01
Date Reported: Jul-20-01

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM101-014-011. Lab ID # 850-002-011	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to South 1-3" Deep, Soil Soil-Brown
GM101-014-012. Lab ID # 850-002-012	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to West 1-3" Deep, Soil Soil-Brown
GM101-014-013. Lab ID # 850-002-013		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 5' to East 1-3" Deep, Soil Soil-Brown
GM101-014-014. Lab ID # 850-002-014		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to East 1-3" Deep, Soil Soil-Brown
GM101-014-015. Lab ID # 850-002-015		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 50' to North, Soil Soil-Brown
GM101-014-016. Lab ID # 850-002-016		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 90' to North, Soil Soil-Brown
GM101-014-017. Lab ID # 850-002-017		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 120' to North, Soil Soil-Brown
GM101-014-018. Lab ID # 850-002-018		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	270' From Corner Fence, 15' From Little Fence, Soil Soil-Brown
GM101-014-019. Lab ID # 850-002-019		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	180' From Corner Fence, 15' From Little Fence, Soil Soil-Brown
GM101-014-020. Lab ID # 850-002-020		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	150' From Corner Fence, 15' From Little Fence, Soil Soil-Brown

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

E-MAIL 9/3/01

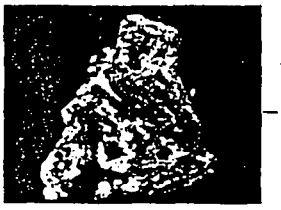
Lab Manager C. Neil Upchurch

Analyst C. Neil Upchurch

- **Fracture** is uneven.
- **Hardness** is 5 - 6.
- **Specific Gravity** is approximately 2.9 - 3.3 (average for translucent minerals).
- **Streak** is brown.
- **Other Characteristics:** pleochroic in translucent specimens. Large crystals have an almost striated or grainy appearance.
- **Associated Minerals** are **quartz**, **feldspars**, **aegirine**, **arfvedsonite**, **diopside**, **pectolite**, **phlogopite**, **chromite**, **Iron-nickel**, **roedderite**, **kosmochlor**, **krinovite**, **tainiolite**, **calcite**, **fluorite**, **svabite**, **sodalite** and **eudialyte**.
- **Notable Occurrences** include the type locality of Langban Mine and Pajsberg, Varmland, Sweden as well as **Mont Saint-Hilaire** and Kipawa, Quebec, Canada; Myanmar; Madagascar and Leucite Hills, Wyoming and in the meteorite at Canyon Diablo, **Arizona**.
- **Best Field Indicators** are crystal habit (especially cross-section), color and cleavage.

Minerals | By Name | By Class | By Groupings | Search | Properties | Silicates
Copyright © 2000 by Amethyst Galleries, Inc.

E-MAILED 8/13/01 LNW



THE MINERAL TREMOLITE

- **Chemistry: $Ca_2Mg_5Si_8O_{22}(OH)_2$, Calcium Magnesium Silicate Hydroxide.**
- **Class: Silicates**
- **Subclass: Inosilicates**
- **Group: Amphibole**
- **Uses: Asbestos and as a mineral specimen.**
- **Specimens**

Tremolite is a relatively common mineral in some metamorphic rocks. It occurs from the conversion of dolomite, silica and water into tremolite, calcite and carbon dioxide by way of the following formula:

$$5CaMg(CO_3)_2 + 8SiO_2 + H_2O \text{ ------> } Ca_2Mg_5Si_8O_{22}(OH)_2 + 3CaCO_3 + 7CO_2$$

It belongs to a series with the minerals actinolite and **ferro-actinolite**. A series occurs when two or more ions can freely substitute between each other. In this case, when iron is predominant the mineral is ferro-actinolite and when magnesium is predominant the mineral is tremolite. Actinolite is the intermediate member and the most common followed by tremolite. Tremolite's formula is often written as the same as actinolite (with iron and magnesium), but specimens of tremolite can be found quite pure (that is, free of iron) and so here the formula reflects the pure end of the series. The entire series can be represented with the actinolite formula: $Ca_2(Mg, Fe)_5Si_8O_{22}(OH)_2$.

Without the iron in the formula tremolite will have the typical creamy white color. With just a small amount of iron tremolite will be green. Increasing iron content will raise the specific gravity, index of refraction and darken the color.

A variety of tremolite is composed of microscopically fibrous crystals called asbestos. Other minerals also form asbestos such as serpentine and the other minerals of the series mentioned above. Serpentine asbestos is more widely used and of a better grade in general. Although asbestos has been shown to cause cancer in humans when inhaled in high enough concentrations, it still has many valuable applications. Asbestos is used for fire retardant materials and brake shoes and pads. Its prior use as insulation has been all but eliminated due to health concerns.

A variety of actinolite, *nephrite*, is one of the two minerals called jade. The other jade mineral is jadeite. Although nephrite is considered to be actinolite, the lighter shades of nephrite probably contain significant amounts of tremolite.

Another variety of tremolite is called *"mountain leather"* or *"mountain cork"* and is an oddity in the mineral world. The tremolite fibers form a felted mass that has all the appearances and feel of a piece of cloth. The mountain leather will even have attached calcite crystals that seem to be knitted in to the fabric. A violet variety of tremolite is called *"hexagonite"* and makes for a nice collection specimen with its attractive color and crystalline habit.

E-MAILED 8/13/01 LNW

Tremolite is an important temperature indicator for petrologists. Because at high temperatures tremolite is unstable and will convert to diopside, $CaMgSi_2O_6$. The presence of only tremolite and no diopside indicates that the rock has not endured terribly high temperatures.

Tremolite can be a fun and very interesting mineral to collect.

PHYSICAL CHARACTERISTICS:

- **Color** is usually white or gray but can be greenish, colorless, yellow and violet.
- **Luster** is vitreous or silky to dull.
- **Transparency:** Specimens are translucent to transparent.
- **Crystal System** is monoclinic; 2/m
- **Crystal Habits** include flattened prismatic and elongated crystals with a dome-like termination that is actually two of the four faces of a prism. Fibrous crystals form radial aggregates, masses and hair like clusters. Also as a felted mass (asbestos and "mountain leather").
- **Cleavage:** is perfect in two directions at close to 60- and 120-degree angles (diamond-shaped).
- **Fracture** is uneven.
- **Hardness** is 5 - 6.
- **Specific Gravity** is approximately 2.9 - 3.1 (very slightly above average for translucent minerals).
- **Streak** is white.
- **Other Characteristics:** Index of refraction is 1.60 - 1.63.
- **Associated Minerals** are calcite, grossular, talc and serpentine.
- **Notable Occurrences** include the area around Wilberforce, Ontario, Canada; De Kalb, St Lawrence Co., New York, California, Arizona and Canaan, Connecticut, USA; Tyrol and Piemonte, Italy; Tremola Valley, Switzerland (hence the name); Tanzania and Finland.
- **Best Field Indicators** are fibrosity (asbestos), color, cleavage, crystal habit and hardness.

Copyright © 1995,1996 by Amethyst Galleries, Inc.

Q-MAILED 7/20/01
6/13/01 - LAW

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 98-231

1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

With Branch Offices Located At:
952 GREG STREET, SPARKS, NV 89431
Ph. (775) 356-9600

E-MAILED
8/13/01 LMW

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

Jul-26-01

Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 98-231
Polarized light microscopy analytical results for 1 bulk sample(s).
Job Site:
Job No.:

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 or 600/M4-82-020 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

E-MAILED
8/13/01 LMW

1409 FIFTH STREET, SUITE C • BERKELEY, CA 94710 • (510) 528-0108 • FAX (510) 528-0109
With Branch Offices Located At: 952 GREG STREET, SPARKS, NV 89431

POLARIZED LIGHT MICROSCOPY
ANALYTICAL REPORT

EPA Method 600/R-93/116 or 600/M4-82-020

Contact: Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Indicated: 1
Reg. Samples Analyzed: 1
Split Layers Analyzed: 0

Job Site / No.

Report No. 28145
Date Submitted: Jul-25-01
Date Reported: Jul-26-01

SAMPLE ID	ASBESTOS % TYPE	OTHER DATA 1) Non-Asbestos Fibers 2) Matrix Materials 3) Date/Time Collected 4) Date Analyzed	DESCRIPTION FIELD / LAB
1. Lab ID # 98-231-001	None Detected	1) 45-60% Winchite,Arfvedsonite 2) 40-55% Mica, Other m.p. 3) 4) Jul-26-01	White. Fiberous Raw Ore Soil/Rock-Off-White
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	E-MAILED 8/13/01 CNW

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager _____ Analyst _____

ASBESTOS TEM LABORATORIES, INC. 1409 FIFTH STREET, BERKELEY, CA 94710 (510) 528-0108
With Branch Offices Located At: 952 GREG STREET, SPARKS, NV 89431

ASBESTOS TEM LABORATORIES, INC.

EPA Quantitative Bulk Test Method
Transmission Electron Microscopy
Analytical Report

Laboratory Report # 27986

1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 CNW

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

Jul/27/2001

Veronica Bovee

Veronica Bovee
P.O. Box 439
Libby, MT 59923

RE: LABORATORY REPORT #27986
Transmission electron microscopy analytical results for 1 bulk material sample(s).
Job Site:
Job No.:

Please find below the results for the TEM analysis of one or more bulk material samples. The analytical procedures were performed according to the EPA Test Method For the Determination of Asbestos in Bulk Building Materials - TEM method modified for quantitative bulk sample analysis. Prior to analysis, each sample was logged-in and all pertinent data was recorded. Each sample was checked for damage and disruption of any chain-of-custody seals. A unique laboratory number was assigned to each sample. A hard copy Log-In sheet was generated. This, and all other relevant paper work was kept with the sample throughout the analytical procedures to assure proper analysis.

Sample preparation began with the homogenization of a representative portion of the submitted bulk material. A subsample was separated, weighed, placed into a ceramic crucible and ashed in a muffle furnace at 480 Deg. C for at least 4 hours. The ashed samples were treated with dilute HCl if suspected to contain carbonate or sulfate minerals, suspended in distilled water, and ultrasonicated to disperse any fibrous matter. A known volume of the liquid suspension was filtered onto a 0.1 micron pore size Millipore mixed cellulose ester filter. The filter was then dried in HEPA filtered, Class 100 air on a clean bench. The filter was placed onto a glass microscope slide, sectioned, and collapsed in acetone. The collapsed filter was plasma-etched to remove 10% of the filter surface and then carbon coated. The carbon coated filter was sectioned and the sections placed onto 200-mesh copper TEM sample grids in dimethyl sulfoxide and acetone wick washers. After sufficient time to dissolve the filter material, the TEM sample grids were removed from the baths and placed into labeled sample containers.

TEM analysis was performed on a Philips EM-300 transmission electron microscope operating at 100kV. The sample was placed into the microscope where it was first scanned at low magnification to confirm that the distribution of material was reasonably homogeneous. High magnification analysis (18,000X) was performed using a two tier approach: 1) A relatively large area of several TEM grid openings for asbestos fiber bundles, and 2) a relatively small area of a number of fields of view for individual asbestos fibers (fibrous particles exhibiting an aspect ratio greater than or equal to 3 to 1, and a length greater than or equal to .5 um). Detected asbestiform structures were subjected to detailed morphological and/or selected area diffraction analysis. If necessary, energy dispersive X-ray analysis was also performed. The length and width of each asbestos fiber was measured. From this data, a total volume and mass of asbestos observed in the scanned area is calculated, and extrapolated to a total weight percent asbestos for each sample.

Sincerely Yours,

Laboratory Manager

E-MAILED
8/13/01

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

1409 FIFTH STREET, SUITE C • BERKELEY, CA 94710 • (510) 528-0108 • FAX (510) 528-0109

TRANSMISSION ELECTRON MICROSCOPY ANALYTICAL REPORT

Contact:	Veronica Bovee	REPORT NO.	27986
Address:	Veronica Bovee P.O. Box 439 Libby, MT 59923	Date:	Jul-20-01
		Date Received:	Jul-16-01
Job Site / No.		Total Samples Analyzed:	1

Client Sample # GM01-013-03.

Laboratory Sample # 98-212-001

SAMPLE DESCRIPTION

Roadway; south of building - East of Creek. Soil Sample.

SAMPLE PREPARATION PARAMETERS

Weight of Material Suspended (mg): 35.6

Volume of Suspension Water (ml): 500

Volume of Suspension Filtered (ml): 0.5

Filter Type & Pore Size MCE 0.1um

Effective Filter Area (sq.mm) 201

ASBESTOS DETECTED IN SCAN AREA

CHRYSOTILE		AMPHIBOLE	
FIBERS	BUNDLES	FIBERS	BUNDLES
ND	ND	ND	ND

CALCULATED ASBESTOS CONCENTRATION (WEIGHT %)

CHRYSOTILE	AMPHIBOLE	TOTAL
ND	ND	ND

COMMENTS

NOTE: Approximately 50% of sample contained a highly fibrous asbestiform mineral called winchite/richterite that is not regulated by EPA. Over 100 fibers were observed and over 10 EDX spectra taken.

Filter Loading: Moderate

SAED Photo ID Nos. None Taken

TEM / ANALYTICAL PARAMETERS

Scanned For Bundles 8 Area (sq.mm) 0.0096 Bundle Scan Area (sq.mm) 0.0768

Scanned For Fibers 8 Area (sq.mm) 0.0096 Fiber Scan Area (sq.mm) 0.0768

Magnification: 18,000X

NOTATION KEY

Chrys. - Chrysotile Asbestos
Amph. - Amphibole Asbestos
ND - None Detected
Non-Asb. - Non-Asbestos

1 um = 1 micron = 0.001 mm
1 mm = 1 millimeter
1 sq.mm = 1 square millimeter
1 cc = 1 cubic centimeter

Analyst Signature

Lab Manager Signature

ASBESTOS TEM LABORATORIES, INC. 1409 FIFTH STREET, BERKELEY, CA 94710 (510) 528-0108

E-MAILED 8/13/01 LAW

HNU X-RAY System 5000
Spectrum Plotting Program
Printplot V3.000

Sample ID: 98-212-1 (Winchite)

Energy Range: 0 - 10 keV 10 eV/ch

Preset: Off

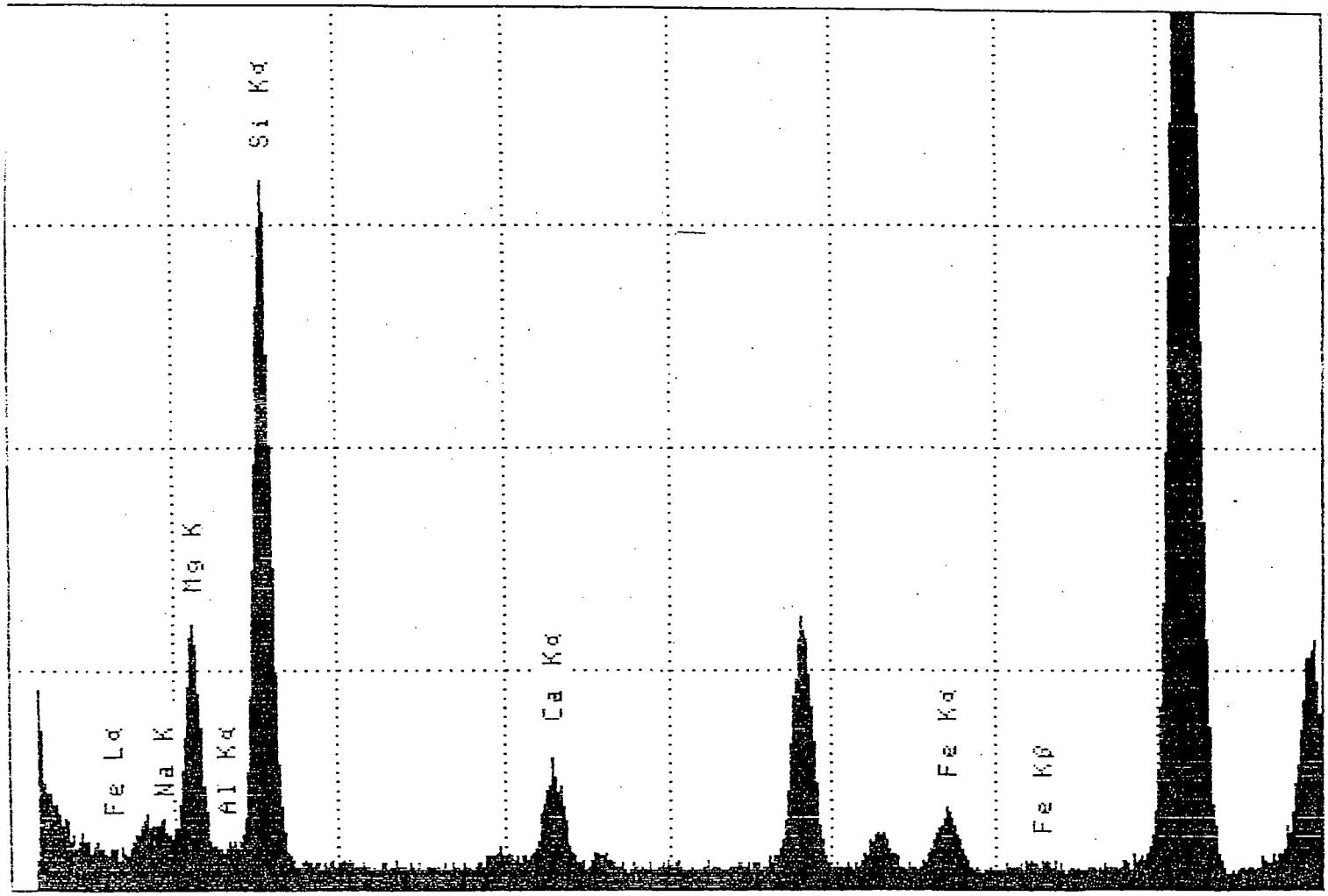
Real Time: 164.06 Sec. Live Time: 143.05 Sec.

13% Deadtime 1535 Counts/Second

Acquisition date: 04-Jul-:1 Acquisition time: 02:46:22

Cfs 2K

EMAILED 8/13/04 LNW



<0.015 keV Cursor = 0 (0.015 keV) = 0 8.991 keV >

HNU X-RAY System 5000
Spectrum Plotting Program
Printplot V3.000

Sample ID: Actinolite From L.A. #2 (Actinolite Standard)

Energy Range: 0 -10 kev 10ev/ch

Preset: Off

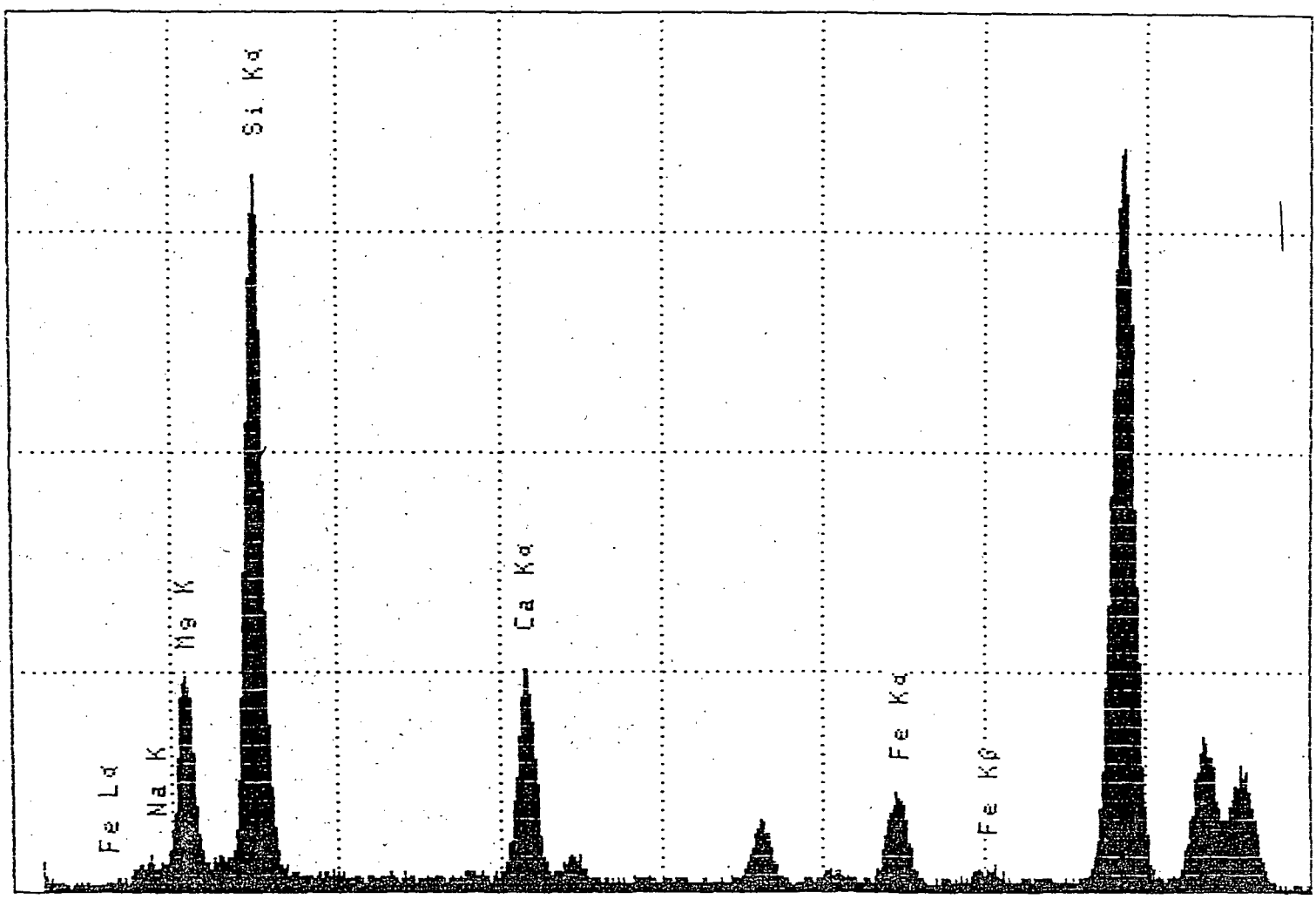
Real Time: 256.66 Sec. Live Time: 243.24 Sec.

5% Deadtime 640 Counts/Second

Acquisition date: 02-Oct-92 Acquisition time: 10:35:06

E-MAILED 8/13/01 CNW

Cfs 2K



<0.000 keV Cursor = 0 (0.000 keV) = 0 9.398 keV >

Actinolite Si/Ca=4 Fe/Mn=0.18

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 850-002

1016 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:
1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 LNW

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

July 25, 2001

Ms. Veronica Bovee
Stimson Lumber Company
875 Highway 2 South
Libby, MT 59923

RE: LABORATORY JOB # 850-002
Polarized light microscopy analytical results for 20 bulk sample(s).
Job Site: Old Champion Nursery Site
Job No.: 01-014

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

1016 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C. BERKELEY, CA 94710 (510) 528-0108

8/13/01

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address: Stimson Lumber Company
875 Highway 2 South
Libby, MT 59923

Samples Submitted: 20
Reg. Samples Analyzed: 20
Split Layers Analyzed: 0

Job Site / No. Old Champion Nursery Site 01-014

Report No. 96113
Date Submitted: Jul-18-01
Date Reported: Jul-20-01

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM101-014-001. Lab ID # 850-002-001		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	50' From Corner Fence, 1-3" Deep, Soil Sample Soil-Brown
GM101-014-002. Lab ID # 850-002-002		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	100' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-003. Lab ID # 850-002-003		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	150' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-004. Lab ID # 850-002-004	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-005. Lab ID # 850-002-005	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 6" Deep, Soil Soil-Brown
GM101-014-006. Lab ID # 850-002-006		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	250' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-007. Lab ID # 850-002-007		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	300' From Corner Fence, 1-3" Deep, Soil Soil-Brown
GM101-014-008. Lab ID # 850-002-008	<1%	Tremolite	Fibers: None Detected Matrix: 100-100% Qtz, Mica, Other m.p.	300' From Corner Fence, 5' to North 1-3" Deep, Soil Soil-Brown
GM101-014-009. Lab ID # 850-002-009		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to North 1-3" Deep, Soil Soil-Brown
GM101-014-010. Lab ID # 850-002-010	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 5' to South 1-3" Deep, Soil Soil-Brown

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC. 1016 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

EMAILED 9/13/01

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address: Stimson Lumber Company
875 Highway 2 South
Libby, MT 59923

Samples Submitted: 20
Reg. Samples Analyzed: 20
Split Layers Analyzed: 0

Job Site / No. Old Champion Nursery Site 01-014

Report No. 96113
Date Submitted: Jul-18-01
Date Reported: Jul-20-01

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM101-014-011. Lab ID # 850-002-011	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to South 1-3" Deep, Soil Soil-Brown
GM101-014-012. Lab ID # 850-002-012	1-5%	Tremolite	Fibers: None Detected Matrix: 95-99% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to West 1-3" Deep, Soil Soil-Brown
GM101-014-013. Lab ID # 850-002-013		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 5' to East 1-3" Deep, Soil Soil-Brown
GM101-014-014. Lab ID # 850-002-014		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	200' From Corner Fence, 10' to East 1-3" Deep, Soil Soil-Brown
GM101-014-015. Lab ID # 850-002-015		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 50' to North, Soil Soil-Brown
GM101-014-016. Lab ID # 850-002-016		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 90' to North, Soil Soil-Brown
GM101-014-017. Lab ID # 850-002-017		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	230' From Corner Fence, 120' to North, Soil Soil-Brown
GM101-014-018. Lab ID # 850-002-018		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	270' From Corner Fence, 15' From Little Fence, Soil Soil-Brown
GM101-014-019. Lab ID # 850-002-019		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	180' From Corner Fence, 15' From Little Fence, Soil Soil-Brown
GM101-014-020. Lab ID # 850-002-020		None Detected	Fibers: None Detected Matrix: 99-100% Qtz, Mica, Other m.p.	150' From Corner Fence, 15' From Little Fence, Soil Soil-Brown

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC. 1016 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

E-MAIL 8/13/01

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 850-001

1016 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:

1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 CNN

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

July 25, 2001

Ms. Veronica Bovee
Stimson Lumber Company
875 Highway 2 South
Libby, MT 59923

RE: LABORATORY JOB # 850-001
Polarized light microscopy analytical results for 2 bulk sample(s).
Job Site: Old Champion Log Yard & Nursery
Job No.: 01-013

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

MAILED 8/13/01 CNW

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

1016 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C. BERKELEY, CA 94710 (510) 528-0108

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address: Stimson Lumber Company
875 Highway 2 South
Libby, MT 59923

Samples Submitted: 2
Reg. Samples Analyzed: 2
Split Layers Analyzed: 0

Job Site / No. Old Champion Log Yard & Nursery 01-013

Report No. 96085
Date Submitted: Jul-13-01
Date Reported: Jul-18-01

SAMPLE ID	ASBESTOS % TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM01-013-01. Lab ID # 850-001-001	None Detected	Fibers: 50-60% Cellulose Matrix: 40-50% Tar, Bndr, Other m.p.	2 Story White Bldg, Tar Paper Black Tar Felt-Black
GM01-013-02. Lab ID # 850-001-002	None Detected	Fibers: 30-40% Cellulose Matrix: 60-70% Tar, Other m.p.	2 Story White Bldg, Barrier Paper Brown & Black Moist Barrier Paper-Brown & Black
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	MAILED 8/13/01 LNW

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC. 1016 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

MCS Environmental, Inc.
10005 E. Montgomery Avenue, Suite 1
Spokane, WA 99206
(509) 924-9236 • Fax (509) 924-2287
www.mcs-environmental.com

13 June 2001

Ms. Veronica Bovee, HR and Safety Coordinator
STIMSON LUMBER COMPANY
875 US Highway 2, South
Libby, Montana 59923

RE COLLECTION AND ANALYSIS OF TRANSMISSION ELECTRON MICROSCOPY SAMPLES, FOR THE IDENTIFICATION OF ASBESTOS-CONTAINING FIBERS AND PARTICLES

Dear Ms. Bovee:

MCS is please to submit the attached report detailing the collection and analysis of ambient airborne asbestos samples.

The sampling performed by MCS Environmental confirms and supports previous sampling data that Stimson Lumber Company employees do not appear to have an occupational exposure to ambient airborne asbestos fibers or particles. Laboratory analysis of personal and area samples did not detect any asbestos structures or fibers within the areas sampled.

Please feel free to contact me at 509-924-9236 at your convenience to discuss the sampling conducted on 11 May 2001.

Sincerely,

Richard A. Johnson, CIH
MCS Environmental

SUMMARY REPORT OF AMBIENT AIR ASBESTOS SAMPLING FOR SELECTED STRUCTURES AND PERSONAL EMPLOYEE EXPOSURE STIMSON LUMBER COMPANY

Prepared for

Ms. Veronica Bovee
HR and Safety Coordinator
STIMSON LUMBER COMPANY
875 US Highway 2, South
Libby, Montana 59923

Prepared by

Richard A. Johnson, CIH
Certificate Number 5956, Expiration 31 December 2005

MCS Environmental, Inc.
9922 E. Montgomery Ave, Suite 1
Spokane, Washington 99206

Project Number SIH-01-112

13 June 2001

MCS Environmental, Inc.
Environmental Logic

At the request of Stimson Lumber, Mr. Richard A. Johnson, CIH, with MCS Environmental performed industrial hygiene sampling to determine the potential residual asbestos exposure of Stimson Lumber Company employees. Portions of the Stimson Lumber Company facilities are located on land formerly used in the production of ore into vermiculite insulation.

Additionally, vermiculite insulation was installed in structures currently used Stimson Lumber Company employees.

EXISTING CONDITIONS

The general Maintenance Building is currently insulated with vermiculite insulation. This structure is equipped with a large gantry crane that traverses the length of the building. Movement of this crane causes vibration within the structure and the release of small amounts of vermiculite insulation from around seams and joints of the clapboard walls, Employees routinely inspect and seal leaking seams and joints with an expanding spray foam caulking compound.

The unpaved parking area used by Stimson Lumber Employees was once used as an aboveground storage area for uncontainerized vermiculite insulation. Vermiculite insulation was piled on the native surface and the soil surface may have been contaminated with a trace amount of asbestos mineral fibers.

The former lunch/break area of the finger-joint facility has been abated. PCM clearance samples collected after the completion of the abatement indicated the area was safe for human occupancy. However, it appears that trace amounts of vermiculite insulation have been released from seams and joints in the clapboard siding as the building has expanded and contacted. Therefore, the cleanliness of the area is considered to be questionable at this time. Currently the area is used as equipment storage

SAMPLE COLLECTION

Stimson Lumber is concerned with employee health and safety. Therefore, they have completed additional air monitoring within the areas of concern. Samples were collected by Mr. Richard A. Johnson, CIH on 11 May 2001. The following sampling equipment was used during the collection of the samples:

- GAST Model 1502 High Volume Sample Pumps
- Air-One Personal Sampling Pumps
- Dwyer Visi-Float Rotameter Model 55-194588-00, Serial Number J-Tech-LV-1 Calibration Date 15 March 2001 Expiration Date 14 September 2001
- Dwyer Visi-Float Rotameter Model 55-194587-00, Serial Number J-Tech-HV-1 Calibration Date 15 March 2001 Expiration Date 14 September 2001
- Environmental Express 25 mm 0.45 um MCE Sampling Cassettes, Lot Number 01800 Production Code 0218

Proper chain of custody procedures was used to transmit the samples to EMSL Laboratories, in Westmont NJ for fiber analysis using the AHERA Transmission Electron Microscopy (TEM) cal protocol.

A summary of the TEM analysis is located in Table 1.

TABLE 1 SUMMARY OF ANALYTICAL RESULTS

SAMPLE NUMBER	DESCRIPTION	ANALYTICAL RESULTS (s/cc of air)	REMARKS
SIH-01-122-1	Forest Black, Personal Sample General Maintenance Mechanic	Less than 0.0044 s/cc Due to low sample volume additional TEM Grids Analyzed	Assumed to be typical of all General Maintenance Mechanic's (Normal Work Shift 8-hr/day)
SIH-01-122-2	Ivan Troyer, Personal Sample Head end of the veneer dryer	Less than 0.0047 s/cc Due to low sample volume additional TEM Grids Analyzed	Assumed to be typical of all head end personnel (Normal Work Shift 10-hr/day)
SIH-01-122-3	Eric Dodge, Personal Sample Tail End of the veneer dryer	Less than 0.0049 s/cc Due to low sample volume additional TEM Grids Analyzed	Assumed to be typical of all tail end personnel (Normal Work Shift 10-hr/day)
SIH-01-122-4	Area sample approximately Ten (10) feet from the interior wall near the center of the maintenance line (High Volume Pump)	Less than 0.0045 s/cc	Mechanic's traversed the Gantry Crane from end to end to simulate maximum vibration conditions
SIH-01-122-5	Area Sample in the former Finger Joint Lunch Room (High Volume Pump) Near North Door	Less than 0.0048 s/cc	Sample collected under aggressive condition created with 1 hp blower unit
SIH-01-122-6	Area Sample in the former Finger Joint Lunch Room (High Volume Pump) Near South Door	Less than 0.0048 s/cc	Sample collected under aggressive condition created with 1 hp blower unit
SIH-01-122-7	Ambient Air Sample North Side of the access to the parking lot	Less than 0.0044 s/cc Due to Low sample volume additional TEM Grids Analyzed	Collected under outdoor conditions.
SIH-01-122-8	Ambient Air Sample South Side of the access to the parking lot	Less than 0.0044 s/cc Due to Low sample volume additional TEM Grids Analyzed	Collected under outdoor conditions.

Certificates of Analysis are located in Appendix A

DISCUSSION OF RESULTS

TEM analysis of the sample filters collected on May 11, 2001 did not identify the presence of any asbestos containing minerals. Therefore, the sample results have been reported as less than a given value.

This sampling confirms the results obtained in previous samples and supports the claim that Stimson Lumber Company employees do not appear to be occupationally exposed to asbestos fibers by activities involved in daily operations

Sincerely,

MCS Environmental, Inc.

Richard A. Johnson, CIH
Industrial Hygienist

THE AMERICAN BOARD OF INDUSTRIAL HYGIENE
INCORPORATED
CERT. NO. 5956 CP
EXPIRES 12-31-2005
PENNSYLVANIA • 1960
RICHARD A. JOHNSON, C.I.H.

EMSL Analytical, Inc.
107 Haddon Ave., Westmont, NJ 08108
Phone: (888) 858-4800 Fax: (856) 858-4960 Email: sslegel@EMSL.com

Attn: Rick
MCS Environmental
10905 E. Montgomery Ave.
Suite 1
Spokane, WA 98206
Fax: (509) 924-2287 Phone: 509-936-0700
Project:

Customer ID: MCS50A
Customer PO: SIH-01-112
Received: 05/15/01 10:45 AM

EMSL Order: 040107174
EMSL Project ID:
Analysis Date: 5/18/2001

Asbestos Fiber Analysis by Transmission Electron Microscopy (TEM) Performed by EPA 40 CFR Part 763 Final Rule (AHERA)

Sample	Volume	Area Analyzed	Non Asb	Asbestos Type(s)	# Structure 0.5μ - 5	# Structure 5μ	Analytical Sensitivity (S/cc)	Asbestos Concentration (S/mm²)	Asbestos Concentration (S/cc)	Notes
SIH-01-112-1 040107174-0001	845.00	0.1032	0	None Detected			0.0044	<9.69	<0.0044	Volume is below recommended limit for method.
SIH-01-112-2 040107174-0002	539.90	0.1290	0	None Detected			0.0047	<7.76	<0.0047	Volume is below recommended limit for method.
SIH-01-112-3 040107174-0003	1009.80	0.0774	0	None Detected			0.0049	<12.92	<0.0049	Volume is below recommended limit for method.
SIH-01-112-4 040107174-0004	1327.30	0.0645	0	None Detected			0.0045	<15.50	<0.0045	
SIH-01-112-5 040107174-0005	1255.70	0.0645	0	None Detected			0.0048	<15.50	<0.0048	
SIH-01-112-6 040107174-0006	1247.00	0.0645	0	None Detected			0.0048	<15.50	<0.0048	
SIH-01-112-7 040107174-0007	1138.40	0.0774	0	None Detected			0.0044	<12.92	<0.0044	Volume is below recommended limit for method.
SIH-01-112-8 040107174-0008	1109.20	0.0774	0	None Detected			0.0046	<12.92	<0.0046	Volume is below recommended limit for method.

Scott Combs
Analyst

Stephen Siegel, CIH
or other approved signatory

Disclaimer: The laboratory is not responsible for data reported in structures/cc, which is dependent on volume collected by non-laboratory personnel. This lab is only responsible for data reported in structures/mm². This report may not be reproduced, except in full, without written approval by EMSL. This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. Government. This report relates only to the samples reported above. Quality control data (including 95% confidence limits and laboratory and analyst accuracy and precision) is available upon request.
Accredited for NVLAP PLM/TEM #101048-0, NY State ELAP #10872

TEMAHERA-1

EMSL ANALYTICAL CHAIN OF CUSTODY ASBESTOS

SAMPLE NUMBER	LOCATION	VOLUME (If Applicable)
SIH-01-112-1	PERSONAL SAMPLE FOREST BLACK GENERAL MAINTENANCE	895.0 LITERS
-2	PERSONAL SAMPLE IVAN TROYER PLYWOOD PLANT HEAD END DRYER	659.9 LITERS
-3	PERSONAL SAMPLE ERIC DODGE PLYWOOD PLANT TAIL END OF DRYER	1009.8 LITERS
-4	AREA GENERAL MAINTENANCE	1327.3 LITERS
-5	OLD LUNCH ROOM FINGER JOINTER BLDG (NORTH END)	1255.7 LITERS
-6	OLD LUNCH ROOM FINGER JOINTER BLDG (SOUTH END)	1247.0 LITERS
-7	NORTH PARKING LOT POPPING PLANT	1,138.4 LITERS
-8	SOUTH END PARKING LOT POPPING PLANT	1109.2 LITERS
-9	BOX BLANK	BOX BLANK
-10	FIELD BLANK	30 SEC.
-11	BULK VERMICULITE SAMPLE	BULK -

01 MAY 15 AM 10:45

EMSL Analytical, Inc.
107 Haddon Ave., Westmont, NJ 08108

EMSL

Order ID: 040111044

Attn:	Ron Johnson MCS Environmental 10905 E. Montgomery Ave., Suite 1 Spokane, WA 99206	Customer ID: Customer PO: Received:	MCS50A SIH-01-112 7/9/01 9:47 AM
Fax: Project:	509-924-2287	EMSL Order: EMSL Project ID: Date Analyzed:	040111044 7/11/01

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Analytical Electron Microscopy

Client Sample ID	EMSL Sample ID	Asbestos Weight %	Asbestos Type(s)
1A	040111044-0001	BQL*	ND**
2B	040111044-0002	BQL	ND

Key
*BQL = Below Quantitation Limit (0.1 weight%)
**ND = None Detected

RECEIVED
JUL 11 2001
By

Stephen Siegel, CIH
Analyst

Stephen Siegel, CIH- Lab Manager
Or other approved signatory

EMSL Analytical, Inc.
107 Haddon Avenue
Westmont, NJ. 08108
(856) 858-4800

05/30/01

Attention: *Richard Johnson*
MCS Environmental
10905 E. Montgomery Avenue
Suite I
Spokane, WA. 99206

Project: SIH-01-112
Ref. Number: 040107196

Asbestos Analysis Performed by The Standard Addition Method Draft Method 1997

Sample ID	Identification	Asbestos Content By PLM	Asbestos Content By TEM
SIH-01-112-11	Bulk Vermiculite Sample	None Detected [1]	Not Analyzed

1) Trace amounts of asbestos (approximately <0.1%) may be obscured by this method.

John Newton
Analyst

30 May, 01
Date of Analysis

Disclaimer: This report may not be reproduced in part without written approval from EMSL Analytical, Inc
TNTQ = Too Numerous To Quantify ND = None Detected

STIMSON LUMBER CO.
LIBBY, MT

To: All Stimson Employees **Date:** Tuesday, July 17, 2001

From: Veronica Bovee

RE: Asbestos Samples

Listed below are the air sample results that were taken on May 11, 2001.

Proper chain of custody procedures was used to transmit the samples to EMSL Laboratories, in Westmont NJ for fiber analysis using the AHERA Transmission Electron Microscopy (TEM) cal protocol.

A summary of the TEM analysis is located in Table 1.

TABLE 1 SUMMARY OF ANALYTICAL RESULTS

SAMPLE NUMBER	DESCRIPTION	ANALYTICAL RESULTS (s/cc of air)	REMARKS
SIH-01-122-1	Forest Black, Personal Sample General Maintenance Mechanic	Less than 0.0044 s/cc Due to low sample volume additional TEM Grids Analyzed	Assumed to be typical of all General Maintenance Mechanic's (Normal Work Shift 8-hr/day)
SIH-01-122-2	Ivan Troyer, Personal Sample Head end of the veneer dryer	Less than 0.0047 s/cc Due to low sample volume additional TEM Grids Analyzed	Assumed to be typical of all head end personnel (Normal Work Shift 10-hr/day)
SIH-01-122-3	Eric Dodge, Personal Sample Tail End of the veneer dryer	Less than 0.0049 s/cc Due to low sample volume additional TEM Grids Analyzed	Assumed to be typical of all tail end personnel (Normal Work Shift 10-hr/day)
SIH-01-122-4	Area sample approximately Ten (10) feet from the interior wall near the center of the maintenance line (High Volume Pump)	Less than 0.0045 s/cc	Mechanic's traversed the Gantry Crane from end to end to simulate maximum vibration conditions
SIH-01-122-5	Area Sample in the former Finger Joint Lunch Room (High Volume Pump) Near North Door	Less than 0.0048 s/cc	Sample collected under aggressive condition created with 1 hp blower unit
SIH-01-122-6	Area Sample in the former Finger Joint Lunch Room (High Volume Pump) Near South Door	Less than 0.0048 s/cc	Sample collected under aggressive condition created with 1 hp blower unit
SIH-01-122-7	Ambient Air Sample North Side of the access to the parking lot	Less than 0.0044 s/cc Due to Low sample volume additional TEM Grids Analyzed	Collected under outdoor conditions.
SIH-01-122-8	Ambient Air Sample South Side of the access to the parking lot	Less than 0.0044 s/cc Due to Low sample volume additional TEM Grids Analyzed	Collected under outdoor conditions.

Comments: _____

Signature: _____

MAILED 8/13/01 LNN

Mountain Laboratories

Division of MCS Environmental, Inc.

10905 E. Montgomery Avenue, Suite 1
Spokane, Washington 99206
(509) 924-9236 • Fax (509) 924-2287

2104 S. Reserve Street • Missoula, Montana 59801
1-800-735-7095 • (406) 728-7755
Fax (406) 728-7367

NVLAP

July 12, 1999

Stimson Lumber Co.
Veronica Bovee
875 Highway 2 South
Libby, MT 59923

Project: Big Dryer
GM99002

Dear Ms. Bovee,

The enclosed report details the results of the analysis for the bulk samples submitted to Mountain Laboratories on July 12, 1999. Mountain Laboratory participates in a National Voluntary Laboratory Accreditation Program (NVLAP) for Bulk Asbestos Analysis, governed by the National Institute for Standards and Technology (NIST)-NVLAP I.D. #101890-0. Sample results must not be used by the client to claim endorsement by NVLAP nor any agency of the United States government. Sample analysis was performed to determine asbestos type and content using Polarized Light Microscopy, supplemented by Dispersion Staining (PLM/DS) in accordance with the following methodologies:

USEPA Test Methods EPA/600/R-93/116, "Method for the Determination of Asbestos in Bulk Building Materials"

ASTM draft "Standard Method for Asbestos Containing Materials by Polarized Light Microscopy" (Committee D22.05, January 14, 1988)

This report includes a summary of the analytical results, chain of custody and copies of the analysis report forms used by our analysts. Analytical results are only reflective of the samples which were tested and presented in this report. Mountain Laboratories, Division of MCS Environmental limits warranty to proper analysis methods and takes no responsibility for sample procurement.

It has been our pleasure providing you with these analytical services. If you have any questions regarding this report, please do not hesitate to call us at (509) 924-9236.

Sincerely,

Karen L. Drader
Laboratory Manager
Mountain Laboratories
MCS Environmental

Enclosures:
51983878

E-MAILED
8/13/01 CNK

BULK SAMPLE ANALYSIS FOR ASBESTOS

Stimson Lumber Co.
Veronica Bovee
875 Highway 2 South
Libby, MT 59923

Project: Big Dryer

Method: PLM With Dispersion Staining

Laboratory No.	B99-3878		
Sample ID No.	GM99002 ~~[illegible]~~		
Sample Information	Insulation Gasket		
Sample Treatment	Teased		
Homogeneous	No		
Layers	Woven		
Fibrous	Yes		
Sample Color	Tan		
Asbestos Present	No		
Asbestos Type and Percentage 1. Chrysotile 2. Amosite 3. Crocidolite 4. Other	N.D.		
Total % Asbestos	None		
Other fibrous material in sample	Synthetic 100%		
Non-Fibrous Materials			

Date analyzed: July 12, 1999

Analyzed By: Karen L. Drader

Mountain Laboratories, Division of MCS Environmental warranty to proper analysis methods only and takes no responsibility for sample procurement. Mountain Laboratories, Division of MCS Environmental, 10905 E. Montgomery, Suite #2, Spokane Washington 99206 (509) 924-9236 - Fax (509) 924-2287. PLM has been known to miss asbestos in a small percentage of samples. Thus negative or <1% PLM results should be tested with either SEM or TEM. Client is responsible for sample separation. This report may only be reproduced in full with written approval by Mountain Laboratories.

MAILED 8/13/01 LNW

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Submitted: 3
Reg. Samples Analyzed: 3
Split Layers Analyzed: 0

Job Site / No. Stimson Lumber 01-011

Report No. 95949
Date Submitted: Jun-26-01
Date Reported: Jun-28-01

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM01-011-01. Lab ID # 949-030-001	30-40% 5-10%	Amosite Chrysotile	Fibers: None Detected Matrix: 50-65% Calc, Other m.p.	FJ South Wall, Insulation Piping / Insulation-White
GM01-011-02. Lab ID # 949-030-002		None Detected	Fibers: 20-40% Cellulose,Fiberglass Matrix: 60-80% Calc, Other m.p.	Plywood - ESP Pipe Insulation / Insulation-Off-White
GM01-011-03. Lab ID # 949-030-003	<1%	Actinolite	Fibers: 1-5% Cellulose Matrix: 95-99% Mica, Other m.p.	FJ - Prestolug Storage Area, Vermiculite Insulation / Insulation-Brown
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	EMAILED 8/13/01 LNW

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch Analyst C. Neil Upchurch

Dryers

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 949-021

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:
1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 CNW

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

Feb/05/2001

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-021
Polarized light microscopy analytical results for 1 bulk sample(s).
Job Site: Stimson - Dryers
Job No.: 01-002

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

MAILED
2/13/01 LNW

952 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C, BERKELEY, CA 94710 (510) 528-0108

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Submitted: 1

Samples Analyzed: 1

Job Site / No. Stimson - Dryers 01-002

Report No. 95257

Date Submitted: Feb-02-01

Date Reported: Feb-05-01

SAMPLE ID	ASBESTOS % TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM010201. Lab ID # 949-021-001	None Detected	Fibers: - None Detected Matrix: 99-100% Mica, Qtz, Other m.p.	Top of Big Dryer #7 Door, Insulation Material, White/Gray Insulation-Grey
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	E-MAILED 8/13/01 LNW

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch

Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC. 952 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

Dryers

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 949-021

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:
1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 cNW

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

Feb/05/2001

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-021
Polarized light microscopy analytical results for 1 bulk sample(s).
Job Site: Stimson - Dryers
Job No.: 01-002

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

MAILED
8/13/01 LNW

952 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C, BERKELEY, CA 94710 • 510 528-0108

POLARIZED LIGHT MICROSCOPY
ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee	Samples Submitted: 1	Report No. 95257
Address: P.O. Box 439, Libby, MT 59923	Samples Analyzed: 1	Date Submitted: Feb-02-01
	Job Site / No. Stimson - Dryers 01-002	Date Reported: Feb-05-01

SAMPLE ID	ASBESTOS % TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM010201. Lab ID # 949-021-001	None Detected	Fibers: None Detected Matrix: 99-100% Mica, Qtz, Other m.p.	Top of Big Dryer #7 Door, Insulation Material, White/Gray Insulation-Grey
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	E-MAILED 8/13/01 - NW

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC. 952 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

ASBESTOS TEM LABORATORIES, INC.

952 Greg Street Sparks, NV 89431 Ph: (775) 359-3377 Fax: (775) 359-2798
Home offices at: 1409 Fifth Street, Suite C Berkeley, CA 94710 Ph: (510) 528-0108 Fax: (510) 528-01

*** BULK SAMPLE SUBMISSION FORM / CHAIN-OF-CUSTODY REPORT ***

Company: VERONICA BOVEE
Address: 875 Hiway 2, SOUTH
City-state-zip: Libby, MT 59923
Contact person: VERONICA

Analysis requested/turnaround: 2-3 days
Job site: STIMSON - Dryers
Job no: 01-002 P.O. #:
Phone: 293-0410 Fax: 293-95

Sample number	Location	Description
GM010201	Top of Big Dryer #7 door	Insulation Material White/Gray

Special instructions:

E-MAILED 8/13/01 LNW

Relinquished by	Date / time	Received by	Date / time
Name/company V. Bovee	1/31/01 9 30	Name/company C. Neil Upchurch/ATOM	2/2/ U.S. ma 12:45p
Signature [signature]		Signature [signature]	
Name/company		Name/company	
Signature		Signature	

Send original to lab - keep yellow copy

Vats

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 949-022

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:
1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 - h

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

March 09, 2001

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-022
Polarized light microscopy analytical results for 3 bulk sample(s).
Job Site: Stimson Lumber
Job No.: 01-004

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upshaw

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

MAILED
8/13/01 LN

952 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C, BERKELEY, CA 94710 (510) 528-0108

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee	Samples Submitted: 3	Report No. 95403
Address: P.O. Box 439, Libby, MT 59923	Samples Analyzed: 3	Date Submitted: Mar-08-01
	Job Site / No. Stimson Lumber 01-004	Date Reported: Mar-09-01

SAMPLE ID	ASBESTOS % TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM01-004 01.	None Detected	Fibers: None Detected	Vat #5 - Ceiling - Glen Sample, Concrete / Vermicultite Material Dark Gray/Brown
Lab ID # 949-022-001		Matrix: 99-100% Calc, Mica, Other m.p.	Concrete-Brown
GM01-004 02.	None Detected	Fibers: None Detected	Vat #5 - Ceiling - 2nd Sample, Concrete Material H. Gray/Green
Lab ID # 949-022-002		Matrix: 99-100% Calc, Mica, Other m.p.	Concrete-Brown
GM01-004 03.	None Detected	Fibers: 1-5% Fiberglass,Cellulose	Vat #5 - Ceiling - 3rd Sample, Surface Ceiling Material, White
Lab ID # 949-022-003		Matrix: 95-99% Calc, Qtz, Other m.p.	Concrete-Grey
Lab ID #		Fibers:	
		Matrix:	
Lab ID #		Fibers:	
		Matrix:	
Lab ID #		Fibers:	
		Matrix:	
Lab ID #		Fibers:	
		Matrix:	
Lab ID #		Fibers:	
		Matrix:	
Lab ID #		Fibers:	
		Matrix:	
Lab ID #		Fibers:	E-MAILED 8/13/01 LNW
		Matrix:	

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC. 952 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

Floor Tiles Green End

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 949-024

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:
1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED 8/13/01 LN

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

March 16, 2001

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-024
Polarized light microscopy analytical results for 2 bulk sample(s) with +2 sample split(s)
Job Site: Stimson Lumber
Job No.: 01-006

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

E-MAILED
8/13/01 CN

952 GREG STREET • SPARKS, NV • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET. SUITE C, BERKELEY, CA 94710 (510) 528-0108

POLARIZED LIGHT MICROSCOPY ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Submitted: 2
Samples Analyzed: 4
Job Site / No. Stimson Lumber 01-006

Report No. 95446
Date Submitted: Mar-16-01
Date Reported: Mar-16-01

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM01-006-01. Lab ID # 949-024-001A	1-5%	Chrysotile	Fibers: None Detected Matrix: 95-99% Calc, Bndr, Other m.p.	Green End Office Floor, White Floor Tile Floor Tile-Beige
GM01-006-01. Lab ID # 949-024-001B		None Detected	Fibers: 1-5% Cellulose Matrix: 95-99% Bndr, Opq, Other m.p.	Green End Office Floor, White Floor Tile Mastic-Yellow
GM01-006-02. Lab ID # 949-024-002A	1-5%	Chrysotile	Fibers: None Detected Matrix: 95-99% Calc, Bndr, Other m.p.	Green End Office Floor, Green Floor Tile Floor Tile-Green
GM01-006-02. Lab ID # 949-024-002B		None Detected	Fibers: 1-5% Cellulose Matrix: 95-99% Bndr, Opq, Other m.p.	Green End Office Floor, Green Floor Tile Mastic-Yellow
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	MAILED 8/13/01 CNW

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Yorkesch Analyst C. Neil Yorkesch

ASBESTOS TEM LABORATORIES, INC. 952 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

Parking Lot

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 949-005

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:
1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 - LNW

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

Mar/24/2000

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-005
Polarized light microscopy analytical results for 3 bulk sample(s).
Job Site: Old Popping Bldg
Job No.:

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

E-MAILED
8/13/01 - LNK

952 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C, BERKELEY, CA 94710 (510) 528-0108

POLARIZED LIGHT MICROSCOPY
ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Submitted: 3
Samples Analyzed: 3
Job Site / No. Old Popping Bldg

Report No. 93628
Date Submitted: Mar-23-00
Date Reported: Mar-24-00

SAMPLE ID	ASBESTOS % TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM00 505. Lab ID # 949-005-001	None Detected	Fibers: <1% Cellulose Matrix: 100-100% Qtz, Calc, Mica, Other m.p.	FJ Parking Lot Next to Road, Dirt Sample Soil-Grey
GM00 506. Lab ID # 949-005-002	None Detected	Fibers: <1% Cellulose Matrix: 100-100% Qtz, Calc, Mica, Other m.p.	FJ Parking Lot, South Side, Dirt Sample Soil-Grey
GM00 507. Lab ID # 949-005-003	None Detected	Fibers: <1% Cellulose Matrix: 100-100% Qtz, Calc, Mica, Other m.p.	FJ Parking Lot in R & R Tracks, Dirt Sample Soil-Grey
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	E-MAILED 8/13/01 - LNN

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upshurch Analyst C. Neil Upshurch

ASBESTOS TEM LABORATORIES, INC. 952 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

Need results no later the 2:00 pm on Friday 3/

ASBESTOS TEM LABORATORIES, INC.

952 Greg Street Sparks, NV 89431 Ph: ~~(702) 356-1300~~ Fax: (702) 359-2798
1409 Fifth Street, Suite C Berkeley, CA 94710 Ph: (510) 528-0108 Fax: (510) 528-0109

*** BULK SAMPLE SUBMISSION FORM / CHAIN-OF-CUSTODY REPORT ***

Company: STIMSON LUMBER CO.
Analysis Requested/Turnaround: Same Day
Address: 875 Highway 2, S
Job Site: Old Popping Bldg.
City-State-Zip: LIBBY, MT 59923
Job No:
P.O. #:
Contact: VERONICA BOVEE
Phone: 406-293-0410 FAX: 406-293-989

SAMPLE NUMBER	LOCATION	DESCRIPTION
GM00505	FJ Parking Lot next to road	Dirt sample
GM00506	FJ Parking Lot South Side	Dirt Sample
GM00507	FJ Parking Lot in R&R tracks	Dirty Sample

Special Instructions: Looking for the same as previous samples — Actinolite was found.

Relinquished By	Date / Time	Received By	Date / Time
Name/Company V Bovee / Stimson	3/22 11:00	Name/Company C. Neil Upchurch / ATEM	3/23/00 11:10 A
Signature V Bovee		Signature	
Name/Company		Name/Company	
Signature		Signature	

Send Original to Lab - Keep Yellow Copy

E-MAILED 8/13/01 - LNW

Mountain Laboratories

Division of MCS Environmental, Inc.

10905 E. Montgomery Drive, Suite #2
Spokane, Washington 99206
(509) 924-9236 • Fax (509) 924-2287

2104 S. Reserve Street • Missoula, Montana 59801
1-800-735-7095 • (406) 728-7755
Fax (406) 728-7367

NVLAP

May 25, 1999

Stimson Lumber Co.
Libby Ops
Veronica Bovee
875 Highway 2 South
Libby, MT 59923

Project: Steamline Removal to Old Loco Building

GM99001

Dear Ms. Bovee,

The enclosed report details the results of the analysis for the bulk samples submitted to Mountain Laboratories on May 25, 1999. Mountain Laboratory participates in a National Voluntary Laboratory Accreditation Program (NVLAP) for Bulk Asbestos Analysis, governed by the National Institute for Standards and Technology (NIST)-NVLAP I.D. #101890-0. Sample results must not be used by the client to claim endorsement by NVLAP nor any agency of the United States government. Sample analysis was performed to determine asbestos type and content using Polarized Light Microscopy, supplemented by Dispersion Staining (PLM/DS) in accordance with the following methodologies:

USEPA Test Methods EPA/600/R-93/116, "Method for the Determination of Asbestos in Bulk Building Materials"

ASTM draft "Standard Method for Asbestos Containing Materials by Polarized Light Microscopy" (Committee D22.05, January 14, 1988)

This report includes a summary of the analytical results, chain of custody and copies of the analysis report forms used by our analysts. Analytical results are only reflective of the samples which were tested and presented in this report. Mountain Laboratories, Division of MCS Environmental limits warranty to proper analysis methods and takes no responsibility for sample procurement.

It has been our pleasure providing you with these analytical services. If you have any questions regarding this report, please do not hesitate to call us at (509) 924-9236.

Sincerely,

Karen L. Drader
Laboratory Manager
Mountain Laboratories
MCS Environmental

Enclosures:
51982802

E-MAILED
8/15/01
LNW

BULK SAMPLE ANALYSIS FOR ASBESTOS

Stimson Lumber Co.
Libby Ops
Veronica Bovee
875 Highway 2 South
Libby, MT 59923

Project: Steamline Removal to Old Loco Building

Method: PLM With Dispersion Staining

Laboratory No.	B99-2802		
Sample ID No.	6M99001		
Sample Information	N/S		
Sample Treatment	Teased		
Homogeneous	Yes		
Layers	No		
Fibrous	Yes		
Sample Color	White		
Asbestos Present	No		
Asbestos Type and Percentage 1. Chrysotile 2. Amosite 3. Crocidolite 4. Other	N.D.		
Total % Asbestos	None		
Other fibrous material in sample	Synthetic 65%		
Non-Fibrous Materials	Binder/Filler 35%		

Date analyzed: May 25, 1999

Analyzed By: Karen L. Drader

Mountain Laboratories, Division of MCS Environmental warranty to proper analysis methods only and takes no responsibility for sample procurement. Mountain Laboratories, Division of MCS Environmental, 10905 E. Montgomery, Suite #2, Spokane Washington 99206 (509) 924-9236 - Fax (509) 924-2287.
PLM has been known to miss asbestos in a small percentage of samples. Thus negative or <1% PLM results should be tested with either SEM or TEM. Client is responsible for sample separation. This report may only be reproduced in full with written approval by Mountain Laboratories.

E-MAILED

FJ - Old Poppies

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 949-004

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:
1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 - LA

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

March 20, 2000

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-004
Polarized light microscopy analytical results for 4 bulk sample(s).
Job Site: Stimson Lumber Co. Old Popping Bldg
Job No.: 01

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch
Lab Manager
ASBESTOS TEM LABORATORIES, INC.

E-MAILED
8/13/01 CNW

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

952 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C, BERKELEY, CA 94710 (510) 528-0108

I LARIZED LIGHT MICR SCOPY
ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Submitted: 4

Samples Analyzed: 4

Job Site / No. Stimson Lumber Co. Old Popping Bldg
01

Report No. 93595

Date Submitted: Mar-16-00

Date Reported: Mar-17-00

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM0501. Lab ID # 949-004-001	5-10%	Actinolite	Fibers: None Detected	Finger Jointer Lunchroom, Insulation btw Walls - Gray
			Matrix: 90-95% Mica, Qtz, Other m.p.	Insulation-Brown
GM0502. Lab ID # 949-004-002	<1%	Actinolite	Fibers: None Detected	Popping Bldg @ Wooden Fence (2"), Ground Dirt - Brown
			Matrix: 99-100% Opq, Qtz, Mica, Other m.p.	Soil-Grey
GM0503. Lab ID # 949-004-003	<1%	Actinolite	Fibers: None Detected	Popping Bldg @ Wooden Fence (12"), Ground Dirt - Brown
			Matrix: 99-100% Opq, Qtz, Mica, Other m.p.	Soil-Grey
GM0504. Lab ID # 949-004-004		None Detected	Fibers: None Detected	C. Maintenance @ Forklit Station, Insulation Between Walls - Gray
			Matrix: 99-100% Mica	Insulation-Brown
Lab ID #			Fibers:	
			Matrix:	
Lab ID #			Fibers:	
			Matrix:	
Lab ID #			Fibers:	
			Matrix:	
Lab ID #			Fibers:	
			Matrix:	
Lab ID #			Fibers:	
			Matrix:	
Lab ID #			Fibers:	MAILED 8/15/01 CNW
			Matrix:	

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Yorkurch

Analyst C. Neil Yorkurch

ASBESTOS TEM LABORATORIES, INC. 952 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

Air Samples CM.

ASBESTOS TEM LABORATORIES, INC.

NIOSH 7400 Method
Phase Contrast Microscopy
Analytical Report

Laboratory Job #. 949-011

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

Home Offices Located At:
1409 Fifth Street, Suite C
Berkeley, CA 94710
Ph. (510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 - LNN

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

May 25, 2000

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-011
Phase contrast microscopy analytical results for 1 air sample(s).
Job Site: Stimson Lumber Company
Job No.:

Enclosed please find the analytical results for one or more air samples submitted for phase contrast microscopy (PCM) analysis. All analysts participate in the American Industrial Hygiene Association (AIHA) Asbestos Analyst Registry Registry proficiancy testing program.

Prior to analysis, air sample cassettes are logged-in and all data pertinent to the sample is recorded into a computer based laboratory information management system. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper sample tracking.

After sample login is complete, the air samples are analyzed as follows: Air filters are individually removed from the cassette holders, a quarter section is separated and placed onto a glass microscope slide. The filter section is collapsed using a "QuikFix" acetone vaporizer. A drop of Triacetin is added and a coverslip is emplaced over the filter. The slide is then placed under an Olympus CH-2 or Meiji ML-POL Phase Contrast Microscope. Fibers are counted until either 100 fibers are counted in a minimum of 20 fields or 100 fields total are observed. Analytical results are calculated according to NIOSH 7400 protocols. Data is then compiled into a standard report format and subjected to a quality assurance review before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Laboratory Manager
ASBESTOS TEM LABORATORIES, INC.

E-MAILED
8/13/01 - LMW

952 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C, BERKELEY, CA 94710 (510) 528-0108

1 ASE CONTRAST MICROSCC /

ANALYTICAL REPORT

Contact: Ms. Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Submitted: 1
Samples Analyzed: 1
Job Site / No. Stimson Lumber Company

Report No.: 93869
Date Submitted: May-25-00
Date Reported: May-25-00

SAMPLE ID	FIBERS per CC	95% UCL	8 - HR TWA	FIBERS per Fields	FIBERS per Filter	LOCATION / DESCRIPTION
FZ00522. Lab ID # 949-011-001	0.0070	0.0106	0.0056	17.0 / 100	8338	Black F. C.M. in Heavy Equipment Bay Volume(L) Pump Time(Min) Flow Rate(LPM) 1195 385 3.00
Lab ID #						Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #						Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #						Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #						Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #						Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #						Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #						Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #						Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #			E-MAILED 8/13/01 - LNN			Volume(L) Pump Time(Min) Flow Rate(LPM)

Detection Limit = 7 Fibers/MM2

Lab Manager C. Neil Upchurch Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC. 952 Greg Street, Sparks, NV 88431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

C.M.

AIR

ASBESTOS TEM LABORATORIES, INC.

NIOSH 7400 Method
Phase Contrast Microscopy
Analytical Report

Laboratory Job # 949-012

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

Home Offices Located At:
1409 Fifth Street, Suite C
Berkeley, CA 94710
Ph. (510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01-LNW

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

May 25, 2000

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-012
Phase contrast microscopy analytical results for 1 air sample(s).
Job Site: Stimson Lumber Company
Job No.:

Enclosed please find the analytical results for one or more air samples submitted for phase contrast microscopy (PCM) analysis. All analysts participate in the American Industrial Hygiene Association (AIHA) Asbestos Analyst Registry Registry proficiency testing program.

Prior to analysis, air sample cassettes are logged-in and all data pertinent to the sample is recorded into a computer based laboratory information management system. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper sample tracking.

After sample login is complete, the air samples are analyzed as follows: Air filters are individually removed from the cassette holders, a quarter section is separated and placed onto a glass microscope slide. The filter section is collapsed using a "QuikFix" acetone vaporizer. A drop of Triacetin is added and a coverslip is emplaced over the filter. The slide is then placed under an Olympus CH-2 or Meiji ML-POL Phase Contrast Microscope. Fibers are counted until either 100 fibers are counted in a minimum of 20 fields or 100 fields total are observed. Analytical results are calculated according to NIOSH 7400 protocols. Data is then compiled into a standard report format and subjected to a quality assurance review before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Laboratory Manager
ASBESTOS TEM LABORATORIES, INC.

E-MAILED
6/13/01 LNW

952 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C, BERKELEY, CA 94710 (510) 528-0108

1 ASE CONTRAST MICROSCO. 1

ANALYTICAL REPORT

Contact: Ms. Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Submitted: 1
Samples Analyzed: 1
Job Site / No. Stimson Lumber Company

Report No.: 93871
Date Submitted: May-25-00
Date Reported: May-25-00

SAMPLE ID	FIBERS per CC	95% UCL	FIBERS per FIELDS	FIBERS per FILTER	LOCATION / DESCRIPTION
FX00523. Lab ID # 949-012-001	< 0.0033	< 0.0067	< 5.5/100	< 1471	Gen. Air Sample @ Work Bench in Heavy Equip Volume(L) Pump Time(Min) Flow Rate(LPM) 810 405 2.00
Lab ID #					Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #					Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #					Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #					Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #					Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #					Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #					Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #					Volume(L) Pump Time(Min) Flow Rate(LPM)
Lab ID #			E-MAILED 8/13/01		Volume(L) Pump Time(Min) Flow Rate(LPM)

Detection Limit = 7 Fibers/MM2

Lab Manager C. Neil Upchurch

Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC.
With Home Offices Located At:
952 Greg Street, Sparks, NV 88431 Ph. 775-359-3377
1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

CM

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 949-008

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:

1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 LNW

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

May 08, 2000

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-008
Polarized light microscopy analytical results for 8 bulk sample(s).
Job Site: Stimson Lumber Co
Job No.: 510

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

MAILED
8/13/01 LNW

952 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C, BERKELEY, CA 94710 (510) 528-0108

I LARIZED LIGHT MICR SCOPY
ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Submitted: 8
Samples Analyzed: 8
Job Site / No. Stimson Lumber Co 510

Report No. 93790
Date Submitted: May-04-00
Date Reported: May-08-00

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM0511. Lab ID # 949-008-001	<1%	Actinolite	Fibers: None Detected Matrix: 99-100% Mica, Other m.p.	C.M. - Cyclinder Tear-Down North Wall, Insulation - Brown Insulation-Grey
GM0512. Lab ID # 949-008-002	<1%	Actinolite	Fibers: None Detected Matrix: 99-100% Mica, Other m.p.	C.M. - @ Electrical Box by Hydr. Room, Insulation - Brown Insulation-Grey
GM0513. Lab ID # 949-008-003	<1%	Actinolite	Fibers: None Detected Matrix: 99-100% Mica, Other m.p.	C.M. - (NW Wall) Forklift Spare Tire, Insulation - Brown Insulation-Grey
GM0514. Lab ID # 949-008-004	<1%	Actinolite	Fibers: None Detected Matrix: 99-100% Mica, Other m.p.	C.M. - Machine Shop @ Welding Area - Cent. Wall, Insulation - Brown Insulation-Grey
GM0515. Lab ID # 949-008-005		None Detected	Fibers: None Detected Matrix: 99-100% Mica, Other m.p.	C.M. - Machine Shop @ 17" Ajax Lathe, Insulation - Brown Insulation-Grey
GM0516. Lab ID # 949-008-006		None Detected	Fibers: 90-95% Fiberglass Matrix: 5-10% GlassFrags, Opq	C.M. - Battery Storage Area, Insulation - Fiber Black Insulation-Black
GM0517. Lab ID # 949-008-007	<1%	Actinolite	Fibers: None Detected Matrix: 99-100% Mica, Other m.p.	C.M. - Repair Shop Access Ladder @ 35T Crane, Insulation - Brown Insulation-Grey
GM0518. Lab ID # 949-008-008		None Detected	Fibers: None Detected Matrix: 99-100% Mica, Other m.p.	C.M. - Work Bench North of Office, Insulation - Brown Insulation-Grey
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	E-MAILED 8/13/01 LNW

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC. 952 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

Truck Storage

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 949-013

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:
1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 LNW

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

May/31/2000

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-013
Polarized light microscopy analytical results for 2 bulk sample(s).
Job Site: Stimson Lumber Co
Job No.:

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

E-MAILED
8/13/01 - LN

952 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C, BERKELEY, CA 94710 (510) 528-0108

P LARIZED LIGHT MICR SCOPY
ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee

Address:
P.O. Box 439
Libby, MT 59923

Samples Submitted: 2
Samples Analyzed: 2
Job Site / No. Stimson Lumber Co

Report No. 93888
Date Submitted: May-31-00
Date Reported: May-31-00

SAMPLE ID	ASBESTOS %	ASBESTOS TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM00524. Lab ID # 949-013-001	<1%	Actinolite	Fibers: None Detected Matrix: 99-100% Mica	Truck Storage Shed - West End, Insulation Gray & Brown Insulation-Grey
Rock Sample. Lab ID # 949-013-002		None Detected	Fibers: <1% Wollast Matrix: 100-100% Qtz, Other m.p.	Green/Gray Colored Rock. Rock-Greenish Grey
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	
Lab ID #			Fibers: Matrix:	A-MAILED 8/13/01 CNW

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC. 952 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

C. M.

ASBESTOS TEM LABORATORIES, INC.

EPA Interim Method
Polarized Light Microscopy
Analytical Report

Laboratory Job # 949-010

952 Greg Street
Sparks, NV 89431
(775) 359-3377
FAX (775) 359-2798

With Home Offices Located At:
1409 Fifth Street
Berkeley, CA 94710
(510) 528-0108
FAX (510) 528-0109

E-MAILED
8/13/01 LNW

ASBESTOS TEM LABORATORIES, INC

Accredited by
U.S. Dept. of Commerce
NVLAP
CA DOHS ELAP

May 11, 2000

Ms. Veronica Bovee

P.O. Box 439
Libby, MT 59923

RE: LABORATORY JOB # 949-010
Polarized light microscopy analytical results for 1 bulk sample(s) with +2 sample split(s)
Job Site: Stimson Lumber Co
Job No.: 520

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with EPA Method 600/R-93/116 for the determination of asbestos in bulk building materials by polarized light microscopy (PLM). Please note that while PLM analysis is commonly performed on non-friable and fine grained materials such as floor tiles and dust, the EPA method recognizes that PLM is subject to limitations. In these situations, accurate results may only be obtainable through the use of more sophisticated and accurate techniques such as transmission electron microscopy (TEM) or X-ray diffraction (XRD).

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Each sample is opened in a class 100 HEPA negative air hood. A representative sampling of the material is selected and placed onto a glass microscope slide containing a drop of refractive index oil. The glass slide is placed under a polarizing light microscope where standard mineralogical techniques are used to analyze and quantify the various materials present, including asbestos. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

Sincerely Yours,

C. Neil Upchurch

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, with the approval of the laboratory. This report must not be used to claim product endorsement by NVLAP or any other agency of the U.S. Government. ---

E-MAILED
8/13/01 - LNW

952 GREG STREET • SPARKS, NV 89431 • (775) 359-3377 • FAX (775) 359-2798
With Home Offices Located at: 1409 FIFTH STREET, SUITE C, BERKELEY, CA 94710 (510) 528-0108

F LARIZED LIGHT MICR SCOPY
ANALYTICAL REPORT

EPA Method 600/R-93/116

Contact: Ms. Veronica Bovee	Samples Submitted: 1	Report No. 93810
Address: P.O. Box 439, Libby, MT 59923	Samples Analyzed: 3	Date Submitted: May-09-00
	Job Site / No. Stimson Lumber Co 520	Date Reported: May-11-00

SAMPLE ID	ASBESTOS % TYPE	NON-ASBESTOS	DESCRIPTION FIELD / LAB
GM0521. Lab ID # 949-010-001A	None Detected	Fibers: 95-99% Cellulose Matrix: 1-5% Bndr, Other m.p.	Central Main, Lathe Area Between Walls, Paper/Felt Material, Black & White & Brown Painted Paper Lyr 1-Brown
GM0521. Lab ID # 949-010-001B	None Detected	Fibers: 1-5% Cellulose Matrix: 95-99% Tar, Other m.p.	Central Main, Lathe Area Between Walls, Paper/Felt Material, Black & White & Brown Mstc Btwen Papr Lyrs-Black
GM0521. Lab ID # 949-010-001C	None Detected	Fibers: 95-99% Cellulose Matrix: 1-5% Bndr, Other m.p.	Central Main, Lathe Area Between Walls, Paper/Felt Material, Black & White & Brown 2nd Paper Layer-Brown
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	
Lab ID #		Fibers: Matrix:	MAILED 8/13/01 - LNW

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager C. Neil Upchurch Analyst C. Neil Upchurch

ASBESTOS TEM LABORATORIES, INC. 952 Greg Street, Sparks, NV 89431 Ph. 775-359-3377
With Home Offices Located At: 1409 Fifth Street, Berkeley, CA 94710 Ph. 510-528-0108

Appendix B

Field Sample Data Sheets

Sheet No.: S- _____

LIBBY MONTANA SITE INVESTIGATION
FIELD SAMPLE DATA SHEET

SOIL-LIKE MATERIALS

Scenario No.: ____ _ Field Logbook No: _____ Page No: _____ Sampling Date: _____

Address: _____ Owner: _____

Land Use: Residential School Commercial Mining Logging Roadway Other ( )

Sampling Team: _____ _____

Data Item	Sample 1	Sample 2	Sample 3
Field ID Number			
Index ID			
GPS Taken?	No Yes	No Yes	No Yes
Category (circle)	FS FD___ _	FS FD_____	FS FD _____
Matrix Type (circle)	Mining Waste Subsurface Soil Surface Soil Fill Other _____	Mining Waste Subsurface Soil Surface Soil Fill Other _____	Mining Waste Subsurface Soil Surface Soil Fill Other _____
Location Description (circle)	Yard Soil Garden Soil Play Area Driveway Other _____	Yard Soil Garden Soil Play Area Driveway Other _____	Yard Soil Garden Soil Play Area Driveway Other _____
Type (circle)	Grab Comp. # subsamples _____	Grab Comp. # subsamples _____	Grab Comp. # subsamples _____
Sample Time			
Top Depth (in.)			
Bottom Depth (in.)			
Map Location			
Field Comments			
	Entered ___ Validated ___	Entered ___ Validated ___	Entered ___ Validated ___

Sheet No.: A-01R- _____

LIBBY MONTANA SITE INVESTIGATION
FIELD SAMPLE DATA SHEET

STATIONARY AIR

Scenario No.: _____ Field Logbook No: _____ Page No: _____ Sampling Date: _____

Address: _____ _____ Owner: _____

Land Use: Residential School Commercial Mining Other ( )

Sampling Team: _____

Data Item	Cassette 1	Cassette 2	Cassette 3
Field ID Number			
Index ID			
Category (circle)	FS Blank Rep_____	FS Blank Rep_____	FS Blank Rep_____
Matrix Type (circle)	Indoor Outdoor	Indoor Outdoor	Indoor Outdoor
Location Description			
Flow Meter Type			
Flow Meter ID No.			
Pump ID Number			
Start Date			
Start Time			
Start Counter			
Start Flow (L/min)			
Stop Date			
Stop Time			
Stop Counter			
Stop Flow (L/min)			
Pump fault?	No Yes	No Yes	No Yes
MET Station onsite?	No Yes	No Yes	No Yes
GPS Taken?	No Yes	No Yes	No Yes
Pump counter used?	No Yes	No Yes	No Yes
Field Comments			
	Entered ___ Validated ___	Entered ___ Validated ___	Entered ___ Validated ___

Sheet No.: P-01R- _____

LIBBY MONTANA SITE INVESTIGATION
FIELD SAMPLE DATA SHEET
PERSONAL AIR

Scenario No.: _____ Field Logbook No: _____ Page No: _____ Sampling Date: _____

Address: _____ Owner: _____

Land Use: Residential School Commercial Mining Other ( )

Sampling Team: _____

Name of Sampler: _____ SSN: _____ Activity _____

Data Item	Cassette 1	Cassette 2	Cassette 3
Field ID Number			
Index ID			
Category (circle)	FS Blank Rep _____	FS Blank Rep_____	FS Blank Rep_____
Matrix Type (circle)	Indoor Outdoor	Indoor Outdoor	Indoor Outdoor
Location Description			
Flow Meter Type			
Flow Meter ID No.			
Pump ID Number			
Start Date			
Start Time			
Start Counter			
Start Flow (L/min)			
Stop Date			
Stop Time			
Stop Counter			
Stop Flow (L/min)			
Pump fault?	No Yes	No Yes	No Yes
MET Station onsite?	No Yes	No Yes	No Yes
Pump counter used?	No Yes	No Yes	No Yes
Field Comments			
	Entered ___ Validated ___	Entered ___ Validated ___	Entered ___ Validated ___

Sheet No.: D- _____

LIBBY MONTANA SITE INVESTIGATION
FIELD SAMPLE DATA SHEET

DUST

Scenario No.: _____ Field Logbook No: _____ Page No: _____ Sampling Date: _____

Address: ____ _____ Owner: _____

Land Use: Residential School Commercial Mining Other ( )

Sampling Team: _____

Data Item	Cassette 1	Cassette 2	Cassette 3
Index ID			
Category (circle)	FS Blank	FS Blank	FS Blank
Location Description			
Sample Area (cm^2)			
Flow Meter Type			
Flow Meter ID No.			
Pump ID Number			
Start Date			
Start Time			
Start Flow (L/min)			
Stop Date			
Stop Time			
Stop Flow (L/min)			
Pump fault?	No Yes	No Yes	No Yes
Field Comments			
	Entered ___ Validated ___	Entered ___ Validated ___	Entered ___ Validated ___

Appendix C

Standard Operating Procedures (SOPs)

CDM Federal Technical Standard Operating Procedures

SOP 1-2	Sample Custody
SOP 1-3	Surface Soil Sampling
SOP 1-4	Subsurface Soil Sampling
SOP 2-1	Packaging and Shipping of Environmental Samples
SOP 4-1	Field Logbook Content and Control
SOP 4-2	Photographic Documentation of Field Activities
SOP 4-5	Field Equipment Decontamination at Nonradioactive Sites

SAMPLE CUSTODY

SOP 1-2
Revision: 2
Date: December 18, 2000
Page 1 of 8

Prepared: Sharon Budney

Technical Review: Darwin Nelson

QA Review: George DeLullo

Approved: [signature] 12/27/00
Signature/Date

Issued: Rose Mary Gustin 12/27/00
Signature/Date

1.0 OBJECTIVE

Due to the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures are followed. All paperwork associated with the sample custody procedures will be retained in CDM Federal Programs Corporation (CDM Federal) files unless the client requests that it be transferred to them for use in legal proceedings or at the completion of the contract.

2.0 BACKGROUND

2.1 Definitions

Sample - A material to be analyzed that is contained in single or multiple containers representing a unique sample identification number.

Sample Custody - A sample is under custody if:

1. It is in your possession.
2. It is in your view, after being in your possession.
3. It was in your possession and you locked it up.
4. It is in a designated secure area.

Chain-of-Custody Record - Form used to document the transfer of custody of samples from one individual to another.

Custody Seal - A custody seal is a tape-like seal that is part of the chain-of-custody process and is used to detect tampering with samples after they have been packed for shipping.

Sample Label - Adhesive label placed on sample containers to designate a sample identification number and other sampling information.

Sample Tag - Tag attached with string to a sample container to designate a sample identification number and other sampling information. Tags may be used when it is difficult to physically place adhesive labels on the container (e.g., in the case of small air sampling tubes).

3.0 RESPONSIBILITIES

Sampler - The sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

Field Team Leader - The Field Team Leader is responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events. The Field Team Leader is also responsible for coordinating with the subcontractor laboratory to ensure that adequate information is recorded on custody records.

4.0 REQUIRED SUPPLIES

- Chain-of-Custody Records (applicable CDM Federal forms)
- Custody seals
- Sample labels or tags
- Clear Tape

5.0 PROCEDURES

5.1 Chain-of-Custody Record

This procedure establishes a method for maintaining custody of samples through use of a Chain-of-Custody Record. This procedure will be followed for all samples collected or split samples accepted.

Field Custody

1. Collect only the number of samples needed to represent the media being sampled. To the extent possible, determine the quantity and types of samples and sample locations prior to the actual fieldwork. As few people as possible should handle samples.

2. The field sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

3. Sample labels or tags shall be completed for each sample, using waterproof ink.

4. The Field Team Leader determines whether proper custody procedures were followed during the fieldwork and decides if additional samples are required.

Transfer of Custody and Shipment

1. Samples are accompanied by a Chain-of-Custody Record (see Figure 1 for an example of a Chain-of-Custody Record). When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in the appropriate laboratory.

   - The date/time will be the same for both signatures when custody is transferred directly to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures. Common carriers are not required to sign the form.

   - In all cases, it must be readily apparent that the person who received custody is the same person who relinquished custody to the next custodian.

   - If samples are left unattended or a person refuses to sign, this must be documented and explained on the Chain-of-Custody Record.

2. Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate custody record accompanying each shipment.

3. All shipments will be accompanied by the Chain-of-Custody Record identifying its contents. The original record will accompany the shipment, and the copies will be retained by the Field Team Leader and if applicable, distributed to the appropriate sample coordinators. Freight bills will also be retained by the Field Team Leader as part of the permanent documentation. (Refer to Figure 1)

Procedure for Completing CDM Federal Chain-of-Custody Record (Refer to Figure 1.)

The following procedure is to be used to fill out the CDM Federal Chain-of Custody Record provided as an example chain-of-custody form. If another type of custody form (i.e., provided by the EPA Contract Laboratory Program or a subcontract laboratory) is utilized to track the custody of samples, the information recorded should be similar to the example CDM Federal Chain-of-Custody Record provided and the form should be filled out in its entirety.

1. Record project number.
2. Record Field Team Leader for the project.
3. Record the name and address of the laboratory to which samples are being shipped.
4. Enter the project name/location or code number.
5. Record overnight courier's airbill number.
6. Record sample location number.
7. Record laboratory sample number.
8. Note preservatives type and reference number.
9. Note media type (matrix) and reference number
10. Note sample type.
11. Enter date of sample collection.
12. Enter time of sample collection in military time.
13. Samplers must enter their initials next to the samples they collected.
14. List parameters for analysis and the number of containers submitted for each analysis.
15. Enter MS/MSD (matrix spike/matrix spike duplicate) if sample is for laboratory quality control, or other remarks (e.g. sample depth).
16. All samplers must sign in the space provided.

Figure 1
EXAMPLE CDM Federal Chain-of-Custody Record

CDM Federal Programs Corporation
A subsidiary of Camp Dresser & McKee Inc.

125 Maiden Lane, 5th Floor
New York, NY 10038
(212) 785-9123
Fax: (212) 785-6114

CHAIN OF CUSTODY RECORD

PROJECT ID.	FIELD TEAM LEADER	LABORATORY AND ADDRESS	DATE SHIPPED
PROJECT NAME/LOCATION		LAB CONTRACT:	AIRBILL NO.

MEDIA TYPE
1. Surface Water
2. Groundwater
3. Leachate
4. Field QC
5. Soil/Sediment
6. Oil
7. Waste
8. Other _____

PRESERVATIVES
1. HCl, pH <2
2. HNO3, pH <2
3. NaOH, pH >12
4. H2SO4, pH <2
5. Zinc Acetate, pH >9
6. Ice Only
7. Not Preserved
8. Other _____

SAMPLE TYPE
G = Grab
C = Composite

SAMPLE LOCATION NO.	LABORATORY SAMPLE NUMBER	PRESER-VATIVES ADDED	MEDIA TYPE	SAMPLE TYPE	19_ _ DATE	TIME SAMPLED	ANALYSES (List no. of containers submitted)								REMARKS (Note if MS/MSD)
1.															
2.															
3.															
4.															
5.															
6.															
7.															
8.															
9.															
10.															

SAMPLER SIGNATURES:

RELINQUISHED BY: (PRINT) / (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) / (SIGN)	DATE/TIME	RELINQUISHED BY: (PRINT) / (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) / (SIGN)	DATE/TIME
RELINQUISHED BY: (PRINT) / (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) / (SIGN)	DATE/TIME	RELINQUISHED BY: (PRINT) / (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) / (SIGN)	DATE/TIME

COMMENTS:

DISTRIBUTION: White and yellow copies accompany sample shipment to laboratory; yellow copy retained by laboratory. Pink copy retained by samplers. 1/98

NOTE: If requested by the client, different Chain-of Custody records may be used. Copies of the template for this record may be obtained from the Fairfax Graphics Department.

17. The originator checks information entered in items 1 through 16 and then signs the top left "Relinquished by" box, prints his/her name, and enters the current date and time (military).

    - Upon completion of the custody record form, the top two copies (usually white and yellow) shall be sent with the samples to the laboratory; the bottom copy (usually pink) is retained for the project files. Additional copies will be retained for the project file or distributed as required to the appropriate sample coordinators.

18. The laboratory sample custodian receiving the samples checks the sample label information against the custody record form. He or she also checks sample condition and notes anything unusual under "Remarks" on the custody record form. The laboratory custodian receiving custody signs in the adjacent "Received by" box and keeps the pink copy. The white copy is returned to CDM Federal.

5.2 Sample Labels and Tags

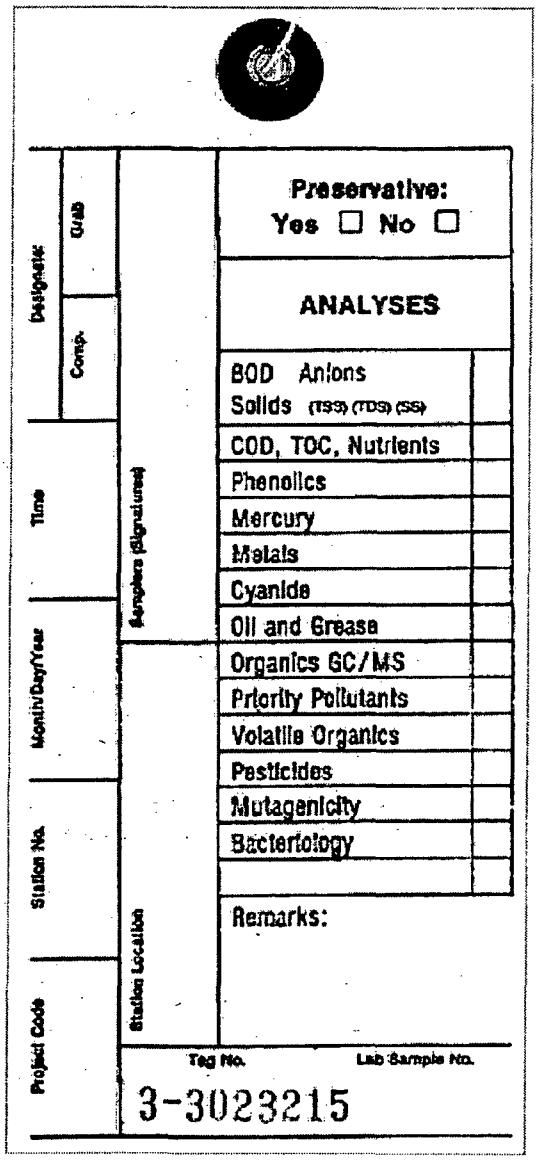
Sample labels or tags will be utilized for all samples collected or accepted for CDM Federal projects.

1. Place adhesive labels directly on the sample containers. Place clear tape over the label to protect from moisture.

2. Sample tags will be securely attached to the sample bottle. On 80 oz. amber bottles, the tag string may be looped through the ring style handle and tied. On all other containers, it is recommended that the string be looped around the neck of the bottle, then twisted and re-looped around the neck until the slack in the string is removed.

3. One label or tag will be completed for each sample container collected. Each label or tag will be completed as follows (see Figure 2 for example of sample tag); labels are completed with the equivalent information:
    - Record the Project Code (i.e., project or task number).
    - Enter the Station Number if applicable.
    - Record the date to indicate the month, day, and year of sample collection.
    - Enter the time (military) of sample collection.
    - Place a check to indicate composite or grab sample.
    - Record the sample location.
    - Samplers must sign in the space provided.
    - Place a check next to "yes" or "no" to indicate if a preservative was added.
    - Under "analyses," place a check next to the parameters for which the sample is to be analyzed. If the desired analysis is not listed, write it in the empty slot. Note: Do not write in the box for "laboratory sample number."
    - Under "remarks," add additional, relevant information.

Figure 2
EXAMPLE Sample Tag



NOTE: Equivalent sample labels or tags may be used.

5.3 Custody Seals

Custody seals must be placed on the shipping containers prior to shipment. The seal should be signed and dated by a field team member.

Custody seals may also be placed on individual sample bottles. Check with the client or refer to EPA regional guidelines for direction.

5.4 Sample Shipping

CDM Federal's Standard Operating Procedures listed below define the requirements for packaging and shipping environmental samples.

- CDM Federal SOP 2-1, Packaging and Shipping of Hexane – Preserved Samples
- CDM Federal SOP 2-2, Packaging and Shipping of Hydrochloric Acid – Preserved Samples
- CDM Federal SOP 2-3, Packaging and Shipping of Sulfuric Acid – Preserved Samples
- CDM Federal SOP 2-4, Packaging and Shipping of Nitric Acid – Preserved Samples
- CDM Federal SOP 2-5, Packaging and Shipping of Sodium Hydroxide – Preserved Samples
- CDM Federal SOP 2-6, Packaging and Shipping of Radioactive Materials in Limited Quantities

6.0 RESTRICTIONS/LIMITATIONS

For EPA Contract Laboratory Program (CLP) sampling events, combined chain-of-custody/traffic report forms or other EPA-specific records may be utilized. Refer to regional guidelines for completing these forms.

7.0 REFERENCES

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.

U.S. Environmental Protection Agency, *Samplers Guide to the Contract Laboratory Program*, EPA/540/P-90/006, December 1990.

PROJECT-SPECIFIC MODIFICATION

Sop No.: 1-2
Revision: 2
Date: 12/28/00

SOP Title: Sample Custody

Technical Review: [signature]

QA Review: [signature] 5/17/01

Approved and Issued: _____
Project Manager Signature/Date

Project No. 2603-015

Client: VOLPE CENTER - DOT

Reason for and Duration of Modification: Site-specific conditions and asbestos sampling requirements for the Libby Project make these modifications necessary for all related sites.

Modification (attach additional sheets if necessary; state section and page number when applicable):

COC procedures will follow the requirements set forth in CDM Federal SOP 1-2 Sample Custody (Appendix B). The following modifications to SOP 1-2 have been reviewed and approved:

Section 5.2, Sample Labels and Tags - Rather than using labels or tags, samples will be identified by writing the sample index ID directly on the one-gallon zipper-top bags using permanent markers.

SURFACE SOIL SAMPLING

SOP 1-3
Revision: 4
Date: June 20, 2001

Prepared: Del Baird

Technical Review: Brian Jenks

QA Review: Matt Brookshire

Approved: Signature/Date

Issued: Signature/Date

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to define the techniques and the requirements for collecting surface soil samples.

2.0 BACKGROUND

Surface soils are generally defined as the soils extending from ground surface to approximately 1 foot below ground surface (bgs). Surface soil samples are frequently collected from 0 to 6 inches bgs. The techniques and protocol described herein may be used to collect other surface media, including sediment and sludge.

2.1 Definitions

Surface Soil - The soil that exists down from the surface approximately one foot (30 centimeters). Depending on application, the soil interval to be sampled will vary.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Composite - Two or more sub-samples taken from a specific media and site at a specific point in time. The sub-samples are collected and mixed, then a single average sample is taken from the mixture.

Spoon/Scoop - A small stainless steel or Teflon® utensil approximately 6 inches in length with a stem-like handle.

Trowel - A small stainless steel or Teflon® shovel approximately 6 to 8 inches in length with a slight (approximately 140°) curve across. The trowel has a stem-like handle (for hand operation). Samples are collected with a spooning action.

2.2 Discussion

Surface soil samples are collected to determine the type(s) and level(s) of contamination and are often important to risk assessment. These samples may be collected as part of an investigative plan, site-specific sampling plan, and/or as a screen for "hot spots," which may require more extensive sampling.

Sediment(s) and sludge(s) that have been exposed by evaporation, stream rerouting, or any other means are collected by the same methods as those for surface soil(s). Typically, the top 1 to 2 centimeters (cm) of material, including vegetation, are carefully removed before collection of the sample.

Surface soil and exposed sediment or sludge are collected using stainless steel and/or Teflon®-lined trowels or scoops.

2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 2-1, Packaging and Shipping of Environmental Samples
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-5, Field Equipment Decontamination at Non-radioactive Sites

3.0 RESPONSIBILITIES

Site Manager - The site manager is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect surface soil samples in accordance with this and other relevant procedures.

4.0 REQUIRED EQUIPMENT

- Insulated cooler and waterproof sealing tape
- Ice bags or "blue ice"
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Stainless steel and/or Teflon®-lined spatulas and pans, trays, or bowls
- Stainless steel and/or Teflon®-lined trowels or spoons (or equipment as specified in the site-specific plans)
- Plastic sheeting
- Project plans (work plan/health and safety plan)
- Appropriate sample containers
- Field logbook
- Indelible ink pen and/or marker
- Sample chain-of-custody forms
- Custody seals
- Decontamination supplies

Additional equipment is discussed in Section 5.2.2, VOC Field Sampling/Preservation Methods.

5.0 PROCEDURES

5.1 Preparation

The following steps must be followed when preparing for sample collection:

1. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

2. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook.

3. Processes for verifying depth of sampling must be specified in the site-specific plans.

4. Place clean plastic sheeting on a flat, level surface near the sampling area, if possible, and place equipment to be used on the plastic; place the insulated cooler(s) on separate plastic sheeting. Cover all equipment and supplies with clean plastic sheeting when not in use.

5. A clean, decontaminated trowel, scoop, or spoon will be used for each sample collected. Other equipment may be used (e.g., shovels) if constructed of stainless steel.

5.2 Collection

The following general steps must be followed when collecting surface soil samples:

1. Surface soil samples are normally collected from the least contaminated to the most-contaminated areas.

2. Document the sampling events, recording the information in the designated field logbook. Document any and all deviations from SOPs in the field logbook and include rationale for changes. See CDM Federal SOP 4-1.

3. Carefully remove stones, vegetation, snow, etc. from the ground surface in the immediate vicinity of the sampling location.

4. First collect required sample aliquot for volatile analyses as well as any other samples that would be degraded by aeration. Follow with collection of samples for other analyses.

5. Decontaminate sampling equipment between locations. See CDM Federal SOP 4-5.

5.2.1 Method for Collecting Samples for Volatile Organic Compound (VOC) Analysis

The requirements for collecting grab samples of surface soil for VOCs or other samples degraded by aeration are as follows:

1. VOC samples shall be collected with the least disturbance possible.

2. VOC samples shall be collected as grab samples; however, the method of collection will vary from site to site, based on data quality objectives and the degree of known or suspected contamination.

3. Complete sample label by filling in the appropriate information and securing the label to the container. Cover the sample label with a piece of clear tape.

4. Use a clean stainless steel or Teflon®-lined trowel or spoon (or tube) to collect sufficient material in one grab to fill the sample containers.

5. With the aid of a clean stainless steel spatula, quickly fill the sample containers directly from the sampling device, removing stones, twigs, grass, etc., from the sample. Fill the containers as full and compact as possible to minimize headspace.

6. Immediately secure the Teflon®-lined cap(s) on the sample container(s).

7. Wipe the containers with a clean Kimwipe or paper towel to remove any residual soil from the exterior of the container.

8. Place the containers in individual zip-top plastic bag(s) and seal the bag(s).

9. Pack all samples as required. Include properly completed documentation, and affix signed and dated custody seals to the cooler lid.

NOTE: A trip blank should be included with sample coolers containing VOC samples. QA sample requirements vary from project to project. Consult the project-specific work plan for requirements.

5.2.2 Field Sampling/Preservation Methods

The following four sections contain SW 846 methods for sampling and field preservation. These methods include EN CORE™ Sampler Method for low-level detection limits, EN CORE™ Sampler Method for high level/detection limits/screening, acid preservation, and methanol preservation. These methods are very detailed and contain equipment requirements at the beginning of each section.

NOTE: Some variations from these methods may be required depending on the contracted analytical laboratory, such as sample volume.

5.2.2.1 EN CORE™ SAMPLER COLLECTION FOR LOW LEVEL ANALYSES (≥1 UG/KG)

EN CORE™ Sampling Equipment Requirements

The following equipment is required for low-level analysis:

- Three 5-g samplers

NOTE: The sample volume requirements are general requirements. Actual sample volumes, sizes, and quantities may vary depending on client or laboratory requirements.

- One 4-ounce widemouth glass jar or applicable container for moisture analysis
- One T-handle
- Paper towels

EN CORE™ Sampling Steps for Low Level Analysis

1. Remove sampler and cap from package and attach T-handle to sampler body.
2. Quickly push the sampler into a freshly exposed surface of soil until the O-ring is visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.
3. Extract the sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.
4. Push cap on with a twisting motion to secure to the sampler body.
5. Rotate the sampler stem counterclockwise until stem locks in place to retain sample within the sampler body.
6. Fill out sample label and attach to sampler.
7. Repeat procedure for the other two samplers.
8. Collect moisture sample in 4-ounce widemouth jar using a clean stainless steel spoon or trowel.
9. Store samplers at 4° Celsius. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

NOTE: Verify state requirements for extraction/holding times.

5.2.2.2 ACID PRESERVATION SAMPLING FOR LOW LEVEL ANALYSES (≤1 UG/KG)

Acid Preservation Sampling Equipment Requirements

The following equipment and supplies are required if field acid preservation is required:

- One 40mL VOA vial with acid preservation (for field testing of soil pH)
- Two pre-weighed 40mL VOA vials with acid preservative and stir bar (for lab analysis)
- Two pre-weighed 40mL VOA vials with water and stir bar (in case samples cannot be pre-preserved)
- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (for screening sample and/or high level analysis)
- One 4-oz widemouth glass jar or applicable container for moisture analysis
- One 2-oz jar with acid preservative (in case additional acid is needed due to high soil pH)
- One appropriately sized scoop capable of delivering 1g of solid sodium bisulfate
- pH paper
- Weighing scale capable of reading to 0.01g
- Set of balance weights used in daily balance calibration
- Gloves for working with pre-weighed sample vials
- Paper towels
- Sodium bisulfate acid ($NaHS0_4$)
- A cutoff plastic syringe or other coring device capable of collecting sufficient sample volume (5g)

Testing Effervescing Capacity of Soils

Soils must be tested with acid to determine the amount of effervescing that will occur when preserved with acid. Effervescing will drive off VOCs as well as create a high pressure in a sealed vial that could result in the explosion of the sample container. The following steps provide information on the effervescing capacity of the soil.

1. Place approximately 5g of soil into a vial that contains acid preservative and no stir bar.

2. Do not cap this vial as it may EXPLODE upon interaction with the soil.

3. Observe the sample for gas formation (due to carbonates in the soil).

4. If vigorous or sustained gas emissions are observed, then acid preservation is not acceptable to preserve the sample.
    - In this case the samples need to be collected in the VOA vials with only water and a stir bar. The vials with acid preservative CANNOT be used.

5. If a small amount or no gas formation occurs, then acid preservation is acceptable to preserve the sample. Keep this testing vial for use in the buffering test detailed below.

    - In this case the samples need to be collected in the VOA vials with the acid preservative and a stir bar.

Testing Buffering Capacity of Soils

The soils must be tested to determine the quantity of acid that is required to achieve a pH reading of ≤ 2 standard units (STUs). The following steps will assist in determining this quantity.

1. If acid preservation is acceptable for sampling soils, then the sample vial that was used to test the effervescing capacity of the soils can be used to test the buffering capacity.

2. Cap the vial that contains 5g of soil, acid preservative, and no stir bar from Step 1 in the effervescing test.

3. Shake the vial gently to homogenize the contents.

4. Open the vial and check the pH of the acid solution with pH paper.

    - If the pH paper reads below 2, then the sampling can be done in the two pre-weighed 40mL VOA vials with the acid preservative and stir bar. Since the pH was below 2, it is not necessary to add additional acid to the vials.

    - If the pH paper reads above 2, then additional acid needs to be added to the sample vial.

5. Use the jar with the solid sodium bisulfate acid and add another 1g of acid to the sample.

6. Cap the vial and shake thoroughly again.

7. Repeat Step 4.

    - If the pH paper reads below 2, then the sampling can be done in the two pre-weighed 40mL VOA vials with the acid preservative and stir bar and one extra gram of acid.

    - Make a note of the extra gram of acid needed so the same amount of acid can be added to the vials the lab will analyze.

    - If the pH paper reads above 2, repeat Steps 5 through 7 until the sample pH ≤ 2 STUs.

Now that the soil chemistry has been determined, the actual sampling can occur. The procedure stated below assumes the correct vials are used based on the guidance discussed.

Sample Preservation Steps

1. Wear gloves during all handling of pre-weighed vials.
2. Add more acid if necessary (based on the buffering capacity testing discussed in the previous section).
3. Quickly collect a 5g sample using a cut off plastic syringe or other coring device designed to deliver 5g of soil from a freshly exposed surface of soil.
4. Carefully wipe exterior of sample collection device with a clean paper towel.
5. Quickly transfer the sample to the appropriate VOA vial, use caution when extruding the sample to prevent splashing of the acid in the vial.
6. Remove any soil from the threads of the sample vial using a clean paper towel.
7. Cap vial and weigh the jar to the nearest 0.01g.
8. Record exact weight on sample label.
9. Repeat sampling procedure for the duplicate VOA vial.
10. Weigh the vial containing methanol preservative in it to the nearest 0.01g. If the weight of the vial with methanol varies by more than 0.01g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation below.
11. Take the empty jar or the jar that contains the methanol preservative.
12. Quickly collect a 25g or 5g sample using a cut off plastic syringe or other coring device designed to deliver 25g or 5g of soil from a freshly exposed surface of soil. The 25g or 5g size is dependent on who is doing the sampling and requirements specified by the analytical laboratory.
13. Carefully wipe the exterior of the collection device with a clean paper towel.
14. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial.
15. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.

16. Remove any soil from the threads of the sample vial using a clean paper towel and cap the jar.

17. Weigh the jar with sample to the nearest 0.01g and record the weight on the sample label.

18. Collect dry weight sample using a clean stainless steel spoon or trowel.

19. Store samples at 4° Celsius.

20. Ship sample containers to the analytical laboratory with plenty of ice in accordance with Department of Transportation (DOT) regulations (CORROSIVE. FLAMMABLE LIQUID. POISON).

5.2.2.3 EN CORE™ SAMPLER COLLECTION FOR HIGH LEVEL ANALYSES (≥200 UG/KG)

EN CORE™ Sampling Equipment Requirements

The following equipment is required for high-level analysis.

- One 25-g sampler or one 5-g sampler

NOTE: The volume requirements specified are general requirements. Actual sample volumes, container sizes, and quantities may vary depending on client or laboratory requirements.

- One 4-oz widemouth glass jar of applicable container specified for moisture analysis
- One T-handle
- Paper towels

EN CORE™ Sampling Steps for High Level Analysis

1. Remove sample and cap from package and attach T-handle to sampler body.

2. Quickly push the sampler into freshly exposed surface of soil until the O-ring is visible within the hole/window on the side of the T-handle. If the O-ring is not visible within the window/hole, then the sampler is not full.

3. Use a clean paper towel to quickly wipe the sampler head so that the cap can be tightly attached.

4. Push cap on with a twisting motion to secure to the sampler body.

5. Fill out sample label and attach to sampler.

6. Rotate sampler stem counterclockwise until the stemlocks in place to retain the sample within the sampler body.

7. Collect moisture sample in 4-oz widemouth glass jar or designated container using a clean stainless steel spoon or trowel.

8. Store samplers at 4° Celsius. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

NOTE: Verify state requirements for extraction/holding times.

5.2.2.4 METHANOL PRESERVATION SAMPLING FOR HIGH LEVEL ANALYSES (≥200 UG/KG)

Methanol Preservation Sampling Equipment Requirements

- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (laboratory grade)
- One dry weight cup
- Weighing balance that accurately weighs to 0.01g
- Set of balance weights used in daily balance calibration
- Latex gloves
- Paper towels
- Cutoff plastic syringe or other coring device to deliver 5g or 25g of soil

Sampling Preservation Steps

1. Wear gloves during all handling of pre-weighed vials.

2. Weigh the vial containing methanol preservative in it to the nearest 0.01g. If the weight of the vial with methanol varies by more than 0.01g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/ collection below.

3. Take the empty jar or the jar that contains the methanol preservative.

4. Quickly collect a 25g or 5g sample using a cut off plastic syringe or other coring device designed to deliver 25g or 5g of soil from a freshly exposed surface of soil.

5. Carefully wipe the exterior of the collection device with a clean paper towel.

6. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on who is doing the laboratory analysis.

7. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.

8. Remove any soil from the exterior of the vial using a clean paper towel and cap the sample jar.

9. Weigh the jar with the soil in it to the nearest 0.01g and record the weight on the sample label.

10. Collect dry weight sample using a clean stainless steel spoon or trowel.

11. Store samples at 4° Celsius.

12. Ship sample containers with plenty of ice to the analytical laboratory in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON).

5.2.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analysis

The requirements for collecting samples of surface soil for nonvolatile organic or inorganic analyses are as follows:

1. Label each sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.

2. Use a decontaminated stainless steel or Teflon®-lined trowel or spoon to obtain sufficient sample from the required interval and sub-sampling points, if necessary, to fill the specified sample containers.

3. Empty the contents of each fill of the sampling device directly into a clean stainless steel or Teflon®-lined tray or bowl.

4. Homogenize the sample by mixing with a spoon, spatula, or trowel.

5. Use the spoon, spatula, or trowel to distribute the uniform mixture into the labeled sample containers. Fill organic sample containers first, then inorganics.

6. Secure the appropriate cap on each container immediately after filling it.

7. Wipe the sample containers with a clean Kimwipe or paper towel to remove any residual soil.

8. Place sample containers in individual zip-top plastic bags and seal the bags.

9. Pack all samples as required. Include properly completed documentation, and affix custody seals to the cooler lid.

10. Decontaminate sampling equipment according to CDM Federal SOP 4-5.

6.0 RESTRICTIONS/LIMITATIONS

When grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and, hence, analyze loss. The representativeness of this sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 REFERENCES

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements For Field Methods*, DOE/HWP-69/R1, July 1990 or current revision.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures For Site Characterizations*, DOE/HWP-100/R2, September 1996 or current revision.

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987 or current revision.

U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste*, Physical/Chemical Methods (SW-846), Third Edition, November 1986, (as amended by Update III, June 1997). Method 5035: Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

PROJECT-SPECIFIC MODIFICATION

Sop No.: 1-3
Revision: 4
Date: 6-20-01

SOP Title: SURFACE SOIL SAMPLING

Technical Review: Frank R. [illegible] QA Review: [illegible] 10/30/01

Approved and Issued: _____
Project Manager Signature/Date

Project No. 2608-016 Client: DOT / VOLPE CENTER

Reason for and Duration of Modification: SITE-SPECIFIC CONDITIONS AND ASBESTOS SIMILAR REQUIREMENTS FOR THE LIBBY PROJECT MAKE THESE MODIFICATIONS NECESSARY FOR ALL RELATED SITES.

Modification (attach additional sheets if necessary; state section and page number when applicable):

All soil samples will be collected in accordance with CDM Federal Technical SOP 1-3 Surface Soil Sampling and SOP 1-4 Subsurface Soil Sampling (Appendix B), with modifications. The following modifications to SOP 1-3 and SOP 1-4 have been reviewed and approved.

Section 2.2, Discussion - Sample depth for surface soil will generally be 0 to 2 inches from the current ground surface. However, if a sample is required from an area with highly compacted soil (i.e., parking lot, railroad right-of-way), the depth from 0 to 1 inches will be acceptable assuming a sufficient amount of soil can be obtained. Subsurface soil samples using direct-push techniques (DPT) down to 4-ft will also be required. Composite samples will be composed of nearly equal portions of soil from five randomly discrete locations within a horizontal radius of the grid or transect unit including the grid midpoint. The actual composite sample for PLM analysis will be prepared at the CDM laboratory in Denver as an aliquot of the processed (i.e., dried and homogenized) volume of soil. If vermiculite is observed in the field, it will be included as at least one discrete biased portion of the sample. Generally, grid and/or segment size will be composed of 100- to 50-ft centers.

Section 4.0, Required Equipment - Neither ice bags nor blue ice will be used. Powder-free nitrile gloves will be used for sample collection. No pans, trays, or bowls are necessary, since samples will be placed directly into zipper-top bags. Since the sampling is for asbestos, rather than metals or organic compounds, the use of stainless steel or Teflon-lined sampling instruments is determined not to be necessary. The sampler may be a garden bulb planter, trowel, direct-push (geoprobe), or other similar sampling device. A list of equipment that may be used for sampling is included in Table 4-1.

Section 5.2.3, Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analysis - One-gallon zipper-top bags will be used as sample containers. The one-gallon bags will be filled approximately half full. Sampling information will be written directly on the bags using a permanent marker. Sampling instruments do not need to be constructed of stainless steel or Teflon lined. Trays and bowls will not be used, as samples will be placed directly into zipper-top bags. Drying and homogenization will be performed in the CDM laboratory in Denver. All samples will be double bagged for shipment.

SUBSURFACE SOIL SAMPLING

Prepared: Del Baird

Technical Review: Brian Jenks

QA Review: Matt Brookshire

Approved: Signature/Date 6/20/01

Issued: Signature/Date 6/20/01

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to define the techniques and requirements for collecting soil samples from the unconsolidated zone. Techniques include use of hand augers, Shelby tubes, continuous core samplers, and split-spoon samplers.

2.0 BACKGROUND

2.1 Definitions

Unconsolidated Zone - The layer of soil above bedrock that exists in a relatively loose state.

Hand Auger - A stainless steel cylinder (bucket) approximately 3 to 4 inches in diameter and 1 foot in length, open at both ends with the bottom edge designed to twist into the soil and cut out a soil core. The bucket collects the soil sample. The auger has a T-shaped handle (for hand operation) attached to the top of the bucket by extendable stainless steel rod(s).

Shelby Tube - A cylindrical sampling device, generally made of steel, which is driven into the subsurface soil through the hollow-stem auger. The tube, once retrieved, may be capped and the undisturbed soil sample extruded in the laboratory prior to analysis.

Split-Spoon - A cylindrical sampling device, generally made of carbon steel, which fits into a hollow stem auger. The spoon is hinged lengthwise, which allows the sample to be retrieved by opening ("splitting") the spoon.

Subsurface Soil - The soil which exists deeper than approximately 1 foot (30 centimeters) from the surface but above bedrock or any other consolidated material.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Liner - A cylindrical sampling device, generally made of brass, stainless steel, or Teflon® that is placed inside a split-spoon or hand auger bucket to collect undisturbed samples.

Composite Sample - Two or more sub-samples taken from a specific media and site at a specific point in time. The sub-samples are collected and mixed, then a single average sample is taken from the mixture.

Auger Flight - A steel section length attached to an auger to extend the auger as coring depth increases.

2.2 Discussion

Shallow subsurface soil samples (to depths between 6 inches and 10 feet) may be collected using hand augers. However, soil samples collected with a hand auger are commonly of poorer quality than those collected by split-spoon or Shelby tube samplers since the soil sample is disturbed in the augering process. Split-spoon and Shelby tube liners may be used to prevent loss of volatile organic compounds (VOCs). The size and construction material of sampling devices should be selected based on project and analytical objectives and defined in site-specific plans.

2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 2-1, Packaging and Shipping of Environmental Samples
- CDM Federal SOP 3-5, Lithologic Logging
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-5, Field Equipment Decontamination at Nonradioactive Sites

3.0 RESPONSIBILITIES

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and the required equipment, and for ensuring that subsurface soil samples are collected in accordance with this procedure and any other SOPs pertaining to specific media sampling.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect subsurface soil samples in accordance with this SOP and other relevant procedures.

4.0 REQUIRED EQUIPMENT

4.1 General

- Site-specific plans
- Field logbook
- Indelible black ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Clear, waterproof tape
- Appropriate sample containers

- Insulated cooler(s) and waterproof sealing tape
- Ice bags or "blue ice"
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Stainless steel and/or Teflon®-lined spatulas and pans, trays, or bowls
- Plastic sheeting

Additional equipment is discussed in Section 5.2.2 VOC Field Sampling/Preservation Methods.

4.2 Manual (Hand) Augering

- T-handle
- Hand auger: flighted-, bucket-, or tube-type auger as required by the site-specific plans
- Extension rods
- Wrench(es), pliers

4.3 Split-Spoon and Shelby Tube Sampling

- Drill rig equipped with a 140-lb drop hammer and sufficient hollow-stem augers to drill to the depths required by the site-specific plans.
- Sufficient numbers of split-spoon or Shelby tube samplers so that at least one is always decontaminated and available for sampling. Three split-spoon or Shelby tube samplers are generally the minimum necessary. (Shelby tubes are usually used only once.)
- Split-spoon liners (as appropriate).
- Wrench(es), hammer.

5.0 PROCEDURES

5.1 Preparation

1. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

2. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc..

3. Processes for verifying depth of sampling must be specified in the site-specific plans.

4. Clear away vegetation and debris from the surface at the boring location.

5. Prepare an area next to the sample collection location for laying out cuttings by placing plastic sheeting on the ground to cover the immediate area surrounding the borehole.

6. Set up a decontamination line, if decontamination is required in accordance with CDM Federal SOP 4-5.

5.2 Collection

The following general steps must be followed when collecting all subsurface soil samples:

1. VOC samples or samples degraded by aeration shall be collected first and with the least disturbance possible. These samples shall be collected as grab samples.

2. Sampling information shall be recorded in the field logbook and on any associated forms. Describe lithology, according to CDM Federal SOP 3-5, in the field logbook or on the lithologic log form.

3. Specific sampling devices to be used shall be identified in the site-specific plans and recorded in the field logbook.

4. Care must be taken to prevent cross-contamination and misidentification of samples.

5. Processes for verifying depth of sampling must be specified in the site-specific plans.

6. Sample bottles for VOC analysis should be filled completely to minimize headspace.

5.2.1 Manual (Hand) Augering

The following steps must be followed when collecting hand-augered samples:

1. Auger to the depth required for sampling. Place cuttings on plastic sheeting or as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.

2. Throughout the augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.

3. Cease augering when the top of the specified sampling depth has been reached. If required, remove the auger from the hole and decontaminate the auger or use a fresh auger. Then obtain the sample.

4. Collect a grab sample for VOC analyses (or samples that may be degraded by aeration)

immediately and place in sample container. Sample bottles should be filled completely to minimize headspace.

5. Label the sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.

6. Remaining sample should be homogenized for other analyses prior to placing samples in the appropriate containers. Label containers as required.

7. Wipe containers with a clean Kimwipe or paper towel to remove residual soil from the exterior of the container(s).

8. Place the containers in zip-top plastic bags and seal the bags. Pack samples in a cooler with ice.

9. Proceed with further sampling, as required by the site-specific plans.

10. When all sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

11. Complete the field logbook entry and other appropriate forms, being sure to record all relevant information before leaving the site.

12. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.2 Field Sampling/Preservation Methods

The following four sections contain SW 846 Methods for sampling and field preservation. These methods include ENCORE ™ Sampler Method for low-level detection limits, ENCORE ™ Sampler Method for high-level limits/screening, acid preservation, and methanol preservation. These methods may be used if required by the EPA Region, client, or governing sample plan. These methods are very detailed and contain equipment requirements at the beginning of each section.

Note: Some variations from these methods may be required depending on the contracted analytical laboratory, such as sample volume.

5.2.2.1 EN CORE™ SAMPLER COLLECTION FOR LOW LEVEL ANALYSES (≥1 UG/KG)

EN CORE™ Sampling Equipment Requirements

The following equipment is required for low level analysis:

- Three 5g samplers

NOTE: The sample volume requirements specified are general requirements. Actual sample volume and/or container sizes, may vary depending on client or laboratory requirements.

- One dry weight cup
- One T-handle
- Paper towels

EN CORE™ Sampling Steps for Low Level Analysis

1. Remove sampler and cap from package and attach T-handle to sampler body.
2. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full.
3. Extract sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.
4. Push cap on with a twisting motion to secure.
5. Fill out sample label and attach to sampler.
6. Repeat procedure for the other two samplers.
7. Collect dry weight sample (60 ml).
8. Store samplers at 4 degrees (°) Celsius.

Ship sample containers with plenty of ice to the laboratory within 40 hours of collection.

NOTE: Verify state requirements for extraction/holding times.

5.2.2.2 ACID PRESERVATION SAMPLING FOR LOW LEVEL ANALYSES (≥1 UG/KG)

Acid Preservation Sampling Equipment Requirements

The following equipment and supplies are required if field preservation is required:

- One 40mL VOA vial with acid preservation (for field testing of soil pH). Two pre-weighed 40mL VOA vials with acid preservative and stir bar (for lab analysis).
- Two pre-weighed 40mL VOA vials with water and stir bar (in case sample effervesces).
- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (for screening sample and/or high level analysis).
- One dry weight cup.
- One 2oz jar with acid preservative (in case additional acid is needed due to high soil pH).
- One scoop capable to deliver about 1g of solid sodium bisulfate.
- pH paper.
- Weighing balance that weighs to 0.01g (with an accuracy ±0.1g).
- Set of balance weights used in daily balance calibration.
- Gloves for working with pre-weighed sample vials.
- Paper towels.
- Sodium bisulfate acid ($NaHS0_4$) acid.
- A cutoff plastic syringe or other coring device to deliver 5g or 25g of soil.

Testing Effervescing Capacity of Soils

Soils must be tested with acid to determine the amount of effervescing that will occur when preserved with acid. Effervescing will drive off VOCs as well as create a very high pressure in a sealed vial which could explode. The following steps will provide information on the effervescing capacity of the soil.

1. Place approximately 5g of soil into a vial that contains acid preservative and no stir bar.

2. Do not cap this vial as it may EXPLODE upon interaction with the soil.

3. Observe the sample for gas evolution (due to carbonates in the soil).

4. If vigorous or sustained gas evolution occurs, then acid preservation is not acceptable to preserve the sample.
   - In this case the samples need to be collected in the VOA vials with only water and a stir bar. The vials with acid preservative CANNOT be used.

5. If a small amount or no gas evolution occurs, then acid preservation is acceptable to preserve the sample. Keep this testing vial for use in the buffering test detailed below.

- In this case the samples need to be collected in the VOA vials with the acid preservative and a stir bar.

Testing Buffering Capacity of Soils

The soils must be tested to determine the quantity of acid that is required to reach a less than 2 pH reading. The following steps will assist in determining this quantity.

1. If acid preservation is acceptable for sampling soils, then the sample vial that was used in the effervescing testing can be used here for the buffering testing.

2. Cap the vial that contains approximately 5g of soil, acid preservative, and no stir bar from Step 1 in the effervescing testing.

3. Shake the vial gently to attempt to make a homogenous solution.

4. When done, open the vial and check the pH of the acid solution with pH paper.

   - If the pH paper reads below 2, then the sampling can be done in the two pre-weighed 40mL VOA vials with the acid preservative and stir bar. Since the pH was below 2, it is not necessary to add additional acid to the vials.

   - If the pH paper reads above 2, then additional acid needs to be added to the sample vial.

5. Use the jar with the solid sodium bisulfate acid and add another 1g of acid to the sample.

6. Cap the vial and shake thoroughly again.

7. When done, open the vial and check the pH of the acid solution with a new piece of pH paper.

   - If the pH paper reads below 2 then the sampling can be done in the two pre-weighed 40mL VOA vials with the acid preservative and stir bar and one extra gram of acid.

   - Make a note of the extra gram of acid needed so the same amount of acid can be added to the vials the lab will analyze.

   - If the pH paper reads above 2, then add another gram of acid and repeat this procedure one more time.

Now that the soil chemistry has been determined, the actual sampling can occur. The procedure stated below assumes the correct vials are used based on the guidance discussed.

Sample Preservation Steps

1. Wear gloves during all handling of pre-weighed vials.
2. Quickly collect a 5g sample using a cut off plastic syringe or other coring device designed to deliver 5g of soil from a freshly exposed surface of soil.
3. Carefully wipe exterior of sample collection device with a clean paper towel.
4. Quickly transfer to the appropriate VOA vial, extruding with caution so that the solution does not splash out of the vial.
5. Add more acid if necessary (this is based on the buffering testing discussed in the previous section).
6. Use the paper toweling and quickly remove any soil off the vial threads.
7. Cap vial and weigh the jar to the nearest 0.01g.
8. Record exact weight on sample label.
9. Repeat sampling procedure for the duplicate VOA vial.
10. Weigh the vial containing methanol preservative to the nearest 0.01g. If the weight of the vial with methanol varies by more than 0.01g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation below.
11. Take the empty jar or the jar that contains the methanol preservative.
12. Quickly collect a 25g or 5g sample using a cut off plastic syringe or other coring device designed to deliver 25g or 5g of soil from a freshly exposed surface of soil. The 25g or 5g size is dependent on who is doing the sampling and who is doing the laboratory analysis.
13. Carefully wipe the exterior of the collection device with a clean paper towel.
14. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar received is dependent on who is doing the laboratory analysis.
15. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.

16. Use the paper toweling and remove any soil off of the vial threads and cap the jar.

17. Weigh the jar with the soil in it to the nearest 0.01g and record the weight on the sample label.

18. Collect dry weight sample-fill container.

19. Store samples at 4° Celsius.

20. Ship sample containers with plenty of ice in accordance with Department of Transportation (DOT) regulations (CORROSIVE. FLAMMABLE LIQUID. POISON) to the laboratory.

5.2.2.3 EN CORE™ SAMPLER COLLECTION FOR HIGH LEVEL ANALYSES (≥200 UG/KG)

EN CORE™ Sampling Equipment Requirements

The following equipment is required for high-level analysis:

- One 25g sampler or one 5g sampler (The sampler size used will be dependent on who is doing the sampling and who is doing the laboratory analysis).
- One dry weight cup.
- One T-handle.
- Paper towels.

EN CORE™ Sampling Steps for High Level Analysis

1. Remove sample and cap from package and attach T-handle to sampler body.

2. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full.

3. Use paper toweling to quickly wipe the sampler head so that the cap can be tightly attached.

4. Push cap on with a twisting motion to attach cap.

5. Fill out a sample label and attach to sampler.

6. Collect dry weight sample.

7. Store samplers at 4° Celsius.

8. Ship sample containers with plenty of ice to the laboratory within 40 hours of collection.

NOTE: Verify state requirements for extraction/holding times.

5.2.2.4 METHANOL PRESERVATION SAMPLING FOR HIGH LEVEL ANALYSES (≥200 UG/KG)

Methanol Preservation Sampling Equipment Requirements

- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (laboratory grade).
- One dry weight cup.
- Weighing balance that accurately weighs to 0.01g (with accuracy of ±0.1g).
- Set of balance weights used in daily balance calibration.
- Latex gloves.
- Paper towel.
- Cutoff plastic syringe or other coring device to deliver 5g or 25g of soil.

Sampling Preservation Steps

1. Wear gloves during all handling of pre-weighed vials.
2. Weigh the vial containing methanol preservative to the nearest 0.01g. If the weight of the vial with methanol varies by more than 0.01g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below.
3. Take the empty jar or the jar that contains the methanol preservative.
4. Quickly collect a 25g or 5g sample using a cut off plastic syringe or other coring device designed to deliver 25g or 5g of soil from a freshly exposed surface of soil. The 25g or 5g size used is dependent on who is doing the sampling and who is doing the laboratory analysis.
5. Carefully wipe the exterior of the collection device with a clean paper towel.
6. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on who is doing the laboratory analysis.
7. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.
8. Using the paper toweling, remove any soil off of the vial threads and cap the jar.
9. Weigh the jar with the soil in it to the nearest 0.01g and record the weight on the sample label.
10. Collect dry weight sample-fill container.

11. Store samples at 4° Celsius.

12. Ship sample containers with plenty of ice in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON) to the laboratory.

5.2.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analysis

The requirements for collecting samples of surface soil for nonvolatile organic or inorganic analyses are as follows:

1. Label each sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.

2. Use a decontaminated stainless steel or Teflon®-lined trowel or spoon to obtain sufficient sample from the required interval and subsampling points, if necessary, to fill the specified sample containers.

3. Empty the contents of each fill of the sampling device directly into a clean stainless steel or Teflon®-lined tray or bowl.

4. Homogenize the sample by mixing with a spoon, spatula, or trowel.

5. Use the spoon, spatula, or trowel to distribute the uniform mixture into the labeled sample containers. Fill organic sample containers first, then inorganics.

6. Secure the appropriate cap on each container immediately after filling it.

7. Wipe the sample containers with a clean Kimwipe or paper towel.

8. Place sample containers in individual zip-top plastic bags and seal the bags.

9. Pack all samples as required. Include properly completed documentation, and affix custody seals to the cooler lid.

10. Decontaminate sampling equipment according to CDM Federal SOP 4-5.

5.2.4 Manual (Hand) Augering Using a Tube Sampler With Liner

The following steps must be followed when collecting hand-augered samples using a tube sampler with liner:

1. Auger to the depth required for sampling. Place cuttings on the plastic sheeting as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.

2. Throughout augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.

3. Cease augering when the top of the specified sampling depth has been reached. Remove the auger from the hole and decontaminate.

4. Prepare a decontaminated tube sampler by installing a decontaminated liner in the auger tube.

5. Obtain the sample and retrieve the auger. Remove the liner from the tube and immediately cover ends with Teflon® tape and cap the ends of the tube. Seal the caps with waterproof tape.

6. Label the sealed liners as required in the site-specific plans. Mark the top and bottom of the sample on the outside of the liner. Indicate boring/well number and depth on outside of liner.

7. Wipe sealed liners with a clean Kimwipe or paper towel.

8. Place sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

9. Proceed with further sampling, as required by the site-specific plans.

10. When sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

11. Decontaminate all equipment according to CDM Federal SOP 4-5.

12. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.

13. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.5 Split-Spoon Sampling

The following steps must be followed when collecting split-spoon samples:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location prior to drilling, per CDM Federal SOP 4-5 or the site-specific decontamination procedures.
3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s) to the drill rig.
4. Begin drilling and proceed to the first designated sample depth, adding auger flight(s) as necessary.
5. Slightly raise the auger flight(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods.
7. Install a decontaminated split spoon on the center rod(s) and insert it into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.
8. Mark the center rod in 6-inch increments from the top of the auger flight(s).
9. Drive the spoon using the hammer. Use a full 30-inch drop as specified by the American Society for Testing and Materials (ASTM) Method D-1586. Record the number of blows required to drive the spoon or tube through each 6-inch increment.
10. Cease driving when the full length of the spoon has been driven or upon refusal. Refusal occurs when little (<1 inch) or no progress is made for 50 blows of the hammer.
11. Pull the spoon or tube free by using upswings of the hammer to loosen the sampler. Pull out the center rod and spoon or tube.
12. Unscrew the split-spoon assembly from the center rod and place it on the plastic sheeting.
13. Remove the drive shoe and head assembly. If necessary, tap the split-spoon assembly with a hammer to loosen threaded couplings.
14. With the drive shoe and head assembly off, open (split) the spoon, being careful not to disturb the sample.

15. Label sample containers with appropriate information. Secure the label, covering it with a piece of clear tape.

16. If VOC analyses are to be conducted on the soil sample, place that sample in its sample container immediately after opening the spoon, filling the sample bottle completely. Seal the container immediately, then describe it in the field logbook and/or associated forms. Record the sample identification number, depth from which the sample was taken, and the analyses to be performed on the samples in the field logbook and on the appropriate forms.

17. Remaining sample should be homogenized prior to placing samples in appropriate containers. Label containers as required.

18. Wipe containers with a clean Kimwipe or paper towel.

19. Place containers in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

20. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.

21. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.

22. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans. Backfill bore hole as specified in project-specific plans.

23. Decontaminate split spoons and other small sampling equipment according to CDM Federal SOP 4-5 before proceeding to other sampling locations.

24. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.

25. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.6 Split-Spoon Sampling Using Liners

The following steps must be followed when collecting samples with lined split spoons:

1. Remove any pavement and sub base material from an area of twice the bit diameter, if necessary.

2. The drilling rig will be decontaminated at a separate location prior to drilling.

3. Attach the hollow-stem auger with the cutting head and center rod(s).

4. Begin drilling and proceed to the first designated sample depth, adding auger flight(s) as necessary.

5. Slightly raise the auger flight(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.

6. Remove the plug and center rods.

7. Install decontaminated liners in the split-spoon barrel.

8. Install a decontaminated split spoon on the center rod(s) and insert it into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.

9. Mark the center rod in 6-inch increments from the top of the auger flight(s).

10. Drive the spoon using the hammer. Use a full 30-inch drop as specified by ASTM Method D-1586. Record the number of blows required to drive the spoon or tube through each 6-inch increment.

11. Cease driving when the full length of the spoon has been driven or upon refusal. Refusal occurs when little (<1 inch) or no progress is made after 50 blows of the hammer.

12. Pull the spoon or tube free by using upswings of the hammer to loosen the sampler. Pull out the center rod and spoon or tube.

13. Unscrew the split-spoon assembly from the center rod and place it on the plastic sheeting.

14. Remove the drive shoe and head assembly. If necessary, tap the split-spoon assembly with a hammer to loosen threaded couplings.

15. With the drive shoe and head assembly off, open (split) the spoon and remove the liners without disturbing the sample.

16. Immediately install Teflon® tape over the ends of the liners, cap the liners, and seal the caps over the ends of the liner with waterproof tape. Label the samples as required by the site-specific plans. Mark the top and bottom of each sample on the outside of each liner. Indicate boring/well number and depth on outside of liner.

17. Wipe sealed liners with a clean Kimwipe or paper towel.

18. Place sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

19. In the field logbook and on the boring log, describe sample lithology by observing cuttings and the bottom end of the sample in the liner.

20. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.

21. When sampling is complete, remove the drilling rig to the heavy equipment decontamination site.

22. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

23. Decontaminate split spoons and other small sampling equipment before proceeding to other sampling locations as required by the CDM Federal SOP 4-5.

24. Complete the field logbook entry, and other forms, being sure to record all relevant information before leaving the site.

25. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.7 Shelby Tube Sampling

The following steps must be followed when collecting samples using the Shelby tube:

1. Remove any pavement and sub base material from an area of twice the bit diameter, if necessary.

2. The drilling rig will be decontaminated at a separate location prior to drilling.

3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s).

4. Begin drilling and proceed to the first designated sample depth, adding auger flight(s) as necessary.

5. Slightly raise the auger flight(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.

6. Remove the plug and center rods.

7. Attach a head assembly to a decontaminated Shelby tube. Attach the Shelby tube assembly to the center rods.

8. Lower the Shelby tube and center rods into the hollow-stem augers and seat it at the bottom. Be sure to leave 30 inches or more of center rod above the lowest point to the hydraulic piston's extension.

9. Use the rig's hydraulic drive to push the Shelby tube into undisturbed soil. The tube should be pushed with a steady force. Note the pressure used to push the Shelby tube in the field logbook.

10. When the Shelby tube has been advanced its full length or to refusal, back off the hydraulic pistons. Attach a hoisting plug to the upper end of the center rod, twist to break off the sample, and pull the apparatus out of the hole with the rig winch.

11. Retrieve the Shelby tube to the surface, detach it from the center rod, and remove the head assembly.

12. Since the typical intent of Shelby tube sampling is for engineering purposes and an undisturbed sample is required, the tube ends should be sealed immediately. Sealing is accomplished by filling any void space in the tube with beeswax, then placing caps on the ends of the tube and taping caps into place. The top and bottom ends of the tube should be marked and the tube transported to the laboratory in an upright position. Indicate boring/well number and depth on outside of liner.

13. Wipe sealed tubes with a clean Kimwipe or paper towel.

14. Place sealed tubes in zip-top plastic bags and seal bags. Pack samples in a chilled cooler.

15. Continue to advance the borehole to the next sampling point. Collect samples as outlined above

16. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.

17. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

18. Complete the field logbook entry, being sure to record all relevant information before leaving the site. These methods may be used if directed by the EPA region, client or governing sample plan.

6.0 RESTRICTIONS/LIMITATIONS

Basket or spring retainers may be needed for split-spoon sampling in loose, sandy soils.

Shelby tubes may not retain the sample in loose, sandy soils.

7.0 REFERENCES

American Society for Testing and Materials, *Penetration Test And Split Barrel Sampling Of Soils*, Standard Method D-1586-84, 1984.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements For Field Methods*, DOE/HWP-69/R1, July 1990.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures For Site Characterizations*, DOE/HWP-100/R2, September 1996 or current revision.

U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition, November 1986, (as amended by Update III, June 1997). Method 5035: Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

PROJECT-SPECIFIC MODIFICATION

SOP Title: SUBSURFACE SOIL SAMPLING

Sop No.: 1-4
Revision: 4
Date: 6-20-01

Technical Review: Frank R. [illegible]

QA Review: [illegible] 10/30/01

Approved and Issued: _____
Project Manager Signature/Date

Project No. 2608-016

Client: DOT\VOLPE CENTER

Reason for and Duration of Modification:

SITE-SPECIFIC CONDITIONS AND ASBESTOS SAMPLING REQUIREMENTS FOR THE LIBBY PROJECT MAKE THESE MODIFICATIONS NECESSARY FOR ALL RELATED SITES.

Modification (attach additional sheets if necessary; state section and page number when applicable):

All soil samples will be collected in accordance with CDM Federal Technical SOP 1-3 Surface Soil Sampling and SOP 1-4 Subsurface Soil Sampling (Appendix B), with modifications. The following modifications to SOP 1-3 and SOP 1-4 have been reviewed and approved.

Section 2.2, Discussion - Sample depth for surface soil will generally be 0 to 2 inches from the current ground surface. However, if a sample is required from an area with highly compacted soil (i.e., parking lot, railroad right-of-way), the depth from 0 to 1 inches will be acceptable assuming a sufficient amount of soil can be obtained. Subsurface soil samples using direct-push techniques (DPT) down to 4-ft will also be required. Composite samples will be composed of nearly equal portions of soil from five randomly discrete locations within a horizontal radius of the grid or transect unit including the grid midpoint. The actual composite sample for PLM analysis will be prepared at the CDM laboratory in Denver as an aliquot of the processed (i.e., dried and homogenized) volume of soil. If vermiculite is observed in the field, it will be included as at least one discrete biased portion of the sample. Generally, grid and/or segment size will be composed of 100- to 50-ft centers.

Section 4.0, Required Equipment - Neither ice bags nor blue ice will be used. Powder-free nitrile gloves will be used for sample collection. No pans, trays, or bowls are necessary, since samples will be placed directly into zipper-top bags. Since the sampling is for asbestos, rather than metals or organic compounds, the use of stainless steel or Teflon-lined sampling instruments is determined not to be necessary. The sampler may be a garden bulb planter, trowel, direct-push (geoprobe), or other similar sampling device. A list of equipment that may be used for sampling is included in Table 4-1.

Section 5.2.3, Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analysis - One-gallon zipper-top bags will be used as sample containers. The one-gallon bags will be filled approximately half full. Sampling information will be written directly on the bags using a permanent marker. Sampling instruments do not need to be constructed of stainless steel or Teflon lined. Trays and bowls will not be used, as samples will be placed directly into zipper-top bags. Drying and homogenization will be performed in the CDM laboratory in Denver. All samples will be double bagged for shipment.

PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES

Prepared: Krista Lippoldt Technical Review: Brian Jenks

QA Review: David O. Johnson Approved: _____ Signature/Date

Issued: _____ Signature/Date

1.0 PACKAGING AND SHIPPING OF ALL SAMPLES – This standard operating procedure (SOP) applies to the packaging and shipping of all environmental samples. If the sample is preserved or radioactive, the following sections may also be applicable.

Section 2.0 – Packaging and Shipping of Samples Preserved with Hexane
Section 3.0 – Packaging and Shipping of Samples Preserved with Sodium Hydroxide
Section 4.0 – Packaging and Shipping of Samples Preserved with Hydrochloric Acid
Section 5.0 – Packaging and Shipping of Samples Preserved with Nitric Acid
Section 6.0 – Packaging and Shipping of Samples Preserved with Sulfuric Acid
Section 7.0 – Packaging and Shipping of Limited Quantity Radioactive Samples

1.1 OBJECTIVE

The objective of this SOP is to outline the requirements for the packaging and shipment of environmental samples.

1.2 BACKGROUND

1.2.1 Definitions

Environmental Sample - An environmental sample is any sample that has less than reportable quantities for any hazardous constituents according to Department of Transportation (DOT) regulations promulgated in 49 CFR - Part 172.

Custody Seal – A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the sample shipping container (i.e. cooler) before offsite shipment. Custody seals are used as a protective mechanism to ensure that sample integrity is not compromised during transportation from the field to the analytical laboratory.

Secondary Containment – A secondary containment is the container that the sample is shipped in (i.e., plastic overpackaging if liquid sample is collected in glass).

Exempted Quantity – Exempted quantity is the amount of hazardous material that does not fall under DOT/IATA/ICAO regulations. This exemption is very difficult to meet; most shipments will be made under limited quantity.

Limited Quantity – Limited quantity is the maximum amount of a hazardous material for which there is a specific labeling or packaging exception.

Performance Testing – Performance testing is the required testing of outer packaging. These tests include the drop and stacking test.

Qualified Shipper – A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

1.2.2 Discussion

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis.

1.2.3 Associated Procedure

- CDM Federal SOP 1-2, Sample Custody

1.3 RESPONSIBILITIES

Field Team Leader (FTL) - The field team leader is responsible for ensuring that packaging and sampling procedures are conducted in accordance with this SOP. The field team leader is also responsible for ensuring that CDM Federal properly coordinates laboratory analysis of samples.

1.4 REQUIRED EQUIPMENT

- Coolers with return address of CDM Federal office
- Heavy-duty plastic garbage bags
- Plastic Ziploc®-type bags, small and large
- Clear tape
- Fiber tape – nylon reinforced strapping tape
- Duct tape
- Vermiculite (or equivalent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or CLP custody records, if applicable
- Completed bill of lading
- "This End Up" and directional arrow labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

1.5 PROCEDURES

The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "Environmental Sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with the appropriate health and safety coordinator or the health and safety manager should be observed.

2. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape. Line the cooler with a large heavy-duty plastic garbage bag.

3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, Sample Custody).

4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent. Note: Trip blanks must be included in coolers containing VOA samples.

5. Place 2 to 4 inches of vermiculite (or equivalent) into a cooler that has been lined with a garbage bag, and then place the bottles and cans in the bag with sufficient space to allow for the addition of more packing material between the bottles and cans. It is preferable to place glass sample bottles and jars into the cooler vertically. Due to the strength properties of a glass container, there is much less chance for breakage when the container is packed vertically rather than horizontally.

6. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place the ice bags on top of and/or between the samples. Several bags of ice are required (dependant on outdoor temperature, staging time, etc.) to maintain the cooler temperature at approximately 4° centigrade. Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large garbage bag with fiber or duct tape.

7. Place the completed chain-of-custody record or the CLP traffic report form (if applicable) for the laboratory into a plastic zip-top bag, seal the bag, tape the bag to the inner side of the cooler lid and close the cooler.

8. The cooler lid shall be secured with nylon reinforced strapping tape by wrapping each end of the cooler a minimum of two times. Attach a completed chain-of-custody seal across the hinges of the cooler on opposite sides. The custody seals should be affixed to the cooler with half of the seal on the strapping tape so that the cooler cannot be opened without breaking the seal. Complete two more wraps around with fiber tape and place clear tape over the custody seals.

9. The shipping container lid must be marked "THIS END UP" and arrow labels that indicate the proper upward position of the container should be affixed to the cooler. A label containing the name and address of the shipper (CDM Federal) shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted on the outside of containers used to transport environmental samples and shall not be used. The name and address of the laboratory shall be placed on the container, or when shipping by common courier, the bill of lading shall be completed and attached to the lid of the shipping container.

1.6 RESTRICTIONS/LIMITATIONS

The holding times for the samples packed for shipment must not be exceeded. It is recommended that samples be packed in time to be shipped nightly for overnight delivery. Use caution when shipping samples for weekend delivery; make arrangements with the laboratory before sending samples.

2.0 PACKAGING AND SHIPPING OF SAMPLES PRESERVED WITH HEXANE

2.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

2.2 BACKGROUND

2.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

2.2.2 Transportation

This section was prepared for the shipment of hexane-preserved samples.

2.2.3 Containers

- 40 ml glass VOA vials (up to 1L per outer package)

2.3 RESPONSIBILITY

It is the responsibility of the qualified shipper to ensure that each shipment contains no more than the maximum of 24 VOA vials for a total liquid volume of 1 liter and that the shipment is packaged according to IATA/ICAO packaging instruction Y305 for limited quantities of hexane.

REQUIRED EQUIPMENT

- Outer packaging (for limited quantities) insulated cooler that has passed the performance test
- Garbage bags
- Clear tape
- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (or equivalent)*
- Bubble wrap
- Ice
- Chain-of-custody seals
- Chain-of-custody form
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 3 flammable liquid labels
- Orientation labels
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

2.5 PACKAGING

The following steps are to be followed when packaging limited quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials

- Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)

- Wrap each container (40 ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble wrapped container into a 2.7 mil Ziploc®-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

HEXANES MIXTURE
UN1208
LTD. QTY.

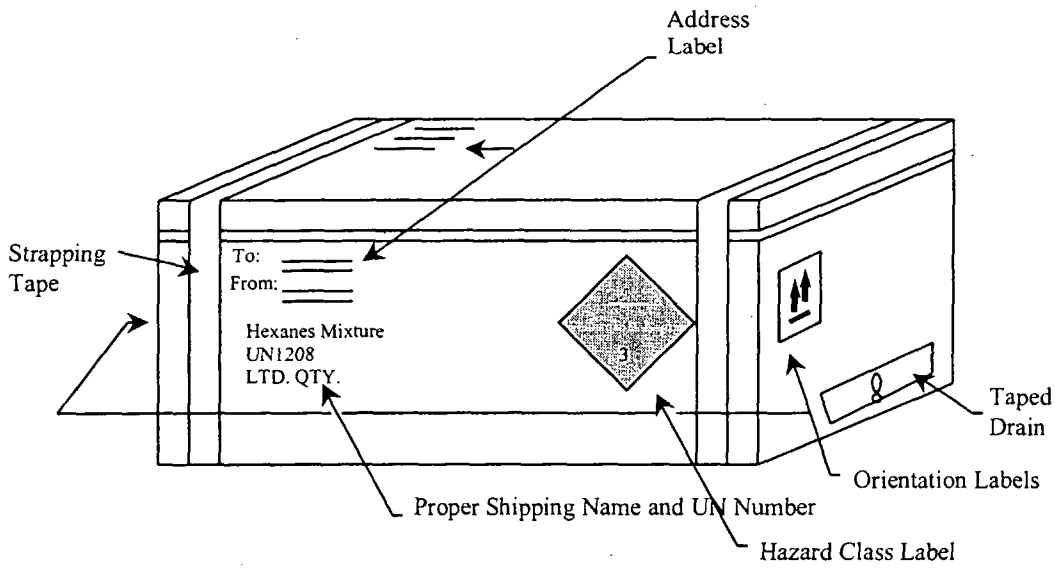
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Flammable Liquid label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

NOTE: No marking or labeling can be obscured by strapping or duct tape.

NOTE: The inner packaging of dangerous goods may be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

Figure 1 Example of Cooler Label/Marking Locations



3.0 PACKAGING AND SHIPPING OF SAMPLES PRESERVED WITH SODIUM HYDROXIDE

3.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

3.2 BACKGROUND

3.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

3.2.2 Transportation

This section was prepared for the shipment of sodium hydroxide (NaOH) preserved samples.

3.2.3 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Exempted Quantities of Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
NaOH	30%	>12	0.08%		.25	0.5	1	2

5 drops = 1 ml

3.3 RESPONSIBILITY

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

REQUIRED EQUIPMENT

- Outer packaging (for limited quantities) insulated cooler that has passed the performance test.
- Garbage bags
- Clear tape
- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (or equivalent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Chain-of-custody form

- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

3.5 PACKAGING

Samples containing NaOH as a preservative that exceed the exempted concentration of 0.08 percent (2 ml of a 30 percent per liter) will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble wrapped container into a 2.7 mil Ziploc®-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.

- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

SODIUM HYDROXIDE SOLUTION
UN1824
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

  NOTE: Samples meeting the exemption concentration of 0.08 percent NaOH by weight will be shipped as non-regulated or non-hazardous.

  NOTE: No marking or labeling can be obscured by strapping or duct tape.

  NOTE: The inner packaging of dangerous goods may be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

4.0 PACKAGING AND SHIPPING OF SAMPLES PRESERVED WITH HYDROCHLORIC ACID

4.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the *DOT Hazardous Materials Regulations* and the *IATA/ICAO Dangerous Goods Regulations* for shipment by air and applies only to domestic shipments.

4.2 BACKGROUND

4.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

4.2.2 Transportation

This section was prepared for the shipment of hydrochloric acid (HCl) preserved samples.

4.2.3 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Exempted quantities of preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
HCl	2N	<2	0.04%	.2	.5	1		

5 drops = 1 ml

4.3 RESPONSIBILITY

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

4.4 REQUIRED EQUIPMENT

- Outer packaging (for limited quantities) insulated cooler that has passed the performance test.
- Garbage bags
- Clear tape

- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (or equivalent)*
- Bubble wrap
- Ice
- Custody seals
- Chain-of-custody form
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

4.5 PACKAGING

The following steps are to be followed when packaging limited quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)
- Wrap each container (40 ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble wrapped container into a 2.7 mil Ziploc®-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.

- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

HYDROCHLORIC ACID SOLUTION
UN1789
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

NOTE: Samples meeting the exemption concentration of 0.04 percent HCl by weight will be shipped as non-regulated or non-hazardous.

NOTE: No marking or labeling can be obscured by strapping or duct tape.

NOTE: The inner packaging of dangerous goods may be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.

- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

5.0 PACKAGING AND SHIPPING OF SAMPLES PRESERVED WITH NITRIC ACID

5.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

5.2 BACKGROUND

5.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

5.2.2 Transportation

This section was prepared for the shipment of nitric acid (HNO_3) preserved samples.

5.2.3 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Exempted quantities of preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
HNO_3	6N	<2	0.15%		2	4	5	8

5 drops = 1 ml

5.3 RESPONSIBILITY

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

5.4 REQUIRED EQUIPMENT

- Outer packaging (for limited quantities) insulated cooler that has passed the performance test.
- Garbage bags
- Clear tape
- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (or equivalent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Chain-of-custody form
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

5.5 PACKAGING

Samples containing HNO_3 as a preservative that exceed the exempted concentration of 0.15% HNO_3 will be shipped as a limited quantity per packing instruction Y807 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)

- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble wrapped container into a 2.7 mil Ziploc®-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

NITRIC ACID SOLUTION (with less then 20%)
UN2031
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

NOTE: Samples meeting the exemption concentration of 0.15 percent HNO_3 by weight will be shipped as non-regulated or non-hazardous.

NOTE: No marking or labeling can be obscured by strapping or duct tape.

NOTE: The inner packaging of dangerous goods may be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

6.0 PACKAGING AND SHIPPING OF SAMPLES PRESERVED WITH SULFURIC ACID

6.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

6.2 BACKGROUND

6.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

6.2.2 Transportation

This section was prepared for the shipment of sulfuric acid (H_2SO_4) preserved samples.

6.2.3 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Exempted quantities of preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
H_2SO_4	37N	<2	0.35%	.1	.25	0.5	1	2

5 drops = 1 ml

6.3 RESPONSIBILITY

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

6.4 REQUIRED EQUIPMENT

- Outer packaging (for limited quantities) insulated cooler that has passed the performance test.
- Garbage bags
- Clear tape
- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (or equivalent)*
- Bubble wrap
- Ice
- Custody seals
- Chain-of-custody form
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

6.5 PACKAGING

Samples containing H_2SO_4 as a preservative that exceed the exempted concentration of 0.35 percent will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection

- Sample location
- Sample identification number
- Collector's initials
- Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)

- Wrap each glass container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble wrapped container into a 2.7 mil Ziploc®-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

SULFURIC ACID SOLUTION
UN2796
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

NOTE: Samples meeting the exemption concentration of 0.35 percent H_2SO_4 by weight will be shipped as non-regulated or non-hazardous.

NOTE: No marking or labeling can be obscured by strapping or duct tape.

NOTE: The inner packaging of dangerous goods may be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

7.0 PACKAGING AND SHIPPING OF LIMITED QUANTITY RADIOACTIVE SAMPLES

7.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

7.2 BACKGROUND

7.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

7.2.2 Transportation

This section was prepared for the shipment of environmental samples containing radioactive materials in limited quantities.

7.2.3 Containers

The inner packaging containers that may be used for these shipments include:

- Any size sample container

7.3 DESCRIPTION/RESPONSIBILITIES

- The qualified shipper will ship all samples that meet the Class 7 definition of radioactive materials and meet the activity requirements specified in Table 7 of 49 CFR 173.425, as Radioactive Materials in Limited Quantity. The qualified shipper will verify that all packages and their contents meet the requirements of 49 CFR 173.421, "Limited Quantities of Radioactive Materials."
- The packaging used for shipping will meet the general requirements for packaging and packages specified in 49 CFR 173.24 and the general design requirements provided in 173.410. These standards state that a package must be capable of withstanding the effects of any acceleration, vibration, or vibration resonance that may arise under normal condition of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.
- If the shipment is from a Department of Energy (DOE) facility, radiological screenings will be completed on all samples taken. The qualified shipper will review the results of each screening (alpha, beta, and gamma speciation). Samples will not be shipped offsite until the radiological screening has been performed.
- The total activity for each package will not exceed the relevant limits listed in Table 7 of 49 CFR 173.425. The A_2 value of the material will be calculated based on all radionuclides found during previous investigations (if any) in the area from which the samples are derived. The A_2 values to be used will be the most restrictive of all potential radionuclides as listed in 49 CFR 173.435.
- The radiation level at any point on the external surface of the package bearing the sample(s) will not exceed 0.005 mSv/hour (0.5 mrem/hour). These will be verified by dose and activity monitoring prior to shipment of the package.
- The removable radioactive surface contamination on the external surface of the package will not exceed the limits specified in 49 CFR 173.443(a). CDM Federal will use the DOE-established free release criteria for removable surface contamination of less than 20 dpm/100 cm^2 (alpha) and 1000 dpm/100 cm^2 (beta/gamma). It should be noted that these values are more conservative than the DOT requirements for removable surface contamination.
- The qualified shipper will verify that the outside of the inner packaging is marked "Radioactive".
- The qualified shipper will verify that the excepted packages prepared for shipment under the provisions of 49 CFR 173.421 have a notice enclosed, or shown on the outside of the package, that reads, "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910".

7.4 REQUIRED EQUIPMENT

- Cooler or other acceptable outer packaging
- Garbage bags
- Clear tape
- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (for water samples) or equivalent*
- Bubble wrap (optional)
- Ice (if necessary)
- Custody seals
- Chain-of-custody form
- Survey documentation/radiation screening results (if shipping from DOE or radiological sites)
- Orientation labels
- Exempted quantities label
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

7.5 PACKAGING

The following steps are to be followed when packaging limited quantity samples shipments.

- The cooler is to be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.

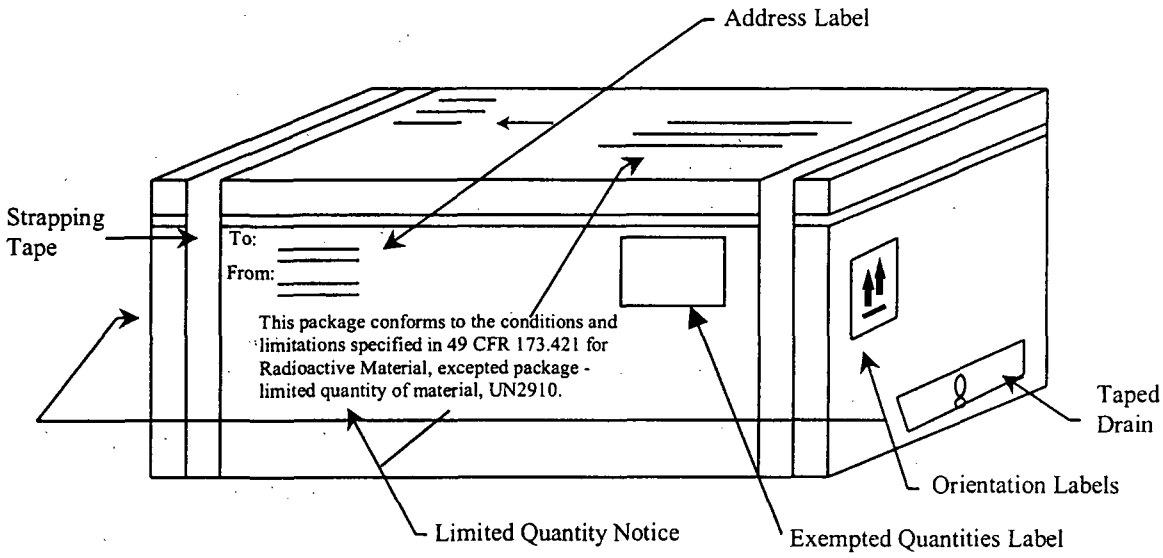
- Place sufficient amount of vermiculite, or approved packaging material, in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- If required, place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- Place a label marked "Radioactive" on the outside of the sealed bag.
- Enclose a notice that includes the name of the consignor or consignee and the following statement: "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910.
- The maximum weight of the package shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- If a cooler is used, wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix package orientation labels on two opposite sides of the cooler/package.
- Affix a completed Excepted Quantities label to the side of the cooler/package.
- Secure any marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of the cooler labeling/marking is shown in Figure 2.

NOTE: No marking or labeling can be obscured by strapping or duct tape.

- Complete the Shipment Quality Assurance Checklist (Appendix B).

NOTE: Except as provided in 49 CFR 173.426, the package will not contain more than 15 grams of ^{235}U.
NOTE: A declaration of dangerous goods is not required.

Figure 2 Radioactive Material - Limited Quantity Cooler Marking Example



8.0 REFERENCES

U.S. Environmental Protection Agency, *Sampler's Guide to the Contract Laboratory Program*, EPA/540/P-90/006, December 1990.

U.S. Environmental Protection Agency, Region IV, *Standard Operating Procedures and Quality Assurance Manual*, February 1991.

APPENDIX B
SHIPMENT QUALITY ASSURANCE CHECKLIST

Date: _____ Shipper: _____ Destination: _____

Item(s) Description: _____

Radionuclide(s): _____

Radiological Survey Results: surface _____mrem/hr 1 meter _____

Instrument Used: Mfgr: _____ Model: _____

S/N: _____ Cal Date: _____

LIMITED QUANTITY OR INSTRUMENT AND ARTICLE

Yes	No	
___	___	1. Strong tight package (package that will not leak material during conditions normally incidental to transportation).
___	___	2. Radiation levels at any point on the external surface of package less than or equal to 0.5 mrem/hr.
___	___	3. Removable surface contamination less than 20 dpm/100 cm^2 (alpha) and 1000 dpm/100 cm^2 (beta/gamma).
___	___	4. Outside inner package bears the marking "Radioactive".
___	___	5. Package contains less than 15 grams of ^{235}U (check yes if ^{235}U not present).
___	___	6. Notice enclosed in or on the package that includes the consignor or consignee and the statement, "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."
___	___	7. Activity less than that specified in 49 CFR 173.425. Permissible package limit: Package Quantity:
___	___	8. On all air shipments, the statement, Radioactive Material, excepted package-limited quantity of material shall be noted on the air waybill.

Qualified Shipper: _____ Signature: _____

PROJECT-SPECIFIC MODIFICATION

SOP Title: PACKAGING AND SHIPPING OF ENV. SAMPLES

Sop No.: 2-1
Revision: 1
Date: 6-20-01

Technical Review: [signature] QA Review: [signature]

Approved and Issued: _____
Project Manager Signature/Date

Project No. 2608-016 Client: DOT/VOLPE

Reason for and Duration of Modification: SITE-SPECIFIC CONDITIONS AND ASBESTOS SAMPLING REQUIREMENTS FOR THE LIBBY PROJECT MAKE THESE MODIFICATIONS NECESSARY FOR ALL RELATED SITES.

Modification (attach additional sheets if necessary; state section and page number when applicable):

See attached.

Samples collected during this investigation will be packaged and shipped in accordance with CDM Federal SOP 2-1 Packaging and Shipping of Environmental Samples (Appendix B), with modification. The proposed modifications to SOP 2-1 are as follows:

Section 1.4, Required Equipment - No vermiculite or other absorbent material will be used. No bubble wrap or ice will be used.

Section 1.5, Procedures - Lining the cooler with a garbage bag is determined not to be necessary since the samples will already be double-bagged. No vermiculite or other absorbent material will be used to pack the samples. No ice will be used.

FIELD LOGBOOK CONTENT AND CONTROL

Prepared: Del Baird

Technical Review: Larry Davidson

QA Review: David O. Johnson

Approved: Signature/Date

Issued: Signature/Date

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to set CDM Federal criteria for content entry and form of field logbooks. Field logbooks are an essential tool to document field activities for historical and legal purposes.

2.0 BACKGROUND

2.1 Definitions

Biota - The flora and fauna of a region.

Magnetic Declination Corrections - Compass adjustments to correct for the angle between magnetic north and geographical meridians.

2.2 Discussion

Information recorded in field logbooks includes field team names, observations, data, calculations, date/time, weather, and description of the data collection activity, methods, instruments, and results. Additionally, the logbook may contain deviations from plans and descriptions of wastes, biota, geologic material, and site features including sketches, maps, or drawings as appropriate.

3.0 RESPONSIBILITIES

Field Team Leader (FTL) - The FTL is responsible for ensuring that the format and content of data entries are in accordance with this procedure.

Site Personnel - All CDM Federal employees who make entries in field logbooks during onsite activities are required to read this procedure prior to engaging in this activity. The FTL will assign field logbooks to site personnel who will be responsible for their care and maintenance. Site personnel will return field logbooks to the records file at the end of the assignment.

4.0 REQUIRED EQUIPMENT

- Site-specific plans
- Field notebook
- Indelible black or blue ink pen
- Ruler or similar scale

5.0 PROCEDURES

5.1 Preparation

In addition to this SOP, site personnel responsible for maintaining logbooks must be familiar with all procedures applicable to the field activity being performed. These procedures should be consulted as necessary to obtain specific information about equipment and supplies, health and safety, sample collection, packaging, decontamination, and documentation. These procedures should be located at the field office.

Field logbooks shall be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the logbook. Prior to use in the field, each logbook will be marked with a specific document control number issued by the document control administrator, if required by the contract quality implementation plan (QIP). Not all contracts require document control numbers. The following information shall be recorded on the cover of the logbook:

- Field logbook document control number.
- Activity (if the logbook is to be activity-specific) and location.
- Name of CDM Federal contact and phone number(s).
- Start date.
- In specific cases, special logbooks may be required (e.g., waterproof paper for storm water monitoring).

The first few (approximately five) pages of the logbook will be reserved for a table of contents (TOC). Mark the first page with the heading and enter the following:

TABLE OF CONTENTS

Date/Description	Page
(Start Date)/Reserved for TOC	1-5

The remaining pages of the table of contents will be designated as such with "TOC" written on the top center of each page.

5.2 Operation

The following is a list of requirements that must be followed when using a logbook:

- Record work, observations, quantities of materials, calculations, drawings, and related information directly in the logbook. If data collection forms are specified by an activity-specific plan, this information need not be duplicated in the logbook. However, any forms used to record site information must be referenced in the logbook.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not erase or blot out any entry at any time. Indicate any deletion by a single line through the material to be deleted. Initial and date each deletion. Take care to not obliterate what was written previously.
- Do not remove any pages from the book.

Specific requirements for field logbook entries include:

- Initial and date each page.
- Sign and date the final page of entries for each day.
- Initial and date all changes.
- Multiple authors must sign out the logbook by inserting the following:

  Above notes authored by:
  - (Sign name)
  - (Print name)
  - (Date)

- A new author must sign and print his/her name before additional entries are made.
- Draw a diagonal line through the remainder of the final page at the end of the day.
- Record the following information on a daily basis:

  - Date and time
  - Name of individual making entry
  - Names of field team and other persons on site
  - Description of activity being conducted including station or location (i.e., well, boring, sampling location number) if appropriate
  - Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction, and speed) and other pertinent data
  - Level of personal protection to be used
  - Serial numbers of instruments
  - Required calibration information
  - Serial/tracking numbers on documentation (e.g., carrier air bills)

Entries into the field logbook shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the logbook must reference the automatic data record or form.

At each station where a sample is collected or an observation or measurement made, a detailed description of the location of the station is required. Use a compass (include a reference to magnetic declination corrections), scale, or nearby survey markers, as appropriate. A sketch of station location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is toward the top of the page. Maps, sketches, figures, or data that will not fit on a logbook page should be referenced and attached to the logbook to prevent separation.

Other events and observations that should be recorded include:

- Changes in weather that impact field activities.
- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation.
- Problems, downtime, or delays.
- Upgrade or downgrade of personal protection equipment.

5.3 Post-Operation

To guard against loss of data due to damage or disappearance of logbooks, completed pages shall be periodically photocopied (weekly, at a minimum) and forwarded to the field or project office. Other field records shall be photocopied and submitted regularly and as promptly as possible to the office. When possible, electronic media such as disks and tapes should be copied and forwarded to the project office.

At the conclusion of each activity or phase of site work, the individual responsible for the logbook will ensure that all entries have been appropriately signed and dated, and that corrections were made properly (single lines drawn through incorrect information, then initialed and dated). The completed logbook shall be submitted to the records file.

6.0 RESTRICTIONS/LIMITATIONS

Field logbooks constitute the official record of onsite technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by CDM Federal personnel and their subcontractors. They are documents that may be used in court to indicate dates, personnel, procedures, and techniques employed during site activities. Entries made in these notebooks should be factual, clear, precise, and non-subjective. Field logbooks, and entries within, are not to be utilized for personal use.

7.0 REFERENCES

Sandia National Laboratories, *Procedure for Preparing, Sampling and Analysis Plan, Site-Specific Sampling Plan, and Field Operating Procedures*, QA-02-03, Albuquerque Environmental Program Department 3220, Albuquerque, New Mexico, 1991.

Sandia National Laboratories, Division 7723, *Field Operation Procedure for Field Logbook Content and Control, Environmental Restoration Department*, Albuquerque, New Mexico, 1992.

PHOTOGRAPHIC DOCUMENTATION OF FIELD ACTIVITIES

Prepared: Del Baird

Technical Review: Larry Davidson

QA Review: David O. Johnson

Approved: Signature/Date

Issued: Signature/Date

1.0 OBJECTIVE

The purpose of this standard operating procedure (SOP) is to provide standard guidelines and methods for photographic documentation, which include still and digital photography and videotape recordings of field activities and site features (geologic formations, core sections, lithologic samples, water samples, general site layout, etc.). This document shall provide guidelines designed for use by a professional or amateur photographer. This SOP is intended for circumstances when formal photographic documentation is required. Based on project requirements, it may not be applicable for all photographic activities.

2.0 BACKGROUND

2.1 Definitions

Photographer - Camera operator (professional or amateur) of still photography, including digital photography, or videotape recording whose primary function with regard to this SOP is to produce documentary or data-oriented visual media.

Identifier Component - Visual components used within a photograph such as visual slates, reference markers, and pointers.

Standard Reference Marker - A reference marker that is used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

Slates - Blank white index cards or paper used to write information pertaining to the subject/procedure being photographed. Letters and numbers on the slate will be bold and written with black, indelible marking pens.

Arrows and Pointers - A marker used to indicate and/or draw attention to a special feature within the photograph.

Contrasting Backgrounds - Backdrop used to lay soil samples, borings, or other objects for clearer viewing and to delineate features.

Data Recording Camera Back - A camera attachment or built-in feature that will record, at the very least, frame numbers and dates directly on the film.

2.2 Discussion

Photographs and videotape recordings made during field investigations are used as an aid in documenting and describing site features, sample collection activities, equipment used, and possible lithologic interpretation. This SOP is designed to illustrate the format and desired placement of identifier components, such as visual slates, standard reference markers, and pointers. These items shall become an integral part of the "visual media" that, for the purpose of this document, shall encompass both still photographs, including digital photographs, and videotape recordings (or video footage). The use of a photographic logbook and standardized entry procedures are outlined as well. These procedures and guidelines will minimize potential ambiguities that may arise when viewing the visual media and ensure the representative nature of the photographic documentation.

2.3 Associated Procedures

- CDM Federal SOP 4-1, Field Logbook Content and Control

3.0 RESPONSIBILITIES

Field Team Leader (FTL) - The FTL is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The FTL is responsible for directing the photographer to specific situations, site features, or operations that the photographer will be responsible for documenting.

Photographer - The photographer shall seek direction from the FTL and regularly discuss the visual documentation requirements and schedule. The photographer is responsible for maintaining a logbook per Sections 5.1, 5.2.4, and 5.3.1 of this SOP.

4.0 REQUIRED EQUIPMENT

The following is a general list of equipment that may be used:

- 35mm camera or disposable single use camera (35mm or panoramic use)
- Digital camera
- Video camera
- Logbook
- Indelible black ink pen
- Standard reference markers
- Slates

- Arrows or pointers
- Contrasting backgrounds
- Medium speed, or multi purpose fine-grain, color, 35 mm, negative film or slide film (project dependent)
- Data recording camera back (if available)
- Storage disk for digital camera

5.0 PROCEDURES

5.1 Documentation

A commercially available, bound logbook will be used to log and document photographic activities. Review the CDM Federal SOP 4-1 Field Logbook Content and Control and prepare all supplies needed for logbook entries.

Note: A separate photographic logbook is not required. A portion of the field logbook may be designated as the photographic log section.

5.1.1 Field - Health and Safety Considerations

There are no hazards that an individual will be exposed to specific to photographic documentation. However, site-specific hazards may arise depending on location or operation. Personal protective equipment used in this operation will be site-specific and dictated through requirements set by the site safety officer, site health and safety plan, and/or prescribed by the CDM Federal Corporate Health and Safety Program. The photographer should contact the site safety officer for health and safety orientation prior to commencing field activities. The site health and safety plan must be read prior to entry to the site, and all individuals must sign the appropriate acknowledgement that this has been done.

The photographer should be aware of any potential physical hazards while photographing the subject (e.g., low overhead hazard, edge of excavation).

5.2 OPERATION

5.2.1 General Photographic Activities in the Field

The following sections provide general guidelines that should be followed to visually document field activities and site features using still cameras and video equipment. Listed below are general suggestions that the photographer should consider when performing activities under this SOP:

- The photographer should be prepared to make a variety of shots, from closeup to wide-angle. Many shots will be repetitive in nature or format especially closeup site feature photographs. Consideration should therefore be given to designing a system or technique that will provide a reliable repetition of performance.
- All still photographs should be made using a medium speed, or multi purpose fine-grain, color negative film in the 35 mm format unless otherwise directed by the FTL.
- It is suggested that Kodak brand "Ektapress Gold Deluxe" film or equivalent be used as the standard film for the still photography requirements of the field activities. This film is stable at room temperature after exposure and will better survive the time lag between exposure and processing. It is suggested that film speed ASA 100 should be used for outdoor photographs in bright sunlight, ASA 200 film should be used in cloudy conditions, and ASA 400 film should be used indoors or for very low-light outdoor photographs.
- No preference of videotape brand is specified and is left to the discretion of the photographer.
- The lighting for sample and feature photography should be oriented toward a flat condition with little or no shadow. If the ambient lighting conditions are inadequate, the photographer should be prepared to augment the light (perhaps with reflectors or electronic flash) to maintain the desired visual effect.
- Digital photography quality is determined by the camera. A camera that obtains a higher resolution has a higher number of pixels and will store a fewer number of photographs per each disk.

5.2.2 General Guidelines for Still Photography

Each new roll of film, digital storage disk, and videotape shall contain upon the first usable frame (for film) or at the beginning of the tape (for video), a slate with consecutively assigned control numbers (a consecutive, unique number that is assigned by the photographer to each roll of film or videotape, as in sample numbers).

Caption Information

All still photographs will have a full caption permanently attached to the back containing the following information (digital photographs should have a caption added after the photographs are downloaded):

- Film roll control number and photograph document control number
- Date and time
- Direction
- Photographed by

A standard reference marker should be used in all documentary visual media. While the standard reference marker will predominantly be used in closeup feature documentation, inclusion in all scenes should be considered.

Digital media should be downloaded at least once each day. Downloads are considered equivalent to a roll of film and should be documented as such.

Closeup and Feature Photography

All closeup photographs will include a standard reference marker of appropriate size as an indication of the feature size and should contain a slate marked with the site name and any identifying label, such as a well number or core depth, that clearly communicates to the viewer the specific feature being photographed.

Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their in situ locations. This enables a more accurate record of their initial condition and color. Include a standard reference color strip (color chart such as Munsell Soil Color Chart or that available from Eastman Kodak Co.) within the scene. This is to be included for the benefit of the viewer of the photographic document and serves as a reference aide to the viewer for lithologic observations and interpretations.

The photographer will permanently attach a caption containing pertinent information to the photograph after it has been produced and prior to submitting it to the project files.

Site Photography

Site photography, in general, will consist predominantly of medium and wide-angle shots. A standard reference marker should be placed adjacent to the feature or, when this is not possible, within the same focal plane.

While it is encouraged that a standard reference marker and caption/slate be included in the scene, it is understood that situations will arise that preclude their inclusion within the scene. This will be especially true of wide-angle shots. In such a case, the film/tape control number shall be entered in the photographic logbook along with the frame number and all other information pertinent to the scene.

The photographer will permanently attach a caption containing this information to the photograph after it has been produced and prior to submitting it to the project files.

Panoramic

In situations where a wide-angle lens does not provide sufficient subject detail, a single-use disposable panoramic camera is recommended. If this type of camera is not available, a panoramic series of two or three photos would be appropriate. Panoramics can provide greater detail while covering a wide subject, such as an overall shot of a site.

To shoot a panoramic series using a standard 35mm camera, the following procedure is recommended.

- Utilizing a stable surface or tripod to support the camera is recommended.
- 20 - 30 percent from overlap while maintaining a uniform horizon is suggested.
- 2 to 3 photos per series is recommended.

5.2.3 General Photographic Documentation Using Video Cameras

As a reminder, it is not within the scope of this document to set guidelines for presentation or "show" videotape recording. The following guidelines are set for documentary videotape recordings only and should be implemented at the discretion of the FTL.

All documentary videotape recordings of field activities shall include an audio slate for all scenes. At the beginning of each video session, an announcer will recite the following information: date, time (in military units), photographer, site ID number, and site location. This oral account should include any additional information clarifying the subject matter being recorded.

A standard reference marker should be used when taking closeup shots of site features with a video camera. The scene should also include a caption/slate. It shall be placed adjacent and parallel to the feature being photographed.

It is strongly encouraged that a standard reference marker and caption/slate be included in all scenes. The caption information is vital to the value of the documentary visual media and should be included. If it is not included within the scene, it should be placed before the scene.

Original videotape recordings will not be edited. This will maintain the integrity of the information contained on the videotape. If editing is desired, a working copy of the original videotape recording can be made.

5.2.4 Photographic Documentation

Photographic activities must be documented in a photographic logbook or in a section of the field logbook. Each logbook will be assigned a document control number. The photographer will be responsible for making proper entries.

In addition to following the technical standards for logbook entry as referenced in CDM Federal SOP 4-1, the following information should be maintained in the appropriate logbook:

- An entry shall be made for each new roll/tape control number assigned. Include information that is recorded on the film/tape control slate (the site location, FTL's name, photographer name, and date).
- A description of the general setup, including approximate distance between the camera and the subject, will be recorded in the logbook. Include pertinent information that is necessary to provide a complete and full caption for each scene.

- The laboratory used for photographic processing will be recorded (if known) in the logbook.
- Document all situations encountered that cause an interruption in the progress of photographic activities under this SOP.
- Record as much other information as possible to assist in the identification of the photographic document.

5.3 Post Operation

All film will be sent for development and printing to a predetermined photographic laboratory (to be determined by the photographer). The photographer will be responsible for arranging transport of the film from the field to the photographic laboratory. The photographer shall also be responsible for delivery of the negatives and photographs or videotape to the project management.

5.3.1 Documentation

At the end of each day's photographic session, the photographer(s) will ensure that the appropriate logbook has been completely filled out and maintained as outlined in CDM Federal SOP 4-1.

5.3.2 Archive Procedures

1. All rolls of film, videotape recordings, digital media, and photographs should be considered controlled documents. Therefore, all photographs and the associated set of negatives, digital media, and original unedited documentary videotape recordings will be submitted to the project files and handled accordingly. The FTL will ensure their proper distribution.

2. Based on specific project requirements, the photographer will assign each roll of film, digital media, or photograph a control number. Film control numbers may be photographed on the first usable frame of the film and permanently attached to the negative sleeve/holders. Control numbers for photographs may contain the control number of the film or digital media and the frame number from which the photograph was made and be written on the back of the photograph. All control numbers will be written with black indelible ink.

3. Original videotape footage shall be assigned a document control number. Videotapes must have a document control number written on the tape case as well as the videotape cassette. All document control numbers will be written with black indelible ink. Original video footage shall not be edited but may be copied.

4. Completed pages of the appropriate logbook will be copied weekly and submitted to the project files.

6.0 RESTRICTIONS/LIMITATIONS

This document is designed to provide a set of guidelines for the field amateur or professional photographer to ensure that an effective and standardized program of visual documentation is maintained.

It is not within the scope of this document to provide instruction in photographic procedures, nor is it within the scope of this document to set guidelines for presentation or "show" photography.

The procedures outlined herein are general by nature. The FTL is responsible for specific operational activity or procedure. Questions concerning specific procedures or requirements should be directed to the FTL.

7.0 REFERENCES

Sandia National Laboratories, *Procedure for Preparing Sampling and Analysis Plans, Site-Specific Sampling Plans, and Field Operating Procedures*, QA-02-03, Environmental Programs Department 3220, Albuquerque, New Mexico, 1991.

Sandia National Laboratories, Division 7723, *Field Operating Procedure for Field Logbook Content and Control*, PRO 92-04, Environmental Restoration Department, Albuquerque, New Mexico, 1992.

U.S. Department of Energy, Yucca Mountain Project, *Branch Technical Procedure: Field Logging, Handling, and Documenting Borehole Samples*, Las Vegas, Nevada, 1989.

FIELD EQUIPMENT DECONTAMINATION AT NONRADIOACTIVE SITES

Prepared: Steven Fundingsland

Technical Review: Darwin Nelson

QA Review: George DeLullo

Approved: 12/27/00
Signature/Date

Issued: Rose Mary Gustin 12/27/00
Signature/Date

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to describe the procedures required for decontamination of field equipment.

2.0 BACKGROUND

2.1 Definitions

Clean - Free of visible contamination and when decontamination has been completed in accordance with this SOP.

Cross-Contamination - The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or non-contaminated samples or areas.

Decontamination - The process of rinsing or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross contamination of samples or exposure of personnel.

2.2 Discussion

Decontamination of field equipment is necessary to ensure the quality of samples by preventing cross contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants off-site.

3.0 RESPONSIBILITIES

Field Team Leader - The Field Team Leader (FTL) ensures that field personnel are trained in the performance of this procedure and that decontamination is conducted in accordance with this procedure. The FTL may also be required to collect and document rinsate samples to provide quantitative verification that these procedures have been correctly implemented.

4.0 REQUIRED EQUIPMENT

- Stiff-bristle scrub brushes
- Plastic buckets and troughs
- Laboratory-grade detergent (low phosphate)
- Nalgene or Teflon Sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting
- Disposable wipes, rags or paper towels
- Potable water and/or de-ionized water and/or American Society for Testing and Materials (ASTM) Type II or better, as defined by ASTM Standard Specification for Reagent Water, Standard D 1193-77 (re-approved 1983)*
- Gloves, safety glasses, and other protective clothing as specified in the site-specific health and safety plan
- High-pressure pump with soap dispenser or steam-spray unit (for large equipment only)
- Appropriate decontamination solutions pesticide grade or better and traceable to a source (e.g. 10% and/or 1% nitric acid (HNO_3), acetone, methanol, isopropanol, hexane)
- Tools for equipment assembly and disassembly (as required)
- 55-gallon drums or tanks (as required)
- Pallets for drums or tanks holding decontamination water (as required)

* Potable, de-ionized, and ASTM Type II water may be required to be tested for contaminants before use. Check field plan for requirements.

5.0 PROCEDURES

All reusable equipment (non-dedicated) used to collect, handle, or measure samples will be decontaminated before coming into contact with any sample. Decontamination of equipment will occur either at the central decontamination station or at portable decontamination stations set up at the sampling location, drill sites, or monitoring well locations. The centrally located decontamination station will include an appropriately sized bermed area on which equipment decontamination will occur and shall be equipped with a collection system and storage vessels. In certain circumstances, berming is not required when small quantities of water are being generated and for some short duration field activities (i.e., pre-remedial sampling). Equipment should be transported to the decontamination station in a manner to prevent cross-contamination of equipment and/or area. Precautions taken may include enclosing augers in plastic wrap while being transported on a flatbed truck.

The decontamination area will be constructed so that contaminated water is either collected directly into appropriate containers (5-gallon buckets or steel wash tubs) or within the berms of the decontamination area which then drains into a collection system. Water from the collection system will be transferred into 55-gallon drums or portable tanks for storage. Typically, decontamination water will be staged until sampling results or waste characterization results are obtained and evaluated and the proper disposition of the waste is determined. The exact procedure for decontamination waste disposal should be discussed in the field plan. Also, decontamination fluids, such as solvents may need to be segregated from other investigation derived wastes.

All items that will come into contact with potentially contaminated media will be decontaminated before use and between sampling and/or drilling locations. If decontaminated items are not immediately used, they will be covered either with plastic or aluminum foil depending on the size of the item. All decontamination procedures for the equipment being used are as follows:

General Guidelines

- Potable and de-ionized water should be free of all contaminants of concern. Following the field plan, analytical data from the water source may be required. If required, either existing analytical data from the water source supplier (i.e., municipality, bottled water company, de-ionized water producer) may be obtained or chemical testing may be performed on the selected source.

- Soap will be a low phosphate detergent.

- Sampling equipment that has come into contact with oil and grease will be cleaned with methanol or other approved alternative to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Regulatory or client requirements will be stated in the field plan.

- Decontaminated equipment will be allowed to air dry before being used.

- Documentation for all cleaning will be recorded in the appropriate logbook.

- All solvents will be pesticide grade or better and traceable to a source. The corresponding lot numbers will be recorded in the appropriate logbook.

- Gloves, boots, safety glasses, and any other personnel protective clothing and equipment will be used as specified in the site-specific health and safety plan.

5.1 Heavy Equipment Decontamination

Heavy equipment includes drilling rigs and backhoes. Follow these steps when decontaminating this equipment:

1. Establish a decontamination area with berms that is large enough to fully contain the equipment to be cleaned. If available, an existing wash pad or appropriate paved and bermed area may be utilized; otherwise, use one or more layers of heavy plastic sheeting to cover the ground surface and berms. All decontamination pads should be upwind of the area under investigation.

2. With the rig in place, spray areas (rear of rig or backhoe) exposed to contaminated soils using a hot water high-pressure sprayer. Be sure to spray down all surfaces, including the undercarriage.

3. Use brushes, low phosphate detergent and potable water to remove dirt whenever necessary.

4. Remove equipment from the decontamination pad and allow it to air dry before returning it to the work site.

5. Record equipment type, date, time, and method of decontamination in the appropriate logbook.

6. After decontamination activities are completed, collect all contaminated wastewater, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal as detailed in the field plan. Liquids and solids must be drummed separately.

5.2 Downhole Equipment Decontamination

Downhole equipment decontamination includes hollow-stem augers, drill pipes, casings, screens, etc. Follow these steps when decontaminating this equipment:

1. Set up a centralized decontamination area, if possible. This area should be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.

2. Set up a "clean" area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. All decontamination pads should be upwind of any areas under investigation.

3. Place the object to be cleaned on aluminum foil or plastic-covered wooden sawhorses or other supports.

4. Using low phosphate detergent and potable water in the hot water high-pressure sprayer (or steam unit), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.

5. If using soapy water, rinse the equipment using clean, potable water. If using hot water, the rinse step is not necessary if the hot water does not contain a detergent. If the hot water contains a detergent, this final clean water rinse is required.

6. Using the manual-pump sprayer, rinse the equipment thoroughly with de-ionized water (ASTM Type II or better).

7. Remove the equipment from the decontamination area and place in a clean area upwind to air dry.

8. Record equipment type, date, time, and method of decontamination in the appropriate logbook.

9. After decontamination activities are completed, collect all contaminated wastewaters, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal. Liquids and solids must be drummed separately.

5.3 Sampling Equipment Decontamination

Sampling equipment includes split spoons, spatulas, and bowls used for sample homogenization that directly contact sample media. Follow these steps when decontaminating this equipment:

1. Set up a decontamination line on plastic sheeting. The decontamination line should progress from "dirty" to "clean" and have an area located upwind for drying decontaminated equipment. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or the surfaces on which decontaminated equipment is to be placed for drying.

2. Before washing, disassemble any items that might trap contaminants internally. Do not reassemble these items until decontamination and air-drying are complete. Wash items thoroughly in a bucket of low phosphate detergent and potable water. Use a stiff-bristle brush to dislodge any gross contamination (soil or debris).

3. Rinse the item in potable water. Rinse water should be replaced as needed, generally when cloudy.

4. Using a hand sprayer, wash bottles, or manual-pump sprayer, rinse the item with de-ionized water (ASTM Type II or better).

5. If required by the site-specific field plans, rinse the item with 10% nitric acid (for stainless steel, glass, plastic, and Teflon), or 1% nitric acid (for items made of low-carbon steel) followed by a de-ionized water (ASTM Type II or better) rinse.

   NOTE: Care should be taken not to get nitric acid on skin or clothing. This step should not be used unless required by sampling needs as dictated in the field plan.

   CAUTION: Do not allow nitric acid to contact methanol or hexane. Contain nitric acid waste separate from organic solvents.

6. If sampling for organic analytes, rinse the item with methanol or approved organic solvent.

7. Rinse the item with de-ionized water (ASTM Type II or better).

8. If required by the field plan, when sampling for polar organic compounds such as pesticides, polychlorinated biphenyls (PCBs), and fuels, rinse the item with hexane or approved alternatives, followed by a second methanol rinse.

9. Allow the item to air dry completely.

10. After drying, wrap the clean item in plastic wrap or in aluminum foil, shiny side out.

11. Record equipment type, date, time, and method of decontamination in the appropriate logbook.

12. After decontamination activities are completed, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable gloves, boots, and clothing. Place contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately. (Refer to site-specific plans for labeling and waste management requirements).

5.4 Pump Decontamination

Follow the manufacturer's recommendation for specified pump decontamination procedures. At a minimum follow these steps when decontaminating pumps:

7.0 REFERENCES

Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures For Site Characterization*, DOE/HWP-100/R1, September 1996.

Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements For Field Methods*, DOE/HWP-69/R2, September 1996.

American Society for Testing and Materials, *Standard Practice for Decontamination of Field Equipment at Nonradioactive Waste Sites*, ASTM D5088-90, June 29, 1990.

U.S. Environmental Protection Agency, Region II, "*CERCLA" Quality Assurance Manual*, Revision 1, 1989.

U.S. Environmental Protection Agency, Region IV, *Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual*, 1986.

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.1, 1987.

PROJECT-SPECIFIC MODIFICATION

Sop No.: 4-5
Revision: 4
Date: 12-18-00

SOP Title: Field Equipment Decontamination at Non-Radioactive Sites

Technical Review: Frank R. [illegible] QA Review: [illegible] 5/17/01

Approved and Issued: _____
Project Manager Signature/Date

Project No. 2603-015 Client: VOLPE CENTER - DOT

Reason for and Duration of Modification: Site-specific conditions and asbestos sampling requirements for the Libby Project make these modifications necessary for all related sites.

Modification (attach additional sheets if necessary; state section and page number when applicable):

Equipment used to collect, handle, or measure waste/product samples will be decontaminated in accordance with CDM Federal SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites, with modification (Appendix B). The following modifications to SOP 4-5 have been reviewed and approved:

Section 5.0, Procedures - Decontamination water will not be captured and will be discharged to the ground at the site.

Section 5.3, Sampling Equipment Decontamination - ASTM Type II DI water will not be used. Rather, locally available DI water will be used. Decontamination water will be discharged to the ground at the site.

Section 5.6, Waste Disposal - Decontamination water will not be captured and will not be packaged, labeled, or stored as investigation-derived waste.

The decontamination procedure for non-disposable equipment will consist of a tap water and alconox wash with brush scrubbing, followed by a tap water rinse, and final DI water rinse. The equipment will then allowed to air-dry before being wrapped in clean plastic or aluminum foil. All equipment will be decontaminated before coming into contact with any sample. Rinse water will be discharged to the ground at the site. Any deviations from the decontamination procedures will be recorded in the appropriate field logbook.

Appendix D

Site Health and Safety Plan

Health and Safety Plan Form	Environmental Protection Agency -- Region 8 --	CDM Federal Programs Corporation Project Document No.:

Project Name	Libby Asbestos Project - Emergency Response	**Work Assignment No.**	Task Orders 9, 13, & 16	**Region** 8
Job Site Address	501 Mineral Avenue	**Client**	US DOT Volpe National Transportation Systems Center	
	Libby, Montana 59923	**Project**	Libby, Montana, Asbestos Removal	
Site Contact	Dave Schroeder	**EPA Client Contact**	Paul Peronard, EPA OSC	
Phone No.	406-293-8595 or 406-293-3568	**Phone No.**	303-312-6808	

■ **Amendment No.** 4 **to Existing Approved HSP - Date Existing Approved HSP** 8-24-2000

Objectives of Field Work:

The purpose of this sampling effort is to acquire information useful for the design of more comprehensive environmental exposure investigations to assess the magnitude and extent of residential exposure to toxicologically relevant asbestos fibers and to provide construction oversight of remedial activities.

Remedial activities include excavation of test pits, excavation, handling and trucking of asbestos contaminated soils, building demolitions, equipment and personnel decontamination confirmatory soil sampling, air sampling and related activities at the Screening Plant Site (OU2) and Export Plant Site (OU1).

Type: Check as many as applicable

☐ Active	☐ Landfill	☐ Unknown
■ Inactive	■ Uncontrolled	☐ Military
■ Secure	■ Industrial	■ Other **specify**: Closed vermiculite mine
☐ Unsecure	☐ Recovery	
☐ Enclosed space	☐ Well Field	

Description and Features: Summarize below. Include principal operations and unusual features (containers, buildings, dikes, power lines, hills, slopes, river)

The town of Libby is located in the northwest corner of Montana. According to historical mining records, 80 percent of the world's vermiculite came from the Zonolite Mountains in Libby, Montana. Vermiculite is used in various building materials and textiles. The scope of this health and safety plan will address the processes of remediating asbestos-containing material (ACM) from the following sites:

W. R. Grace Screening Plant
KDC Development Properties
Libby High School, Junior High School, and Elementary
Residential Locations
Stimson Lumber Company

These operations will involve removal action oversight, soil sampling, and residential air sampling.

Surrounding Population: ■ Residential ■ Industrial ■ Rural ☐ Urban ☐ Other:

This Page Reserved for Map (Show Exclusion, Contamination Reduction, and Support Zones. Indicate evacuation and reassembly points.)

Site Location Map

History: Summarize below. In addition to history, include complaints from public, previous agency actions, known exposures or injuries, etc.

Asbestos was released into the air during more than six decades of vermiculite mining at Zonolite Mountain, three miles east of Libby. The Zonolite Mine began operation in 1924 by owner Edward Alley. In 1925, Great Northern Railroad shipped the first boxcar of "Zonolite" from Libby to an Ohio company that used it to insulate bank vaults, office safes, and filing cabinets. Other firms used the material to make building boards and roofing materials. Processing the material was a straightforward process. The vermiculite ore was stripped from the mine and hauled in trucks to a mill, where it was separated into various commercial sizes through a screening system. Some of the ore was shipped untouched. Other material was sent to an expansion plant where it was run through ovens at about 2,000 degrees, causing it to expand to 15 times its original size. In 1939, Zonolite merged with another company mining at the bottom of the hill that eventually became known as the Zonolite Co. In 1963, the company was sold to W.R. Grace and Co. who expanded the operation and increased production. Through the '60s, '70s, and '80s, millions of tons of vermiculite ore was hauled by rail to Grace plants and other companies in 30 states and six foreign countries. At one time, 80 percent of the world's vermiculite came from Libby. The W.R. Grace Company, which owned the mine for 30 years, closed it in 1990 and sold the property four years later.

Waste Types: ☐ Liquid ■ Solid ☐ Sludge ☐ Gas ☐ Unknown ☐ Other **Specify**:

Waste Characteristics: Check as many as applicable.

☐ Corrosive ☐ Flammable ☐ Radioactive*
■ Toxic ☐ Volatile ☐ Reactive
☐ Inert Gas ☐ Unknown ■ Other **specify**: Carcinogenic

*Based on available information there is no evidence that this site has received or used radioactive substances. None are described in facility processes.

Work Zones: Describe the Exclusion, Contamination Reduction, and Support Zones in terms onsite personnel will recognize.

Work zones will be established during sampling activities. The exclusion zone will be in close proximity to removal activities, sampling areas, and residences. The contamination reduction zone will include an equipment and/or personal decontamination station. The support zone will be considered the 10-foot perimeter around support vehicles.

Hazards of Concern:

■ Heat Stress attach guidelines ☐ Noise:
■ Cold Stress attach guidelines ☐ Inorganic Chemicals
☐ Explosive/Flammable ☐ Organic Chemicals
☐ Oxygen Deficient ■ Motorized Traffic
☐ Radiological ■ Heavy Machinery:
■ Biological: snakes, spiders ■ Slips, Trips and Falls
■ Other **Specify**: Inhalation of particulate matter

Principle Disposal Methods and Practices: **Summarize below:**

The mine on Zonolite Mountain is now dormant and most of the buildings have been dismantled. Raw vermiculite was graded, sorted, and stored at the screening plant and conveyed to a railroad loading area. Vermiculite was heated or "popped" at the export plant. The vermiculite product was then loaded onto railroad cars for distribution. Waste piles of potential asbestos-containing material (ACM) remain onsite at present. Potential ACM was distributed in the Libby area as home insulation, garden amendments, and fill dirt for a number of sites, including schools.

Hazardous Material Summary: Circle waste type and estimate amounts by category

Chemicals Amounts/Units:	*Solids Amounts/Units:*	*Sludges Amounts/Units:*	*Solvents Amounts/Units:*	*Oils Amounts/Units:*	*Other Amounts/Units:*
☐ Acids	☐ Flyash	☐ Paint	☐ Halogenated (chloro, bromo)	☐ Oily Wastes	☐ Laboratory
☐ Pickling Liquors	■ Asbestos	☐ Pigments	☐ Solvents	☐ Gasoline	☐ Pharmaceutical
☐ Caustics	■ Milling/Mine Tailings	☐ Metal Sludges	☐ Hydrocarbons	☐ Diesel Oil	☐ Hospital
☐ Pesticides	☐ Ferrous Smelter	☐ POTW Sludge	☐ Alcohols	☐ Lubricants	☐ Radiological
☐ Dyes/Inks	☐ Non-ferrous Smelter	☐ Aluminum	☐ Ketones	☐ PCBS	☐ Municipal
☐ Cyanides	☐ Metals:	☐ Distillation Bottoms	☐ Esters	☐ Polynuclear Aromatics	☐ Construction
☐ Phenols			☐ Ethers		☐ Munitions
☐ Halogens	☐ Other	☐ Other	☐ Other	☐ Other	☐ Other
☐ Dioxins	**Specify: Fe, Mn, Ni, Cd, Zn, Pb, Cu, Ag, Cr**	**Specify:**	**Specify: Trichloroethene (TCE), Tetrachloroethylene (PCE), cis-1,2 dichloroethene (DCE), trans-1,2 DCE**	**Specify:**	**Specify:**
■ Other **Specify: Arsenic dissolved in groundwater**					

Overall Hazard Evaluation: ☐ High ☐ Medium ■ Low ☐ Unknown (Where tasks have different hazards, evaluate each. Attach additional sheets if necessary)

Justification: Air sampling results from last year's activities (2000) and to date (2001) have indicated low asbestos concentrations (≤ 10 percent of PEL/TWA). Care will be taken by all site personnel to avoid unnecessarily agitating suspect materials. PPE prescriptions are adequate to address current potential hazards. Review of recently acquired data and information will be completed as obtained.

Fire/explosion Potential: ☐ High ☐ Medium ■ Low ☐ Unknown

Background Review: ■ Complete ☐ Incomplete

Known Contaminants	Highest Observed Concentration (specify units and media)	PEL/TLV ppm or mg/m³ (specify)	IDLH ppm or mg/m³ (specify)	Excursion Limit (≤30 minutes)	Symptoms/Effects of Acute Exposure	Photoionization Potential
Asbestos	5 to 7 percent in the waste piles	0.1 f/cc*/ 0.01 f/cc**	N/A	1.0 f/cc	Irritated eyes, mucous membranes, and respiratory system	N/A
Asbestos	4.481 f.cc***	0.1 f/cc*/ 0.01 f/cc**	N/A	1.0 f/cc	Irritated eyes, mucous membranes, and respiratory system	N/A

ACGIH = American Conference of Government Industrial Hygienists
CA = Human carcinogen
CAS = Chemical Abstract Service
IDLH = Immediately Dangerous to Life and Health (NIOSH standard enforced by law)
LEL = Lower Explosive Limit
mg/m³ = milligrams per cubic meter
NE = Not established
NIOSH = National Institute for Occupational Safety and Health
OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Limit (OSHA-established workplace standards enforced by law)
ppm = parts per million
STEL = Short Term Exposure Limit (15 minute TWA)
TLV = Threshold Limit Values (Recommended by ACGIH)
TWA = Time-Weighted Average (Average concentration for a normal 8-hour working day or 40-hour working week)
µg/kg = micrograms per kilogram
µg/ = micrograms per Liter

* = personal air monitoring
** = ambient/perimeter reoccupancy
*** = cutting hole in ceiling - 30 minute excursion

Field Activities Covered under this Plan				*Hazard*
Task Description/specific Technique-Standard Operating Procedures/Site Location(attach additional sheets as necessary)	*Type*	*Primary*	*Contingency*	*Schedule*
1 Soil Sampling -	Intrusive	Level C - Modified	Exit Area	Hazard Risk: LOW
	Non-Intrusive			Date: 2001
2 Residential Dust/Air Sampling - Scenario 1 - Air sampling during routine household activities (e.g., all activities except active cleaning).	Intrusive	Level D - Modified	Level D or Exit Area	Hazard Risk: LOW
	Non-Intrusive			Date: 2001
3 Residential Dust/Air Sampling - Scenario 2 - Air sampling during active household activities (e.g., vacuuming, sweeping, and dusting).	Intrusive	Level C - Modified	Exit Area	Hazard Risk: LOW
	Non-Intrusive			Date: 2001
4 Residential Dust/Air Sampling - Scenario 3 - Sampling during simulated house remodeling activities (e.g., removing insulation, replumbing, etc.).	Intrusive	Level C - Modified	Level B - Modified	Hazard Risk: MED
	Non-Intrusive			Date: 2001
5 Removal Action Oversight/Air Sampling -	Intrusive	Level C - Modified	Level C or Exit Area	Hazard Risk: LOW
	Non-Intrusive			Date: 2001
6 Residential Dust/Air Sampling - Scenario 4 - Sampling during garden rototilling activities.	Intrusive	Level C - Modified	Exit Area	Hazard Risk: LOW
	Non-Intrusive			Date: 2001
7 Direct Push Technology (DPT) Soil Sampling	Intrusive	Level C - Modified	Exit Area	Hazard Risk:
	Non-Intrusive			Date:

Personnel and Responsibilities (Include subcontractors)

Name	Firm/Region	CDM Federal Health Clearance	Responsibilities	Onsite Involvement
Dave Schroeder	CDM Federal	Yes	Work Assignment Manager	Tasks 1 - 7
Douglas J. Updike	CDM Federal -	Yes	Site Health and Safety Coordinator	Tasks 1 - 7
Noel Anderson	CDM Federal -	Yes	Alternate Site H&S Coordinator	Tasks 1 - 7
Angela Fransden	CDM Federal -	Yes	Sample Coordinator	Administrative
Dee Warren	CDM Federal -	Yes	Sample Coordinator	Administrative
Terry Keller	CDM Federal -	Yes	Sample Coordinator	Administrative
David Michailof	CDM Federal -	Yes	Field Team Leader	Tasks 1 - 7
Tom Thornburgh	CDM Federal -	Yes	Staff	Tasks 1 - 7
Tommy Cook	CDM Federal -	Yes	Staff	Tasks 1 - 7
Anni Autio	CDM Federal -	Yes	Assistant Project Manager	Administrative
Brian Scott Pyles	CDM Federal -	Yes	Staff	Tasks 1 - 7

Protective Equipment: Specify by task. Indicate type and/or material as necessary. Use copies of this sheet if needed.

Block A — **Tasks: 1** — **Level: C - Modified** — ■ **Primary** ☐ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
■ APR:
■ Cartridge: P100
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
■ Safety Glasses:
☐ Face Shield:
☐ Goggles:
☐ Hard Hat: For drilling and CPT/DPT activities
☐ Other:

Boots: ☐ Not Needed
■ Boots: **Leather steel-toed safety boots**
☐ Overboots:
☐ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
■ Tyvek Coverall: if needed
☐ Cloth Coverall: Cotton as needed
☐ Other: Long pants & long-sleeved shirt

Gloves: ☐ Not Needed
☐ Undergloves:
■ Gloves: Nitrile or surgical/latex.
☐ Overgloves:

☐ Other - specify below:

Block B — **Tasks: 1** — **Level: Exit Area** — ☐ **Primary** ■ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
☐ APR:
☐ Cartridge: P100
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
☐ Safety Glasses:
☐ Face Shield:
☐ Goggles:
☐ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: **Leather steel-toed safety boots**
☐ Overboots:
☐ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
☐ Tyvek Coverall:
☐ Cloth Coverall: Cotton as needed
☐ Other: Long pants & long-sleeved shirt

Gloves: ☐ Not Needed
☐ Undergloves:
☐ Gloves: nitrile or surgical/latex
☐ Overgloves:

■ Other - specify below:
Exit Area

Block C — **Tasks: 2** — **Level: D - Modified** — ■ **Primary** ☐ **Contingency**

Respiratory: ■ Not Needed
☐ SCBA, Airline:
☐ APR:
☐ Cartridge:
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
☐ Safety Glasses:
☐ Face Shield:
☐ Goggles:
☐ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
■ Boots: **Leather steel-toed safety boots**
☐ Overboots:
☐ Rubber:

Prot. Clothing: ■ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
☐ Tyvek Coverall:
☐ Cloth Coverall:
☐ Other:

Gloves: ■ Not Needed
☐ Undergloves:
☐ Gloves:
☐ Overgloves:

☐ Other - specify below:

Block D — **Tasks: 2** — **Level:** — ☐ **Primary** ■ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
☐ APR:
☐ Cartridge:
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
☐ Safety Glasses:
☐ Face Shield:
☐ Goggles:
☐ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: Leather steel-toed work boots
☐ Overboots:
☐ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
☐ Tyvek Coverall:
☐ Cloth Coverall:
☐ Other:

Gloves: ☐ Not Needed
☐ Undergloves:
☐ Gloves:
☐ Overgloves:

■ Other - specify below:
Exit Area

Protective Equipment: Specify by task. Indicate type and/or material as necessary. Use copies of this sheet if needed.

Block A — **Tasks: 3** — **Level: C** — ■ **Primary** ☐ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
■ APR:
■ Cartridge: P100
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
■ Safety Glasses:
☐ Face Shield:
☐ Goggles:
■ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: **Leather steel-toed safety boots**
■ Overboots:
■ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
■ Tyvek Coverall: if needed
☐ Cloth Coverall: Cotton as needed
☐ Other: Long pants & long-sleeved shirt

Gloves: ☐ Not Needed
☐ Undergloves:
■ Gloves: Nitrile or surgical/latex.
☐ Overgloves:

☐ Other - specify below:

Block B — **Tasks: 3** — **Level: C- Modified** — ☐ **Primary** ■ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
☐ APR:
☐ Cartridge: P100
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
☐ Safety Glasses:
☐ Face Shield:
☐ Goggles:
☐ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: **Leather steel-toed safety boots**
☐ Overboots:
☐ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
☐ Tyvek Coverall:
☐ Cloth Coverall: Cotton as needed
☐ Other: Long pants & long-sleeved shirt

Gloves: ☐ Not Needed
☐ Undergloves:
☐ Gloves: nitrile or surgical/latex
☐ Overgloves:

■ Other - specify below:
Exit Area

Block C — **Tasks: 4** — **Level: B - Modified** — ■ **Primary** ☐ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
☐ APR:
☐ Cartridge:
☐ Escape Mask:
■ Other: PAPA

Head and Eye: ☐ Not Needed
■ Safety Glasses:
☐ Face Shield:
☐ Goggles:
■ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: **Leather steel-toed safety boots**
■ Overboots:
■ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
■ Tyvek Coverall:
☐ Cloth Coverall:
☐ Other:

Gloves: ☐ Not Needed
☐ Undergloves:
■ Gloves: Leather
☐ Overgloves:

■ Other - specify below: Each Scenario 3 requires an activity-specific health and safety plan

Block D — **Tasks: 4** — **Level:** — ☐ **Primary** ■ **Contingency**

Respiratory: ☐ Not Needed
■ SCBA, Airline:
☐ APR:
☐ Cartridge:
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
■ Safety Glasses:
☐ Face Shield:
☐ Goggles:
■ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: Leather steel-toed work boots
■ Overboots:
■ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
■ Tyvek Coverall:
☐ Cloth Coverall:
☐ Other:

Gloves: ☐ Not Needed
☐ Undergloves:
■ Gloves: Leather
☐ Overgloves:

☐ Other - specify below:

Protective Equipment: Specify by task. Indicate type and/or material as necessary. Use copies of this sheet if needed.

Block A — **Tasks: 5** — **Level: D - Modified** — ■ **Primary** ☐ **Contingency**

Respiratory: ■ Not Needed
☐ SCBA, Airline:
☐ APR:
☐ Cartridge:
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
■ Safety Glasses:
☐ Face Shield:
☐ Goggles:
■ Hard Hat:
■ Other: Orange traffic vest

Boots: ☐ Not Needed
■ Boots: **Leather steel-toed safety boots**
☐ Overboots:
☐ Rubber:

Prot. Clothing: ■ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
☐ Tyvek Coverall: if needed
☐ Cloth Coverall: Cotton as needed
☐ Other: Long pants & long-sleeved shirt

Gloves: ■ Not Needed
☐ Undergloves:
☐ Gloves: Nitrile or surgical/latex.
☐ Overgloves:

☐ Other - specify below:

Block B — **Tasks: 5** — **Level: C- Modified** — ☐ **Primary** ■ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
■ APR:
■ Cartridge: P100
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
■ Safety Glasses:
☐ Face Shield:
☐ Goggles:
■ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: **Leather steel-toed safety boots**
■ Overboots:
■ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
■ Tyvek Coverall:
☐ Cloth Coverall: Cotton as needed
☐ Other: Long pants & long-sleeved shirt

Gloves: ☐ Not Needed
☐ Undergloves:
■ Gloves: nitrile or surgical/latex
☐ Overgloves:

■ Other - specify below: **All activities which occur within the exclusion zone require entry/egress through the decon trailer.**

Block C — **Tasks: 6** — **Level: C - Modified** — ■ **Primary** ☐ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
■ APR:
■ Cartridge: P100
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
■ Safety Glasses:
☐ Face Shield:
☐ Goggles:
■ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: **Leather steel-toed safety boots**
■ Overboots:
■ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
■ Tyvek Coverall:
☐ Cloth Coverall:
☐ Other:

Gloves: ☐ Not Needed
☐ Undergloves:
■ Gloves: Leather
☐ Overgloves:

☐ Other - specify below:

Block D — **Tasks: 6** — **Level:** — ☐ **Primary** ■ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
☐ APR:
☐ Cartridge:
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
☐ Safety Glasses:
☐ Face Shield:
☐ Goggles:
☐ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: Leather steel-toed work boots
☐ Overboots:
☐ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
☐ Tyvek Coverall:
☐ Cloth Coverall:
☐ Other:

Gloves: ☐ Not Needed
☐ Undergloves:
☐ Gloves:
☐ Overgloves:

■ Other - specify below: **Exit Area**

Protective Equipment: Specify by task. Indicate type and/or material as necessary. Use copies of this sheet if needed.

Block A — **Tasks: 7** — **Level: C - Modified** — ■ **Primary** ☐ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
■ APR:
■ Cartridge: P100
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
■ Safety Glasses:
☐ Face Shield:
☐ Goggles:
☐ Hard Hat: For drilling and CPT/DPT activities
☐ Other:

Boots: ☐ Not Needed
■ Boots: **Leather steel-toed safety boots**
☐ Overboots:
☐ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
■ Tyvek Coverall: if needed
☐ Cloth Coverall: Cotton as needed
☐ Other: Long pants & long-sleeved shirt

Gloves: ☐ Not Needed
☐ Undergloves:
■ Gloves: Nitrile or surgical/latex.
☐ Overgloves:

☐ Other - specify below:

Block B — **Tasks: 7** — **Level: Exit Area** — ☐ **Primary** ■ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
☐ APR:
☐ Cartridge: P100
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
☐ Safety Glasses:
☐ Face Shield:
☐ Goggles:
☐ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: **Leather steel-toed safety boots**
☐ Overboots:
☐ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
☐ Tyvek Coverall:
☐ Cloth Coverall: Cotton as needed
☐ Other: Long pants & long-sleeved shirt

Gloves: ☐ Not Needed
☐ Undergloves:
☐ Gloves: nitrile or surgical/latex
☐ Overgloves:

■ Other - specify below:
Exit Area

Block C — **Tasks:** — **Level:** — ☐ **Primary** ☐ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
☐ APR:
☐ Cartridge:
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
☐ Safety Glasses:
☐ Face Shield:
☐ Goggles:
☐ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: **Leather steel-toed safety boots**
☐ Overboots:
☐ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
☐ Tyvek Coverall:
☐ Cloth Coverall:
☐ Other:

Gloves: ☐ Not Needed
☐ Undergloves:
☐ Gloves:
☐ Overgloves:

☐ Other - specify below:

Block D — **Tasks:** — **Level:** — ☐ **Primary** ☐ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline:
☐ APR:
☐ Cartridge:
☐ Escape Mask:
☐ Other:

Head and Eye: ☐ Not Needed
☐ Safety Glasses:
☐ Face Shield:
☐ Goggles:
☐ Hard Hat:
☐ Other:

Boots: ☐ Not Needed
☐ Boots: Leather steel-toed work boots
☐ Overboots:
☐ Rubber:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit:
☐ Splash Suit:
☐ Apron
☐ Tyvek Coverall:
☐ Cloth Coverall:
☐ Other:

Gloves: ☐ Not Needed
☐ Undergloves:
☐ Gloves:
☐ Overgloves:

☐ Other - specify below:

Monitoring Equipment: Specify by task. Indicate type as necessary. Attach additional sheets as necessary.

Instrument	*Task*	*Action Guidelines*		*Comments (Include schedules of use)*
Combustible Gas Indicator	1 - 7	0-10% LEL 10-25% LEL **>25% LEL** 21.0% O_2 <21.0% O_2 **<19.5% O_2**	No explosion hazard Potential explosion hazard; notify SHSC. **Explosion hazard; interrupt task/evacuate** Oxygen normal Oxygen deficient; notify SHSC **Interrupt task/evacuate**	■ Not Needed Oxygen-deficient or other dangerous atmospheres are not expected to be encountered during site work. Entrance into confined spaces where toxic gases could be concentrated is strictly forbidden.
Radiation Survey Meter Type _____	1 - 7	3X Background **>2mR/hr**	Notify SHSO and CDM Federal HSM, establish REZ **Interrupt task/evacuate**	■ Not Needed
Photoionization Detector Type _____ ☐ 11.7 eV ☐ 10.2 eV ☐ 9.8 eV ☐ ___ eV	1 - 7	**Specify:** **Detectable Odor**	**If odor of any kind is detected, cease work, move to fresh air.**	■ Not Needed If further work is necessary in the area where odors are detected, personnel protection will be evaluated.
Flame Ionization Detector Type _____	1 - 7	**Specify:**		■ Not Needed If further work is necessary in the area where odors are detected, personnel protection will be evaluated.
Detector Tubes/Monitor Type _____ Type _____	1 - 7	**Specify:**		■ Not Needed Toxic gases are not expected to be encountered. Entrance into confined spaces where toxic gases could be concentrated is strictly forbidden.
Respirable Dust Monitor Type _____ Type _____	1 - 7	**Specify:**		■ Not Needed If dusty conditions persist, site will be abandoned and personnel protection reevaluated.
Other **Specify: Visible or nuisance dust and/or unusual vapors (odors)**	1 - 7	**Specify: If team notices unusual odors, heavy dust, or irritation of the eyes or throat, they will exit area and reevaluate personnel protection.**		

Decontamination Procedures

Personalized Decontamination

Wash well before hand to mouth contact is made. A shower will be taken as soon as possible after leaving the field. Workers will remove protective clothing in this order:

(1) wash overboots in soapy water and rinse
(2) remove overboots or booties
(3) remove gloves
(4) remove safety glasses
(5) remove Tyvek or cloth coverall, if used
(6) remove respirator, if used
(7) remove inner gloves
(8) wash hands/face before eating/drinking

☐ Not Needed

Sampling Equipment Decontamination

See CDM Federal SOP 4-5. All sampling equipment will be thoroughly decontaminated as follows:

(1) wash and scrub with low phosphate detergent
(2) potable tap water rinse
(3) potable tap water rinse
(4) thoroughly rinse with deionized water
(5) air dry
(6) wrap in aluminum foil for transport

☐ Not Needed

Heavy Equipment Decontamination

Exclusion Zone Egress Decontamination

(1) wash overboots
(2) remove overboots
(3) hang safety vest and hard hat in exclusion area equipment drop room
(4) enter decon trailer dirty room
(5) remove Tyvek coveralls
(6) enter shower and clean respirator
(7) remove respirator after thorough cleaning
(8) complete personal decon
(9) dry with disposable towels
(10) proceed to clean room, dress, and exit

Note - All doors on the decon trailer must remain closed in order to maintain negative pressure

☐ Not Needed

Containment and Disposal Method

All disposable PPE will be double-bagged prior to disposal. Decon water to be disposed onsite.

☐ Not Needed

Containment and Disposal Method

Decon water to be disposed onsite.

☐ Not Needed

Containment and Disposal Method

All disposable PPE will be double-bagged prior to disposal.

☐ Not Needed

Hazardous Materials Inventory (Investigation-Associated Substances: Attach MSDS)

Preservatives

☐ Hydrochloric Acid (HCl)
☐ Nitric Acid (HNO_3)
☐ Sulfuric Acid (H_2SO_4)
☐ Sodium Hydroxide (NaOH)
☐ Zinc Acetate (ZnOAc)
☐ Ascorbic Acid
☐ Other:
☐ Other:

Decontamination

☐ Alconox™
☐ Liquinox™
☐ Acetone
☐ Methanol
☐ Mineral Spirits
☐ Hexane
☐ Isopropanol
☐ Nitric Acid
■ Other: Water

Calibration Gases and Fluids

☐ Isobutylene
☐ Methane
☐ Pentane
☐ Hydrogen
☐ Propane
☐ pH Standard
☐ Conductivity Standard
☐ Other
☐ Other

*If standard field clothes are used, the clothing must be kept separate from all personal articles and washed before it is reused. Under no circumstance can soiled clothing be donned at the beginning of each work day. Any article of clothing that becomes unusually soiled during field activities must be replaced with a clean item.

Emergency Contacts	
Water Supply	NA
Site Telephone	1-406-293-8595
EPA Release Report No.	1-800-424-8802
CDM 24-Hour Emergency Chuck Myers	(cell) 1-571-216-7004
Facility Management	NA
Other (Specify) Health & Safety Mgr.	Chuck Myers (home) 1-703-754-0700 SHSO 1-406-293-3567
CHEMTREC Emergency	1-800-424-9300

Emergency Contacts	Name	Phone
Health and Safety Manager	Chuck Myers, CIH	1-703-968-0900
Site Manager	Dave Schroeder	1-406-293-3388
Health & Safety Coordinator	Noel Anderson Douglas J. Updike	1-406-293-3567 1-816-412-3149
DOT Contact	John McGuiggin	1-617-494-2574
EPA Contact	Paul Peronard	1-303-312-6808
Environmental Agency		1-800-234-5677
Health Department		1-406-293-7881
Sheriff's Department	Lincoln County	911
State Spill Line		911
Fire Department		911
Police Department - Libby		911
State Police	Highway Patrol	1-800-525-5555
Poison Control Center		1-800-525-5042
Occupational Physician	Dr. Edward Barnes	1-800-229-3674

Contingency Plans Summarize below:

Evacuate site if any unexpected hazardous conditions are encountered. If staff observe hazards for which they have not been prepared, they will withdraw from the area and call CDM Federal Health and Safety. CDM Federal personnel will leave the site and upgrade their level of protection if they experience nausea or dizziness. No volatile compounds are expected to be encountered at concentrations dangerous to human health. If any odors are noted, work will cease and personnel protection reevaluated. In the event of medical emergency, contact Hospital, Police, or Sheriff's Department. If respirable dust is noted, additional engineering controls will be implemented. If these controls do not eliminate the exposure, personnel protection will be reevaluated.

Medical Emergency

Hospital Name: St. John's Lutheran Hospital	911
Hospital Address: 350 Louisiana Avenue	
Name of Contact at Hospital: NA	
Name of 24-Hour Ambulance:	911

Health and Safety Plan Approvals

Prepared by: Doug Updike	Date: 10-24-2001
SHSO Signature:	Date:
HSM Signature:	Date:
For: Chuck Myers, CIH	

Route to Hospital (Attach map with route to hospital)

See the attached map (Page 13) to the hospital. Become familiar with location of hospital prior to any site activities.

Directions to the hospital will vary depending on where you are located in the site area. The hospital is located at the intersection of Louisiana and 4th Avenue.

Site: Libby, Montana, Asbestos Removal

Distance to Hospital: Variable

This Page Reserved for Hospital Route Map

The following personnel have read and fully understand the contents of this Health and Safety Plan and further agree to all requirements contained herein.

Site: Libby, Montana, Asbestos Removal | **Project No.:**

Name and Responsibility	Affiliation	Date	Signature
Dave Schroeder	CDM Federal Programs Corporation		
Anni Autio	CDM Federal Programs Corporation		
Douglas Updike	CDM Federal Programs Corporation		
Noel Anderson	CDM Federal Programs Corporation		
Angela Fransden	CDM Federal Programs Corporation		
Dee Warren	CDM Federal Programs Corporation		
Terry Keller	CDM Federal Programs Corporation		
David Michailof	CDM Federal Programs Corporation		
Tom Thornburgh	CDM Federal Programs Corporation		
Tommy Cook	CDM Federal Programs Corporation		
Brian Scott Pyles	CDM Federal Programs Corporation		

Appendix E
Laboratory Analytical Methods

EPA Standard Operating Procedures

SOP 2015 Asbestos Sampling

ASTM DESIGNATION: D 5755-95

D 5755-95 Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by TEM for Asbestos Structure Number Concentrations

1.0 SCOPE AND APPLICATION

Asbestos has been used in many commercial products including building materials such as flooring tiles and sheet goods, paints and coatings, insulation, and roofing asphalts. These products and others may be found at hazardous waste sites hanging on overhead pipes, contained in drums, abandoned in piles, or as part of a structure. Asbestos tailing piles from mining operations can also be a source of ambient asbestos fibers. Asbestos is a known carcinogen and requires air sampling to assess airborne exposure to human health. This Standard Operating Procedure (SOP) provides procedures for asbestos air sampling by drawing a known volume of air through a mixed cellulose ester (MCE) filter. The filter is then sent to a laboratory for analysis. The U.S. Environmental Protection Agency/Environmental Response Team (U.S. EPA/ERT) uses one of four analytical methods for determining asbestos in air. These include: U.S. EPA's Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air for Transmission Electron Microscopy (TEM)[1]; U.S. EPA's Modified Yamate Method for TEM[2]; National Institute for Occupational Safety and Health (NIOSH) Method 7402 (direct method only) for TEM; and NIOSH Method 7400 for Phase Contrast Microscopy (PCM)[3]. Each method has specific sampling and analytical requirements (i.e., sample volume and flow rate) for determining asbestos in air.

The U.S. EPA/ERT typically follows procedures outlined in the TEM methods for determining mineralogical types of asbestos in air and for distinguishing asbestos from non-asbestos minerals. The Phase Contrast Microscopy (PCM) method is used by U.S. EPA/ERT as a screening tool since it is less costly than TEM. PCM cannot distinguish asbestos from non-asbestos fibers, therefore the TEM method may be necessary to confirm analytical results. For example, if an action level for the presence of fibers has been set and PCM analysis indicates that the action level has been exceeded, then TEM analysis can be used to quantify and identify asbestos structures through examination of their morphology crystal structures (through electron diffraction), and elemental composition (through energy dispersive X-ray analysis). In this instance samples should be collected for both analyses in side by side sampling trains (some laboratories are able to perform PCM and TEM analysis from the same filter). The Superfund method is designed specifically to provide results suitable for supporting risk assessments at Superfund sites, it is applicable to a wide range of ambient air situations at hazardous waste sites. U.S. EPA's Modified Yamate Method for TEM is also used for ambient air sampling due to high volume requirements. The PCM and TEM NIOSH analytical methods require lower sample volumes and are typically used indoors; however, ERT will increase the volume requirement for outdoor application.

Other Regulations pertaining to asbestos have been promulgated by U.S. EPA and OSHA. U.S. EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) regulates asbestos-containing waste materials. NESHAP establishes management practices and standards for the handling of asbestos and emissions from waste disposal operations (40 CFR Part 61, Subparts A and M). U.S. EPA's 40 CFR 763 (July 1, 1987)[4] and its addendum 40 CFR 763 (October 30, 1987)[4] provide comprehensive rules for the asbestos abatement industry. State and local regulations on these issues vary and may be more stringent than federal requirements. The OSHA regulations in 29 CFR 1910.1001 and 29 CFR 1926.58 specify work practices and safety equipment such as respiratory protection and protective clothing when handling asbestos. The OSHA standard for an 8-hour, time-weighted average (TWA) is 0.2 fibers/cubic centimeters of air. This standard pertains to fibers with a length-to-width ratio of 3 to 1 with a fiber length >5 μm[5,6]. An action level of 0.1 fiber/cc (one-half the OSHA standard) is the level U.S. EPA has established in which employers must initiate such activities as air monitoring, employee training, and

medical surveillance[5,6].

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Prior to sampling, the site should be characterized by identifying on-site as well as off-site sources of airborne asbestos. The array of sampling locations and the schedule for sample collection, is critical to the success of an investigation. Generally, sampling strategies to characterize a single point source are fairly straightforward, while multiple point sources and area sources increase the complexity of the sampling strategy. It is not within the scope of this SOP to provide a generic asbestos air sampling plan. Experience, objectives, and site characteristics will dictate the sampling strategy.

During a site investigation, sampling stations should be arranged to distinguish spatial trends in airborne asbestos concentrations. Sampling schedules should be fashioned to establish temporal trends. The sampling strategy typically requires that the concentration of asbestos at the source (worst case) or area of concern (downwind), crosswind, as well as background (upwind) contributions be quantified. See Table 1 (Appendix A) for U.S. EPA/ERT recommended sampling set up for ambient air. Indoor asbestos sampling requires a different type of strategy which is identified in Table 2 (Appendix A). It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks can be utilized to determine other sources.

Much information can be derived from each analytical method previously mentioned. Each analytical method has specific sampling requirements and produce results which may or may not be applicable to a specific sampling effort. The site sampling objectives should be carefully identified so as to select the most appropriate analytical method. Additionally, some preparation (i.e., lot blanks results) prior to site sampling may be required, these requirements are specified in the analytical methods.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Sample Preservation

No preservation is required for asbestos samples.

3.2 Sample Handling, Container and Storage Procedures

1. Place a sample label on the cassette indicating a unique sampling number. Do not put sampling cassettes in shirt or coat pockets as the filter can pick up fibers. The original cassette box is used to hold the samples.

2. Wrap the cassette individually in a plastic sample bag. Each bag should be marked indicating sample identification number, total volume, and date.

3. The wrapped sampling cassettes should be placed upright in a rigid container so that the cassette cap is on top and cassette base is on bottom. Use enough packing material to prevent jostling or damage. Do not use vermiculite as packing material for samples. If possible, hand carry to lab.

4. Provide appropriate documentation with samples (i.e., chain of custody and requested analytical methodology).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Flow rates exceeding 16 liters/minute (L/min) which could result in filter destruction due to (a) failure of its physical support under force from the increased pressure drop; (b) leakage of air around the filter mount so that the filter is bypassed, or (c) damage to the asbestos structures due to increased impact velocities.

4.1 U.S. EPA's Superfund Method

4.1.1 Direct-transfer TEM Specimen Preparation Methods

Direct-Transfer TEM specimen preparation methods have the following significant interferences:

- The achievable detection limit is restricted by the particulate density on the filter, which in turn is controlled by the sampled air volume and the total suspended particulate concentration in the atmosphere being sampled.

- The precision of the result is dependent on the uniformity of the deposit of asbestos structures on the sample collection filter.

- Air samples must be collected so that they have particulate and fiber loadings within narrow ranges. If too high a particulate loading occurs on the filter, it is not possible to prepare satisfactory TEM specimens by a direct-transfer method. If too high a fiber loading occurs on the filter, even if satisfactory TEM specimens can be prepared, accurate fiber counting will not be possible.

4.1.2 Indirect TEM Specimen Preparation Methods

Indirect TEM specimen preparation methods have the following interferences:

- The size distribution of asbestos structures is modified.

- There is increased opportunity for fiber loss or introduction of extraneous contamination.

- When sample collection filters are ashed, any fiber contamination in the filter medium is concentrated on the TEM specimen grid.

It can be argued that direct methods yield an under-estimate of the asbestos structure concentration because many of the asbestos fibers present are concealed by other particulate material with which they are associated. Conversely, indirect methods can be considered to yield an over-estimate because some types of complex asbestos structures disintegrate during the preparation, resulting in an increase in the numbers of structures counted.

4.2 U.S. EPA's Modified Yamate Method for TEM

High concentrations of background dust interfere with fiber identification.

4.3 NIOSH Method for TEM

Other amphibole particles that have aspect ratios greater than 3:1 and elemental compositions similar to the asbestos minerals may interfere in the TEM analysis. Some non-amphibole minerals may give electron diffraction patterns similar to amphiboles. High concentrations of background dust interfere with fiber identification.

4.4 NIOSH Method for PCM

PCM cannot distinguish asbestos from non-asbestos fibers; therefore, all particles meeting the counting criteria are counted as total asbestos fibers. Fiber less than 0.25 um in length will not be detected by this method. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

5.0 EQUIPMENT/MATERIALS

5.1 Sampling Pump

The constant flow or critical orifice controlled sampling pump should be capable of a flow-rate and pumping time sufficient to achieve the desired volume of air sampled.

The lower flow personal sampling pumps generally provide a flow rate of 20 cubic centimeters/minute (cc/min) to 4 L/min. These pumps are usually battery powered. High flow pumps are utilized when flow rates between 2 L/min to 20 L/min are required. High flow pumps are used for short sampling periods so as to obtain the desired sample volume. High flow pumps usually run on AC power and can be plugged into a nearby outlet. If an outlet is not available then a generator should be obtained. The generator should be positioned downwind from the sampling pump. Additional voltage may be required if more than one pump is plugged into the same generator. Several

electrical extension cords may be required if sampling locations are remote.

The recommended volume for the Superfund method (Phase I) requires approximately 20 hours to collect. Such pumps typically draw 6 amps at full power so that 2 lead/acid batteries should provide sufficient power to collect a full sample. The use of line voltage, where available, eliminates the difficulties associated with transporting stored electrical energy.

A stand should be used to hold the filter cassette at the desired height for sampling and the filter cassette shall be isolated from the vibrations of the pump.

5.2 Filter Cassette

The cassettes are purchased with the required filters in position, or can be assembled in a laminar flow hood or clean area. When the filters are in position, a shrink cellulose band or adhesive tape should be applied to cassette joints to prevent air leakage.

5.2.1 TEM Cassette Requirements

Commercially available field monitors, comprising 25 mm diameter three-piece cassettes, with conductive extension cowls shall be used for sample collection. The cassette must be new and not previously used. The cassette shall be loaded with an MCE filter of pore size 0.45 µm, and supplied from a lot number which has been qualified as low background for asbestos determination. The cowls should be constructed of electrically conducting material to minimize electrostatic effects. The filter shall be backed by a 5 µm pore size MCE filter (Figure 1, Appendix B).

5.2.2 PCM Cassette Requirements

NIOSH Method 7400, PCM involves using a 0.8 to 1.2 µm mixed cellulose ester membrane, 25 mm diameter, 50 mm conductive cowl on cassette (Figure 2, Appendix B). Some labs are able to perform PCM and TEM analysis on the same filter; however, this should be discussed with the laboratory prior to sampling.

5.3 Other Equipment

- Inert tubing with glass cyclone and hose barb
- Whirlbags (plastic bags) for cassettes
- Tools - small screw drivers
- Container - to keep samples upright
- Generator or electrical outlet (may not be required)
- Extension cords (may not be required)
- Multiple plug outlet
- Sample labels
- Air data sheets
- Chain of Custody records

6.0 REAGENTS

Reagents are not required for the preservation of asbestos samples.

7.0 PROCEDURES

7.1 Air Volumes and Flow Rates

Sampling volumes are determined on the basis of how many fibers need to be collected for reliable measurements. Therefore, one must estimate how many airborne fibers may be in the sampling location.

Since the concentration of airborne aerosol contaminants will have some effect on the sample, the following is a suggested criteria to assist in selecting a flow rate based on real-time aerosol monitor (RAM) readings in milligrams/cubic meter (mg/m^3).

	Concentration	Flow Rate
• Low RAM readings:	<6.0 mg/m^3	11-15. L/min
• Medium RAM readings:	>6.0 mg/m_3	7.5 L/min
• High RAM readings:	>10. mg/m^3	2.5 L/min

In practice, pumps that are available for environmental sampling at remote locations operate under a maximum load of approximately 12 L/min.

7.1.1 U.S. EPA's Superfund Method

The Superfund Method incorporates an indirect preparation procedure to provide flexibility in the amount of deposit that be can be tolerated on the sample filter and to allow for the selective concentration of asbestos prior to analysis. To minimize contributions to background contamination from asbestos present in the plastic matrices of membrane filters while allowing for sufficient quantities of asbestos to be collected, this method also requires the collection of a larger volume of air per unit area of filter than has traditionally been collected

for asbestos analysis. Due to the need to collect large volumes of air, higher sampling flow rates are recommended in this method than have generally been employed for asbestos sampling in the past. As an alternative, samples may be collected over longer time intervals. However, this restricts the flexibility required to allow samples to be collected while uniform meteorological conditions prevail.

The sampling rate and the period of sampling should be selected to yield as high a sampled volume as possible, which will minimize the influence of filter contamination. Wherever possible, a volume of 15 cubic meters (15,000 L) shall be sampled for those samples intended for analysis only by the indirect TEM preparation method (Phase 1 samples). For those samples to be prepared by both the indirect and the direct specimen preparation methods (Phase 2 samples), the volumes must be adjusted so as to provide a suitably-loaded filter for the direct TEM preparation method. One option is to collect filters at several loadings to bracket the estimated optimum loading for a particular site. Such filters can be screened in the laboratory so that only those filters closest to optimal loading are analyzed. It has been found that the volume cannot normally exceed 5 cubic meters (5000 L) in an urban or agricultural area, and 10 cubic meters (10,000 L) in a rural area for samples collected on a 25 mm filter and prepared by a direct-transfer technique.

An upper limit to the range of acceptable flow rates for this method is 15 L/min. At many locations, wind patterns exhibit strong diurnal variations. Therefore, intermittent sampling (sampling over a fixed time interval repeated over several days) may be necessary to accumulate 20 hours of sampling time over constant wind conditions. Other sampling objectives also may necessitate intermittent sampling. The objective is to design a sampling schedule so that samples are collected under uniform conditions throughout the sampling interval. This method provides for such options. Air volumes collected on Phase I samples are maximized (<16 L/min). Air volumes collected on Phase 2 samples are limited to provide optimum loading for filters to be prepared by a direct-transfer procedure.

7.1.2 U.S. EPA's Modified Yamate Method for TEM

U.S. EPA's TEM method requires a minimum volume of 560 L and a maximum volume of 3,800 L in order to obtain an analytical sensitivity of 0.005 structures/cc. The optimal volume for TEM is 1200 L to 1800 L. These volumes are determined using a 200 mesh EM grid opening with a 25-mm filter cassette. Changes in volume would be necessary if a 37-mm filter cassette is used since the effective area of a 25 mm (385 sq mm) and 37 mm (855 sq m) differ.

7.1.3 NIOSH Method for TEM and PCM

The minimum recommended volume for TEM and PCM is 400 L at 0.1 fiber/cc. Sampling time is adjusted to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for eight hours (700 to 2800 L) is appropriate in non-dusty atmospheres containing 0.1 fiber/cc. Dusty atmospheres i.e., areas with high levels of asbestos, require smaller sample volumes (<400 L) to obtain countable samples.

In such cases, take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3,000 to 10,000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If > 50% of the filter surface is covered with particles, the filter may be too overloaded to count and will bias the measured fiber concentration. Do not exceed 0.5 mg total dust loading on the filter.

7.2 Calibration Procedures

In order to determine if a sampling pump is measuring the flow rate or volume of air correctly, it is necessary to calibrate the instrument. Sampling pumps should be calibrated immediately before and after each use. Preliminary calibration should be conducted using a primary calibrator such as a soap bubble type calibrator, (e.g., a Buck Calibrator, Gilibrator, or equivalent primary calibrator) with a representative filter cassette installed between the pump and the calibrator. The representative sampling cassette can be reused for calibrating other pumps that will be used for asbestos sampling. The same cassette lot used for sampling should also be used for the calibration. A sticker should be affixed to the outside of the extension cowl marked "Calibration Cassette."

A rotameter can be used provided it has been recently precalibrated with a primary calibrator. Three separate constant flow calibration readings should be obtained both before sampling and after sampling. Should the flow rate change by more than 5% during the sampling period, the average of the pre- and post-calibration rates will be used to calculate the total sample volume. The sampling pump used shall provide a non-fluctuating air-flow through the filter, and shall maintain the initial volume flow-rate to within ± 10% throughout the sampling period. The mean value of these flow-rate measurements shall be used to calculate the total air volume sampled. A constant flow or critical orifice controlled pump meets these requirements. If at any time the measurement indicates that the flow-rate has decreased by more than 30%, the sampling shall be terminated. Flexible tubing is used to connect the filter cassette to the sampling pump.Sampling pumps can be calibrated prior to coming on-site so that time is saved when performing on-site calibration.

7.2.1 Calibrating a Personal Sampling Pump with an Electronic Calibrator

1. See Manufacturer's manual for operational instructions.

2. Set up the calibration train as shown in (Figure 3, Appendix B) using a sampling pump, electronic calibrator, and a representative filter cassette. The same lot sampling cassette used for sampling should also be used for calibrating.

3. To set up the calibration train, attach one end of the PVC tubing (approx. 2 foot) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the electronic calibrator.

4. Turn the electronic calibrator and sampling pump on. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.

5. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

6. Perform the calibration three times until the desired flow rate of ± 5% is attained.

7.2.2 Calibrating a Rotameter with an Electronic Calibrator

1. See manufacturer's manual for operational instructions.

2. Set up the calibration train as shown in (Figure 4, Appendix B) using a sampling pump, rotameter, and electronic calibrator.

3. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6° vertical.

4. Turn the electronic calibrator and sampling pump on.

5. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.

6. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

7. Record the electronic calibrator flow rate reading and the corresponding rotameter reading. Indicate these values on the rotameter (sticker). The rotameter should be able to work within the desired flow range. Readings can also be calibrated for 10 cm^3 increments for Low Flow rotameters, 500 cm^3 increments for medium flow rotameters and 1 liter increments for high flow rotameters.

8. Perform the calibration three times until the desired flow rate of ± 5% is attained. Once on site, a secondary calibrator, i.e., rotameter may be used to calibrate sampling pumps.

7.2.3 Calibrating a Personal Sampling Pump with a Rotameter

1. See manufacturer's manual for Rotameter's Operational Instructions.

2. Set up the calibration train as shown in (Figure 5, Appendix B) using a rotameter, sampling pump, and a representative sampling cassette.

3. To set up the calibration train, attach one end of the PVC tubing (approx. 2 ft) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the rotameter.

4. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6° vertical.

5. Turn the sampling pump on.

6. Turn the flow adjust screw (or knob) on the personal sampling pump until the float ball on the rotameter is lined up with the precalibrated flow rate value. A sticker on the rotameter should indicate this value.

7. A verification of calibration is generally performed on-site in the clean zone immediately prior to the sampling.

7.3. Meteorology

It is recommended that a meteorological station be established. If possible, sample after two to three days of dry weather and when the wind conditions are at 10 mph or greater. Record wind speed, wind direction, temperature, and pressure in a field logbook. Wind direction is particularly important when monitoring for asbestos downwind from a fixed source.

7.4 Ambient Sampling Procedures

7.4.1 Pre-site Sampling Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling equipment and ensure it is in working order and fully charged (if necessary).

3. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety plan.

4. Once on-site the calibration is performed in the clean zone. The calibration procedures are listed in Section 7.2.

5. After calibrating the sampling pump, mobilize to the sampling location.

7.4.2 Site Sampling

1. To set up the sampling train, attach the air intake hose to the cassette base. Remove the cassette cap (Figure 6 and 7, Appendix B). The cassette should be positioned downward, perpendicular to the wind

2. If AC or DC electricity is required then turn it on. If used, the generator should be placed 10 ft. downwind from the sampling pump.

3. Record the following in a field logbook: date, time, location, sample identification number, pump number, flow rate, and cumulative time.

4. Turn the pump on. Should intermittent sampling be required, sampling filters must be covered between active periods of sampling. To cover the sample filter: turn the cassette to face upward, place the cassette cap on the cassette, remove the inlet plug from the cassette cap, attach a rotameter to the inlet opening of the cassette cap to measure the flow rate, turn off the sampling pump, place the inlet plug into the inlet opening on the cassette cap. To resume sampling: remove the inlet plug, turn on the sampling pump, attach a rotameter to measure the flow rate, remove the cassette cap, replace the inlet plug in the cassette cap and invert the cassette, face downward and perpendicular to the wind.

5. Check the pump at sampling midpoint if sampling is longer than 4 hours. The generators may need to be regased depending on tank size. If a filter darkens in appearance or if loose dust is seen in the filter, a second sample should be started.

6. At the end of the sampling period, orient the cassette up, turn the pump off.

7. Check the flow rate as shown in Section 7.2.3. When sampling open-faced, the sampling cap should be replaced before post calibrating. Use the same cassette used for sampling for post calibration (increase dust/fiber loading may have altered the flow rate.

8. Record the post flow rate.

9. Record the cumulative time or run.

10. Remove the tubing from the sampling cassette. Still holding the cassette upright, replace the inlet plug on the cassette cap and the outlet plug on the cassette base.

7.4.3. Post Site Sampling

1. Follow handling procedures in Section 3.2, steps 1-4.

2. Obtain an electronic or hard copy of meteorological data which occurred during the sampling event. Record weather: wind speed, ambient temperature, wind direction, and precipitation. Obtaining weather data several days prior to the sampling event can also be useful.

7.5 Indoor Sampling Procedures

PCM analysis is used for indoor air samples. When analysis shows total fiber count above the OSHA action level 0.1 f/cc then TEM (U.S. EPA's Modified Yamate Method) is used to identify asbestos from non-asbestos fibers.

Sampling pumps should be placed four to five feet above ground level away from obstructions that may influence air flow. The pump can be placed on a table or counter. Refer to Table 2 (Appendix A) for a summary of indoor sampling locations and rationale for selection.

Indoor sampling utilizes high flow rates to increased sample volumes (2000 L for PCM and 2800 to 4200 L for TEM) in order to obtain lower detection limits below the standard, (i.e., 0.01 f/cc or lower [PCM] and 0.005 structures/cc or lower [TEM]).

7.5.1 Aggressive Sampling Procedures

Sampling equipment at fixed locations may fail to detect the presence of asbestos fibers. Due to limited air movement, many fibers may settle out of the air onto the floor and other surfaces and may not be captured on the filter. In the past, an 8-hour sampling period was recommended to cover various air circulation conditions. A quicker and more effective way to capture asbestos fibers is to circulate the air artificially so that the fibers remain airborne during sampling. The results from this sampling option typifies worst case condition. This is referred to as aggressive air sampling for asbestos. Refer to Table 2 for sample station locations.

1. Before starting the sampling pumps, direct forced air (such as a 1-horsepower leaf blower or large fan) against walls, ceilings, floors, ledges, and other surfaces in the room to initially dislodge fibers from surfaces. This should take at least 5 minutes per 1000 sq. ft. of floor.

2. Place a 20-inch fan in the center of the room. (Use one fan per 10,000 cubic feet of room space.) Place the fan on slow speed and point it toward the ceiling.

3. Follow procedures in Section 7.4.1 and 7.4.2 (Turn off the pump and then the fan(s) when sampling is complete.).

4. Follow handling procedures in Section 3.2, steps 1-4.

8.0 CALCULATIONS

The sample volume is calculated from the average flow rate of the pump multiplied by the number of minutes the pump was running (volume = flow rate X time in minutes). The sample volume should be submitted to the laboratory and identified on the chain of custody for each sample (zero for lot, field and trip blanks).

The concentration result is calculated using the sample volume and the numbers of asbestos structures reported after the application of the cluster and matrix counting criteria.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Follow all QA/QC requirements from the laboratories as well as the analytical methods.

9.1 TEM Requirements

1. Examine lot blanks to determine the background asbestos structure concentration.

2. Examine field blanks to determine whether there is contamination by extraneous asbestos structures during specimen preparation.

3. Examine of laboratory blanks to determine if contamination is being introduced during critical phases of the laboratory program.

4. To determine if the laboratory can satisfactorily analyze samples of known asbestos structure concentrations, reference filters shall be examined. Reference filters should be maintained as part of the laboratory's Quality Assurance program.

5. To minimize subjective effects, some specimens should be recounted by a different microscopist.

6. Asbestos laboratories shall be accredited by the National Voluntary Laboratory Accreditation Program.

7. At this time, performance evaluation samples for asbestos in air are not available for Removal Program Activities.

9.2 PCM Requirements

1. Examine reference slides of known concentration to determine the analyst's ability to satisfactorily count fibers. Reference slides should be maintained as part of the laboratory's quality assurance program.

2. Examine field blanks to determine if there is contamination by extraneous structures during sample handling.

3. Some samples should be relabeled then submitted for counting by the same analyst to determine possible bias by the analyst.

4. Participation in a proficiency testing program such as the AIHA-NIOSH proficiency analytical testing (PAT) program.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures. More specifically, when entering an unknown situation involving asbestos, a powered air purifying respirator (PAPR) (full face-piece) is necessary in conjunction with HEPA filter cartridges. See applicable regulations for action level, PEL, TLV, etc. If previous sampling indicates asbestos concentrations are below personal health and safety levels, then Level D personal protection is adequate.

12.0 REFERENCES

(1) Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air, Part 1: Method, EPA/540/2-90/005a, May 1990, and Part 2: Technical Background Document, EPA/540/2-90/005b, May 1990.

(2) Methodology for the Measurement of Airborne Asbestos by Electron Microscopy, EPA's Report No. 68-02-3266, 1984, G. Yamate, S.C. Agarwal, and R. D. Gibbons.

(3) National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Method. Third Edition. 1987.

(4) U.S. Environmental Protection Agency. Code of Federal Regulations 40 CFR 763. July 1, 1987. Code of Federal Regulations 40 CFR 763 Addendum. October 30, 1987.

(5) U.S. Environmental Protection Agency. Asbestos-Containing Materials in Schools; Final Rule and Notice. 52 FR 41826.

(6) Occupational Safety and Health Administration. Code of Federal Regulations 29 CFR 1910.1001. Washington, D.C. 1987.

APPENDIX A

Tables

TABLE 1.

SAMPLE STATIONS FOR OUTDOOR SAMPLING

Sample Station Location	Sample Numbers	Rationale
Upwind/Background[1]	Collect a minimum of two simultaneous upwind/background samples 30° apart from the prevailing windlines.	Establishes background fiber levels.
Downwind	Deploy a minimum of 3 sampling stations in a 180 degree arc downwind from the source.	Indicates if asbestos is leaving the site.
Site Representative and/or Worst Case	Obtain one site representative sample which shows average condition on-site or obtain worst case sample (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

[1] More than one background station may be required if the asbestos originates from different sources.

APPENDIX A (Cont'd)

Tables

TABLE 2

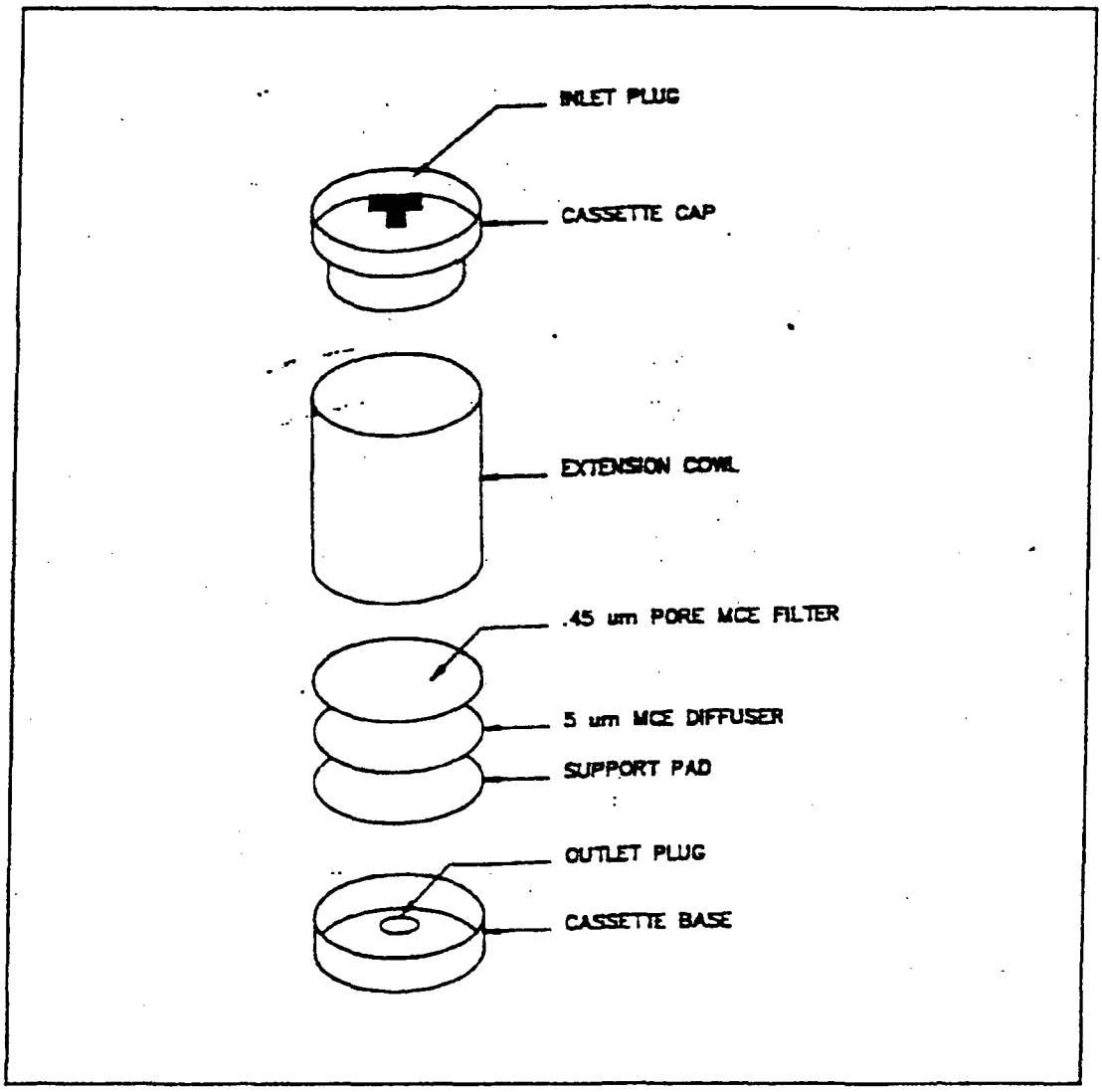
SAMPLE STATIONS FOR INDOOR SAMPLING

Sample Station Location	Sample Numbers	Rationale
Indoor Sampling	If a work site is a single room, disperse 5 samplers throughout the room. If the work site contains up to 5 rooms, place at least one sampler in each room. If the work site contains more than 5 rooms, select a representative sample of the rooms.	Establishes representative samples from a homogeneous area.
Upwind/Background	If outside sources are suspected, deploy a minimum of two simultaneous upwind/background samples 30° apart from the prevailing windlines.	Establish whether indoor asbestos concentrations are coming from an outside source.
Worst Case	Obtain one worst case sample, i.e., aggressive sampling (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

APPENDIX B

Figures

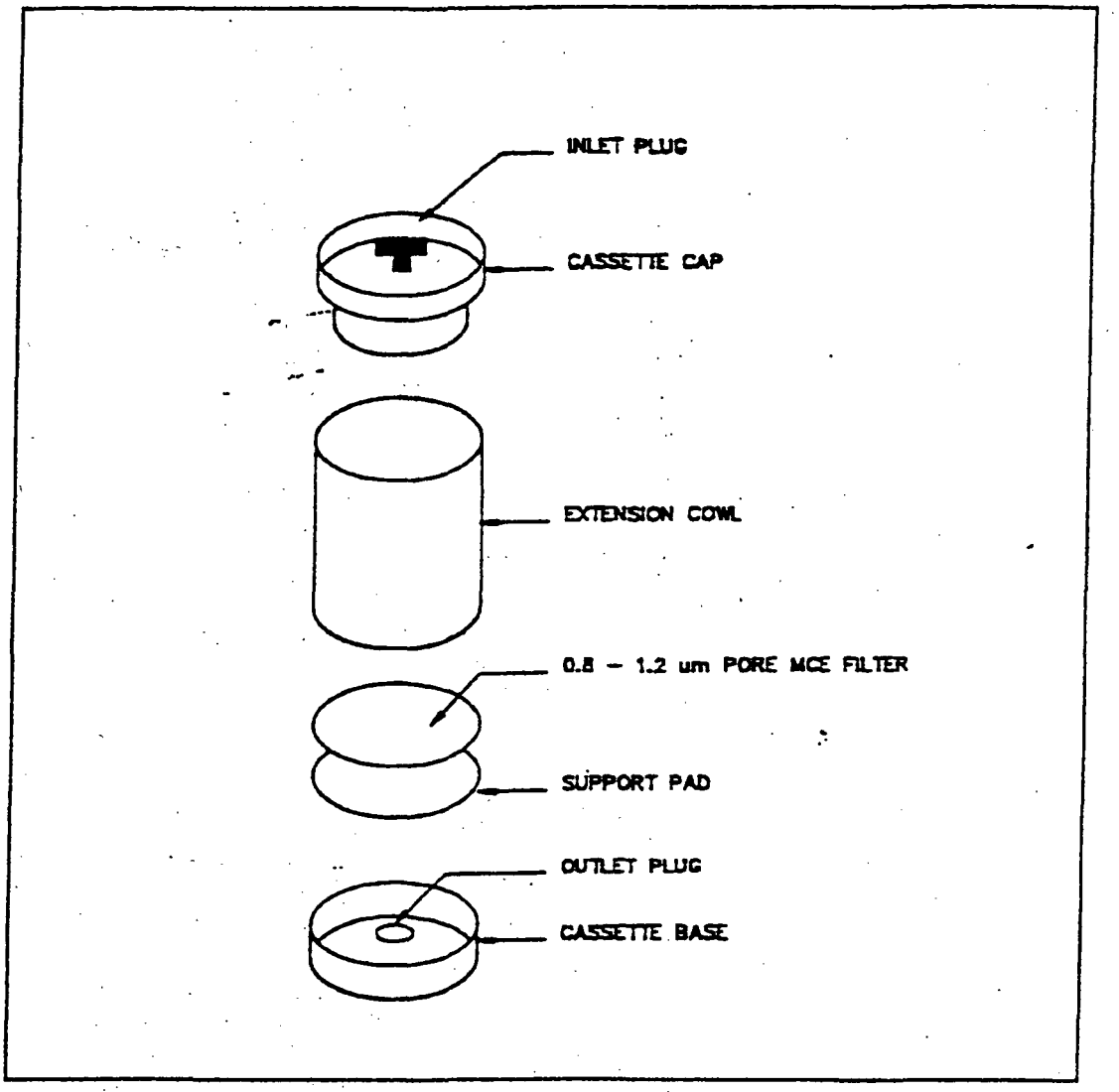
FIGURE 1. Transmission Electron Microscopy Filter Cassette



APPENDIX B (Cont'd)

Figures

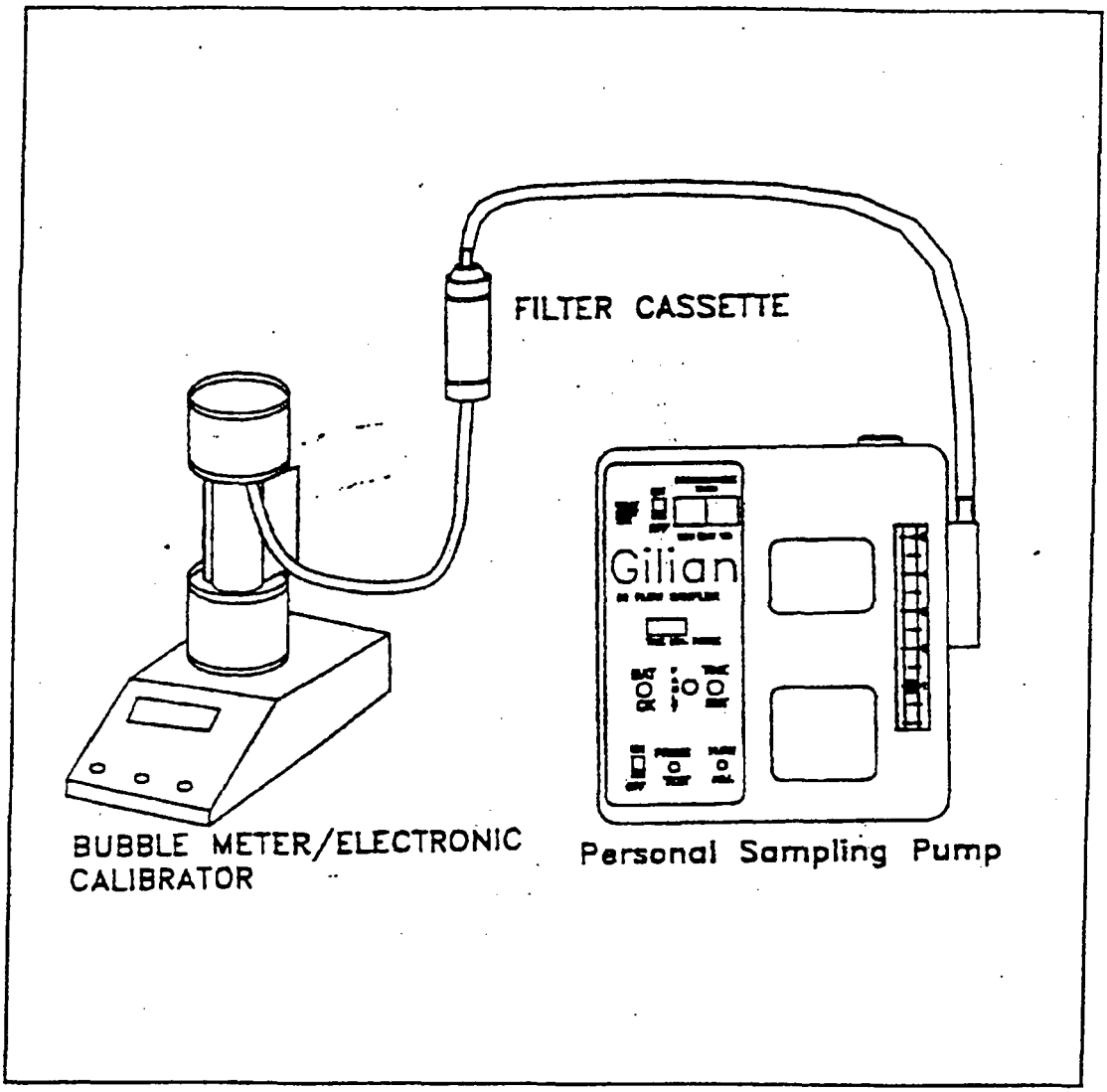
FIGURE 2. Phase Contrast Microscopy Filter Cassette



APPENDIX B (Cont'd)

Figures

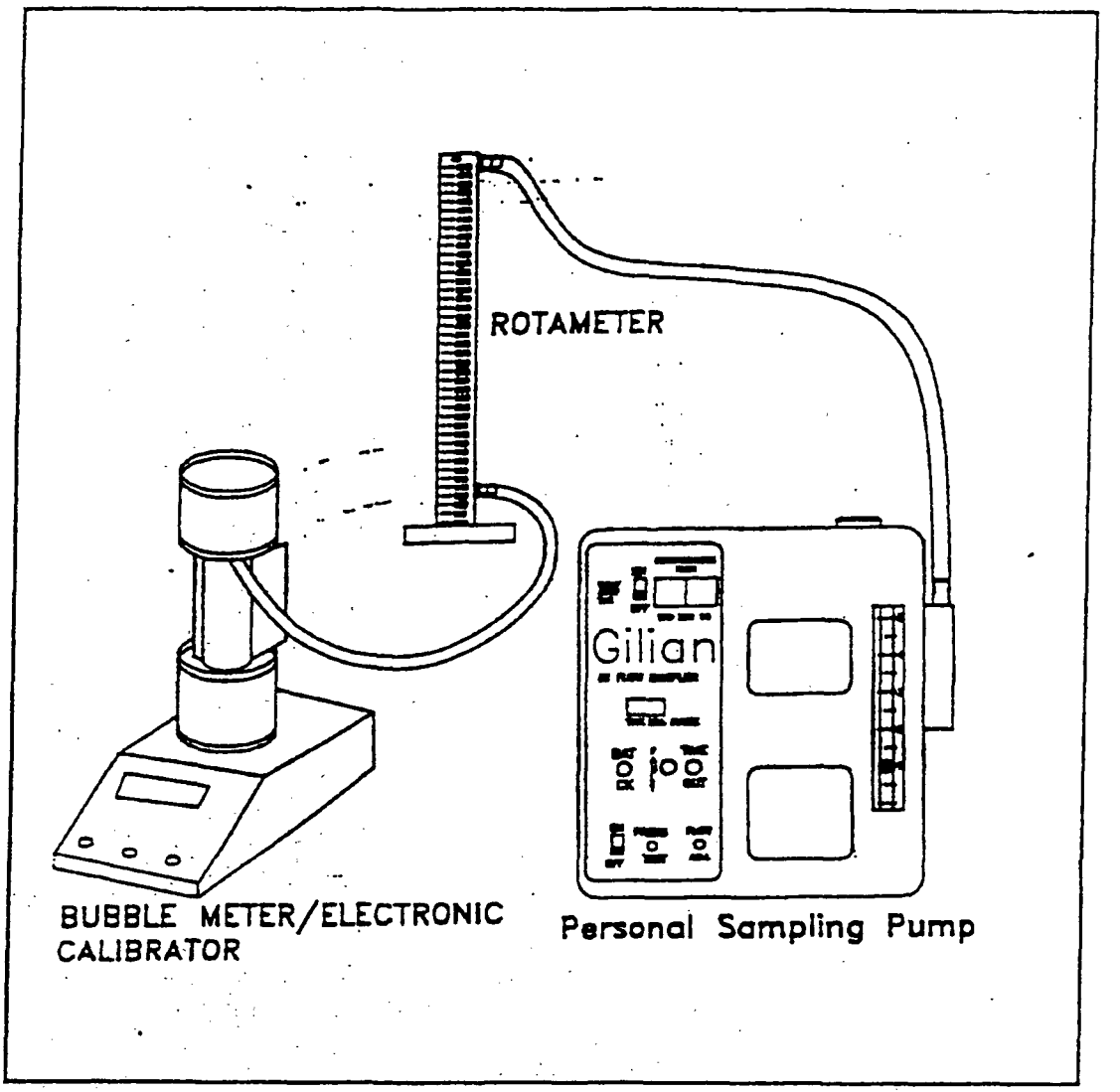
FIGURE 3. Calibrating a Personal Sampling Pump with a Bubble Meter



APPENDIX B (Cont'd)

Figures

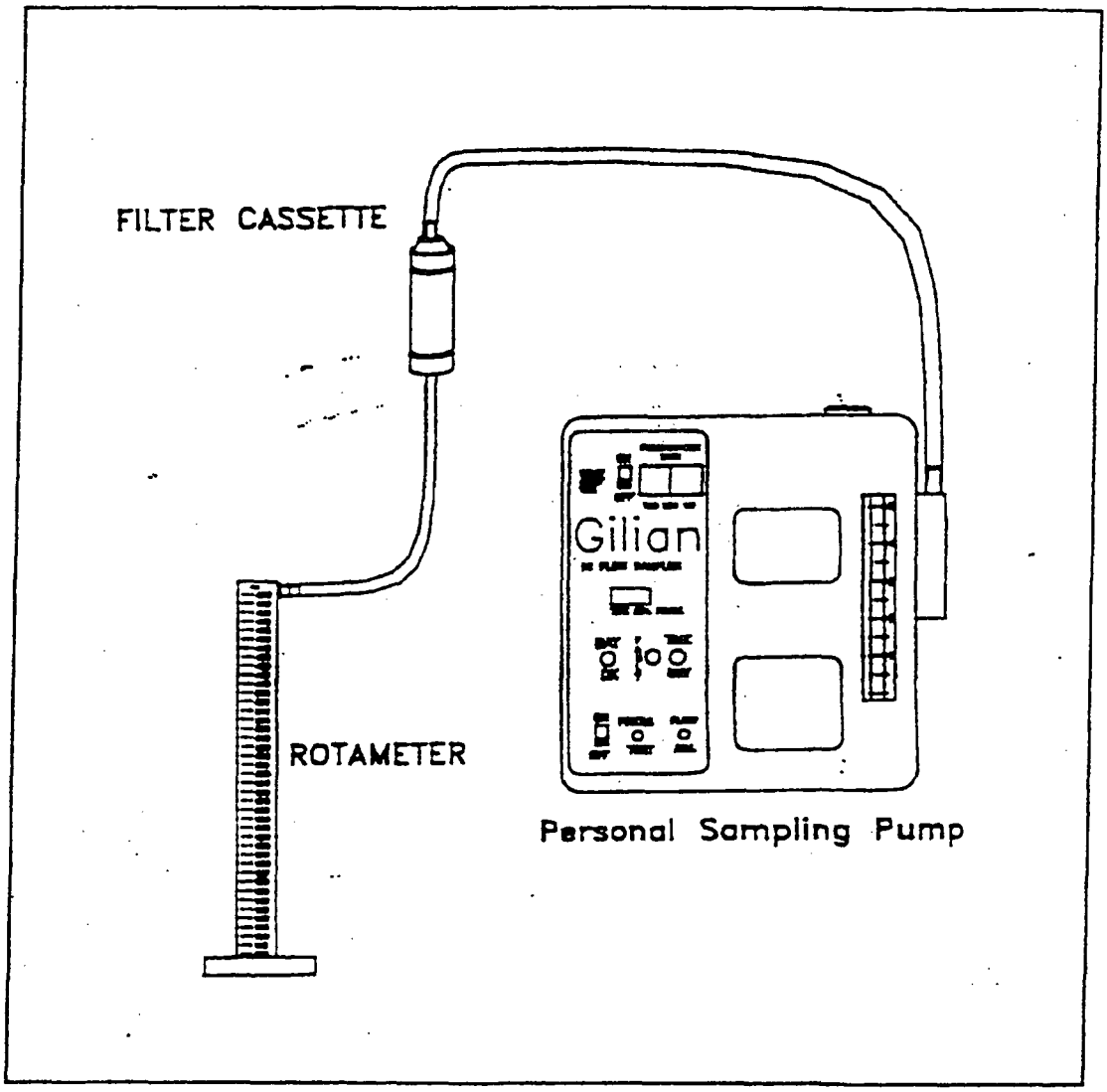
FIGURE 4. Calibrating a Rotameter with a Bubble Meter



APPENDIX B (Cont'd)

Figures

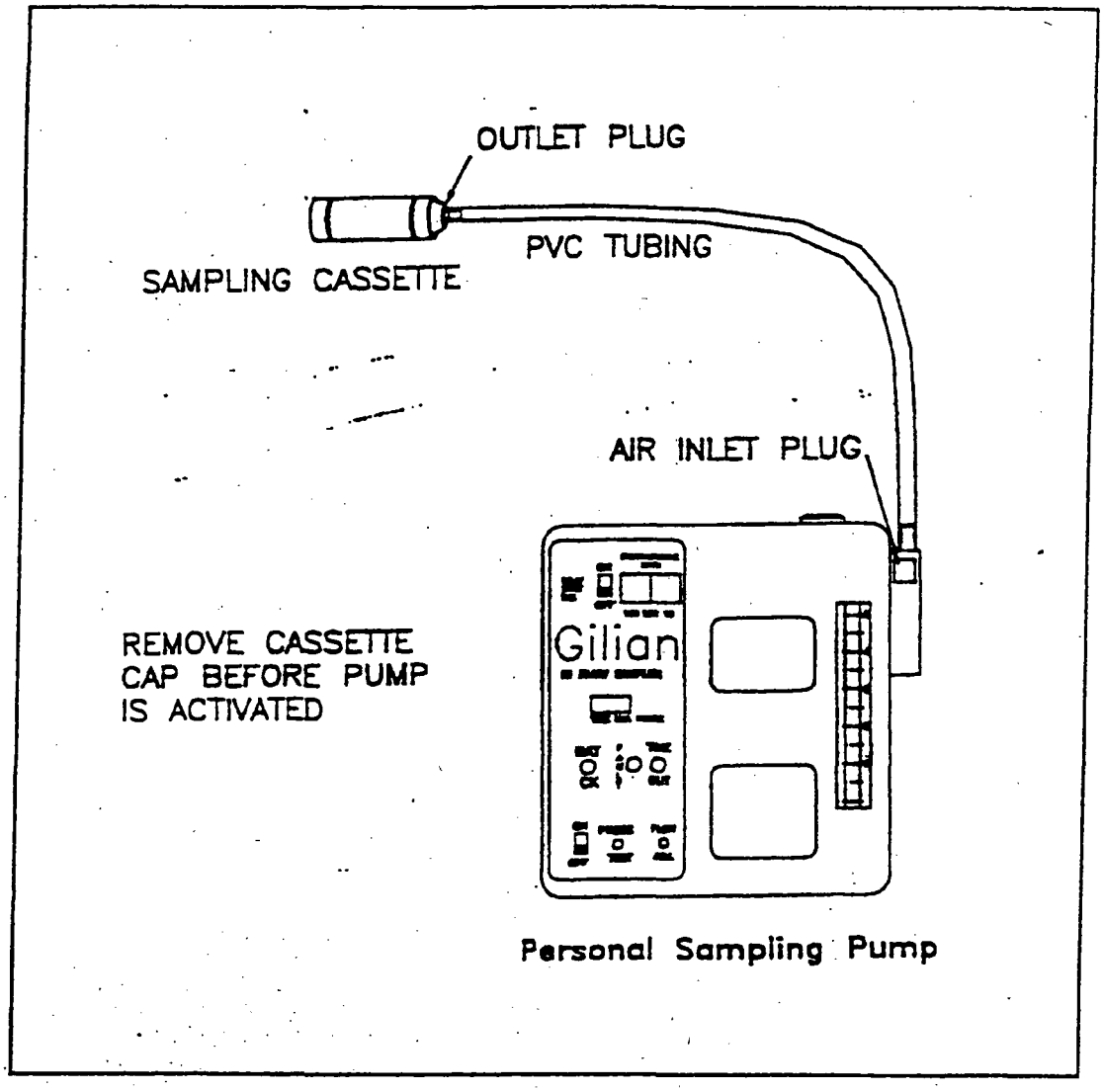
FIGURE 5. Calibrating a Sampling Pump with a Rotameter



APPENDIX B (Cont'd)

Figures

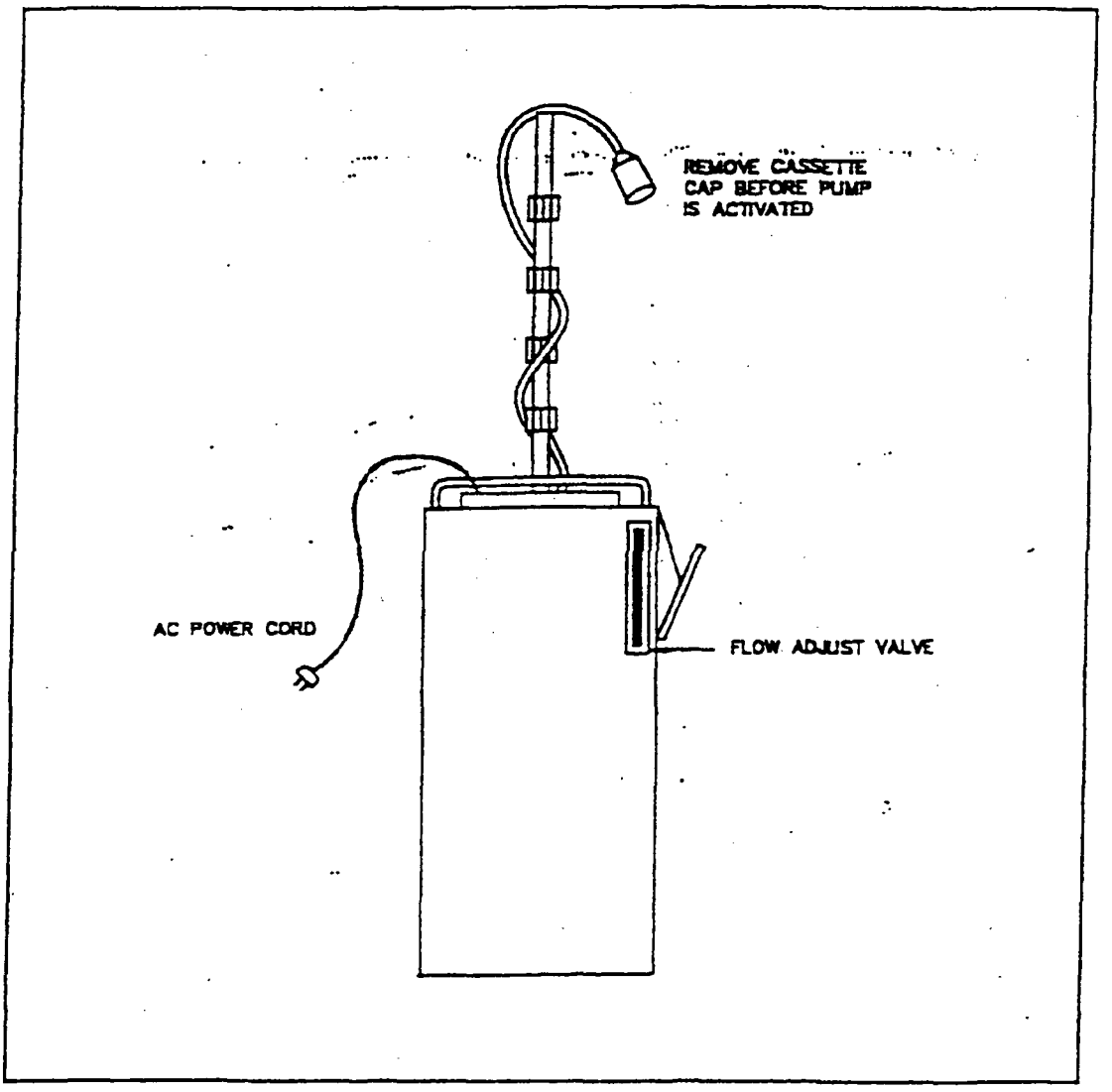
FIGURE 6. Personal Sampling Train for Asbestos



APPENDIX B (Cont'd)

Figures

FIGURE 7. High Flow Sampling Train for Asbestos



Designation: D 5755 – 95

AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race St. Philadelphia, Pa 19103
Reprinted from the Annual Book of ASTM Standards. Copyright ASTM
If not listed in the current combined index, will appear in the next edition.

Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Concentrations[1]

This standard is issued under the fixed designation D 5755; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a procedure to (*a*) identify asbestos in dust and (*b*) provide an estimate of the concentration of asbestos in the sampled dust reported as the number of asbestos structures per unit area of sampled surface.

1.1.1 If an estimate of the asbestos mass is to be determined, the user is referred to Test Method D 5756.

1.2 This test method describes the equipment and procedures necessary for sampling, by a microvacuum technique, non-airborne dust for levels of asbestos structures. The non-airborne sample is collected inside a standard filter membrane cassette from the sampling of a surface area for dust which may contain asbestos.

1.2.1 This procedure uses a microvacuuming sampling technique. The collection efficiency of this technique is unknown and will vary among substrates. Properties influencing collection efficiency include surface texture, adhesiveness, electrostatic properties and other factors.

1.3 Asbestos identified by transmission electron microscopy (TEM) is based on morphology, selected area electron diffraction (SAED), and energy dispersive X-ray analysis (EDXA). Some information about structure size is also determined.

1.4 This test method is generally applicable for an estimate of the concentration of asbestos structures starting from approximately 1000 asbestos structures per square centimetre.

1.4.1 The procedure outlined in this test method employs an indirect sample preparation technique. It is intended to disperse aggregated asbestos into fundamental fibrils, fiber bundles, clusters, or matrices that can be more accurately quantified by transmission electron microscopy. However, as with all indirect sample preparation techniques, the asbestos observed for quantification may not represent the physical form of the asbestos as sampled. More specifically, the procedure described neither creates nor destroys asbestos, but it may alter the physical form of the mineral fibers.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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

2. Referenced Documents

2.1 *ASTM Standards:*

D 1193 Specification for Reagent Water[2]

D 1739 Test Method for the Collection and Measurement of Dustfall (Settleable Particulate Matter)[3]

D 3195 Practice for Rotameter Calibration[3]

D 3670 Guide for Determination of Precision and Bias of Methods of Committee D-22[3]

D 5756 Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Mass Concentration[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *asbestiform*—a special type of fibrous habit in which the fibers are separable into thinner fibers and ultimately into fibrils. This habit accounts for greater flexibility and higher tensile strength than other habits of the same mineral. For more information on asbestiform mineralogy, see Refs (1),[4] (2) and (3).

3.1.2 *asbestos*—a collective term that describes a group of naturally occurring, inorganic, highly fibrous, silicate dominated minerals, which are easily separated into long, thin, flexible fibers when crushed or processed.

DISCUSSION—Included in the definition are the asbestiform varieties of: serpentine (chrysotile); riebeckite (crocidolite); grunerite (grunerite asbestos); anthophyllite (anthophyllite asbestos); tremolite (tremolite asbestos); and actinolite (actinolite asbestos). The amphibole mineral compositions are defined according to nomenclature of the International Mineralogical Association (3).

Asbestos	Chemical Abstract Service No.[5]
Chrysotile	12001-29-5
Crocidolite	12001-28-4
Grunerite Asbestos	12172-73-5
Anthophyllite Asbestos	77536-67-5
Tremolite Asbestos	77536-68-6
Actinolite Asbestos	77536-66-4

3.1.3 *fibril*—a single fiber that cannot be separated into

[1] This test method is under the jurisdiction of ASTM Committee D-22 on Sampling and Analysis of Atmospheres and is the direct responsibility of Subcommittee D22.07 on Sampling and Analysis of Asbestos.

Current edition approved August 15, 1995. Published October 1995.

[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 11.03.

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

[5] The non-asbestiform variations of the minerals indicated in 5.1.3 have different Chemical Abstract Service (CAS) numbers.

smaller components without losing its fibrous properties or appearance.

3.2 *Descriptions of Terms Specific to This Standard:*

3.2.1 *aspect ratio*—the ratio of the length of a fibrous particle to its average width.

3.2.2 *bundle*—a structure composed of three or more fibers in a parallel arrangement with the fibers closer than one fiber diameter to each other.

3.2.3 *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 of fibers must have more than two points touching.

3.2.4 *debris*—materials that are of an amount and size (particles greater than 1 mm in diameter) that can be visually identified as to their source.

3.2.5 *dust*—any material composed of particles in a size range of ≤1 mm and large enough to settle by virtue of their weight from the ambient air (see definition for settleable particulate matter in Test Method D 1739).

3.2.6 *fiber*—a structure having a minimum length of 0.5 µm, an aspect ratio of 5:1 or greater, and substantially parallel sides (4).

3.2.7 *fibrous*—of a mineral composed of parallel, radiating, or interlaced aggregates of fibers, from which the fibers are sometimes separable. That is, the crystalline aggregate may be referred to as fibrous even if it is not composed of separable fibers, but has that distinct appearance. The term fibrous is used in a general mineralogical way to describe aggregates of grains that crystallize in a needle-like habit and appear to be composed of fibers. Fibrous has a much more general meaning than asbestos. While it is correct that all asbestos minerals are fibrous, not all minerals having fibrous habits are asbestos.

3.2.8 *indirect preparation*—a method in which a sample passes through one or more intermediate steps prior to final filtration.

3.2.9 *matrix*—a structure in which one or more fibers, or fiber bundles that are touching, are attached to, or partially concealed by a single particle or connected group of nonfibrous particles. The exposed fiber must meet the fiber definition (see 3.2.6).

3.2.10 *structures*—a term that is used to categorize all the types of asbestos particles which are recorded during the analysis (such as fibers, bundles, clusters, and matrices). Final results of the test are always expressed in asbestos structures per square centimetre.

4. Summary of Test Method

4.1 The sample is collected by vacuuming a known surface area with a standard 25 or 37 mm air sampling cassette using a plastic tube that is attached to the inlet orifice which acts as a nozzle. The sample is transferred from inside the cassette to an aqueous solution of known volume. Aliquots of the suspension are then filtered through a membrane. A section of the membrane is prepared and transferred to a TEM grid using the direct transfer method. The asbestiform structures are identified, sized, and counted by TEM, using SAED and EDXA at a magnification of 15 000 to 20 000X.

5. Significance and Use

5.1 This microvacuum sampling and indirect analysis method is used for the general testing of non-airborne dust samples for asbestos. It is used to assist in the evaluation of dust that may be found on surfaces in buildings such as ceiling tiles, shelving, electrical components, duct work, carpet, etc. This test method provides an index of the concentration of asbestos structures in the dust per unit area analyzed as derived from a quantitative TEM analysis.

5.1.1 This test method does not describe procedures or techniques required to evaluate the safety or habitability of buildings with asbestos-containing materials, or compliance with federal, state, or local regulations or statutes. It is the user's responsibility to make these determinations.

5.1.2 At present, a single direct relationship between asbestos-containing dust and potential human exposure does not exist. Accordingly, the user should consider these data in relationship to other available information in their evaluation.

5.2 This test method uses the definition, settleable particulate material, found in Test Method D 1739 as the definition of dust. This definition accepts all particles small enough to pass through a 1 mm (No. 18) screen. Thus, a single, large asbestos containing particle(s) (from the large end of the particle size distribution) dispersed during sample preparation may result in anomalously large asbestos concentration results in the TEM analyses of that sample. It is, therefore, recommended that multiple independent samples are secured from the same area, and a minimum of three samples analyzed by the entire procedure.

6. Interferences

6.1 The following minerals have properties (that is, chemical or crystalline structure) which are very similar to asbestos minerals and may interfere with the analysis by causing a false positive to be recorded during the test. Therefore, literature references for these materials must be maintained in the laboratory for comparison to asbestos minerals so that they are not misidentified as asbestos minerals.

6.1.1 *Antigorite.*

6.1.2 *Palygorskite (Attapulgite).*

6.1.3 *Halloysite.*

6.1.4 *Pyroxenes.*

6.1.5 *Sepiolite.*

6.1.6 *Vermiculite scrolls.*

6.1.7 *Fibrous talc.*

6.1.8 Hornblende and other amphiboles other than those listed in 3.1.2.

6.2 Collecting any dust particles greater than 1 mm in size in this test method may cause an interference and, therefore, must be avoided.

7. Materials and Equipment

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without

lessening the accuracy of the determination.[6]

7.2 *Transmission Electron Microscope (TEM)*, an 80 to 120 kV TEM, capable of performing electron diffraction, with a fluorescent screen inscribed with calibrated gradations, is required. The TEM must be equipped with energy dispersive X-ray spectroscopy (EDXA) and it must have a scanning transmission electron microscopy (STEM) attachment or be capable of producing a spot size of less than 250 nm in diameter in crossover.

7.3 *Energy Dispersive X-ray System (EDXA).*

7.4 *High Vacuum Carbon Evaporator*, with rotating stage.

7.5 *High Efficiency Particulate Air (HEPA)*, filtered negative flow hood.

7.6 *Exhaust or Fume Hood.*

7.7 *Particle-free Water* (ASTM Type II, see Specification D 1193).

7.8 *Glass Beakers* (50 mL).

7.9 *Glass Sample Containers*, with wide mouth screw cap (200 mL) or equivalent sealable container (height of the glass sample container should be approximately 13 cm high by 6 cm wide).

7.10 *Waterproof Markers.*

7.11 *Forceps* (tweezers).

7.12 *Ultrasonic Bath*, table top model (100 W).

7.13 *Graduated Pipettes* (1, 5, 10 mL sizes), glass or plastic.

7.14 *Filter Funnel*, either 25 mm or 47 mm, glass or disposable. Filter funnel assemblies, either glass or disposable plastic, and using either a 25 mm or 47 mm diameter filter.

7.15 *Side Arm Filter Flask*, 1000 mL.

7.16 *Mixed Cellulose Ester (MCE) Membrane Filters*, 25 or 47 mm diameter, ≤0.22 µm and 5 µm pore size.

7.17 *Polycarbonate (PC) Filters*, 25 or 47 mm diameter, ≤0.2 µm pore size.

7.18 *Storage Containers*, for the 25 or 47 mm filters (for archiving).

7.19 *Glass Slides*, approximately 76 by 25 mm in size.

7.20 *Scalpel Blades*, No. 10, or equivalent.

7.21 *Cabinet-type Desiccator*, or low temperature drying oven.

7.22 *Chloroform*, reagent grade.

7.23 *Acetone*, reagent grade.

7.24 *Dimethylformamide (DMF).*

7.25 *Glacial Acetic Acid.*

7.26 *1-methyl-2-pyrrolidone.*

7.27 *Plasma Asher*, low temperature.

7.28 *pH Paper.*

7.29 *Air Sampling Pump*, low volume personal-type, capable of achieving a flow rate of 1 to 5 L/min.

7.30 *Rotameter.*

7.31 *Air Sampling Cassettes*, 25 mm or 37 mm, containing 0.8 µm or smaller pore size MCE or PC filters.

7.32 *Cork Borer*, 7 mm.

7.33 *Non-Asbestos Mineral*, references as outlined in 6.1.

7.34 *Asbestos Standards*, as outlined in 3.1.2.

7.35 *Tygon*[7] *Tubing*, or equivalent.

7.36 *Small Vacuum Pump*, that can maintain a pressure of 92 kPa.

7.37 *Petri Dishes*, large glass, approximately 90 mm in diameter.

7.38 *Jaffe Washer*, stainless steel or aluminum mesh screen, 30 to 40 mesh, and approximately 75 mm by 50 mm in size.

7.39 *Copper TEM Finder Grids*, 200 mesh.

7.40 *Carbon Evaporator Rods.*

7.41 *Lens Tissue.*

7.42 *Ashless Filter Paper Filters*, 90 mm diameter.

7.43 *Gummed Paper Reinforcement Rings.*

7.44 *Wash Bottles*, plastic.

7.45 *Reagent Alcohol*, HPLC Grade (Fisher A995 or equivalent).

7.46 *Opening Mesh Screen*, plastic, 1.0 by 1.0 mm, (Spectra-Mesh #146410 or equivalent).

7.47 *Diffraction Grating Replica.*

8. Sampling Procedure for Microvacuum Technique

8.1 For sampling asbestos-containing dust in either indoor or outdoor environments, commercially available cassettes must be used. Air monitoring cassettes containing 25 mm or 37 mm diameter mixed cellulose ester (MCE) or polycarbonate (PC) filter membranes with a pore size less than or equal to 0.8 µm are required (7.31). The number of samples collected depends upon the specific circumstances of the study.

8.2 Maintain a log of all pertinent sampling information and sampling locations.

8.3 Sampling pumps and flow indicators shall be calibrated using a certified standard apparatus or assembly (see Practice D 3195 and 7.29).

8.4 Record all calibration information (5).

8.5 Perform a leak check of the sampling system at each sampling site by activating the pump (7.29) with the closed sampling cassette in line. Any air flow shows that a leak is present that must be eliminated before initiating the sampling operation.

8.6 Attach the sampling cassette to the sampling pump at the outlet side of the cassette with plastic tubing (7.35). The plastic tubing must be long enough in that the sample areas can be reached without interference from the sampling pump. Attach a clean, approximately 25.4 mm long piece of plastic tubing (6.35 mm internal diameter) directly to the inlet orifice. Use this piece of tubing as the sampling nozzle. Cut the sampling end of the tubing at a 45° angle as illustrated in Fig. 1. The exact design of the nozzle is not critical as long as some vacuum break is provided to avoid simply pushing the dust around on the surface with the nozzle rather than vacuuming it into the cassette. The internal diameter of the nozzle and flow rate of the pump may vary as long as the air velocity is 100 (±10) cm/s. This air velocity calculation is based on an internal sampling tube diameter of 6.35 mm at a flow rate of 2 L/min.

8.7 Measure and determine the sample area of interest. A

[6] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.

[7] Tygon is a registered trademark of the DuPont Co.

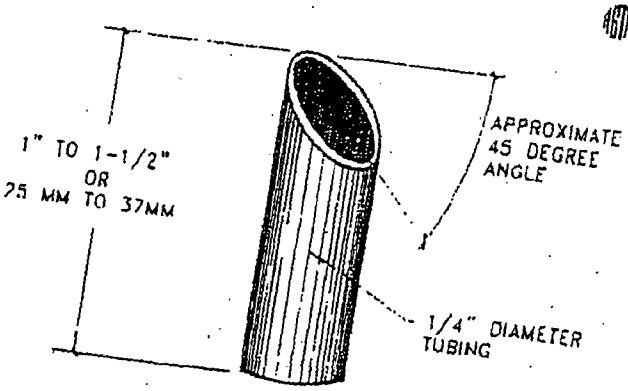


FIG. 1 Example of the Tubing Nozzle

sample area of 100 cm² is vacuumed until there is no visible dust or particulates matter remaining. Perform a minimum of two orthogonal passes on the surface within a minimum of 2 min of sampling time. Avoid scraping or abrading the surface being sampled. (Do not sample any debris or dust particles greater than 1 mm in diameter (see 4.2).) Smaller or larger areas can be sampled, if needed. For example, some surfaces of interest may have a smaller area than 100 cm². Less dusty surfaces may require vacuuming of larger areas. Unlike air samples, the overloading of the cassettes with dust will not be a problem. As defined in 3.2.5, only dust shall be collected for this analysis.

8.8 At the end of sample collection, invert the cassette so that the nozzle inlet faces up before shutting off the power to the pump. The nozzle is then sealed with a cassette end-plug and the cassette/nozzle taped or appropriately packaged to prevent separation of the nozzle and cassette assembly. A second option is the removal of the nozzle from the cassette, then plugging of the cassette and shipment of the nozzle (also plugged at both ends) sealed in a separate closeable plastic bag. A third option is placing the nozzle inside the cassette for shipment. The nozzle is always saved and rinsed because a significant percentage of the dust drawn from a lightly loaded surface may adhere to the inside walls of the tubing.

8.9 Check that all samples are clearly labeled, that all dust sampling information sheets are completed, and that all pertinent information has been enclosed, in accordance with laboratory quality control practices, before transfer of the samples to the laboratory. Include an unused cassette and nozzle as a field blank.

8.10 Wipe off the exterior surface of the cassettes with disposable wet towels (baby wipes) prior to packaging for shipment.

9. Sample Shipment

9.1 Ship dust samples to an analytical laboratory in a sealed container, but separate from any bulk or air samples. The cassettes must be tightly sealed and packed in a material free of fibers or dust to minimize the potential for contamination. Plastic "bubble pack" is probably the most appropriate material for this purpose.

10. Sample Preparation

10.1 Under a negative flow HEPA hood (7.5), carefully wet-wipe the exterior of the cassettes to remove any possible contamination before taking cassettes into a clean preparation area.

10.2 Perform sample preparation in a clean facility that has a separate work area from both the bulk and air sample preparation areas.

10.3 Initial specimen preparation shall take place in a clean HEPA filtered negative pressure hood to avoid any possible contamination of the laboratory or personnel, or both, by the potentially large number of asbestos structures in an asbestos-containing dust sample. Cleanliness of the preparation area hoods is measured by the cumulative process blank concentrations (see Section 11).

10.4 All sample preparation steps 10.4.1 through 10.4.6 shall take place in the dust preparation area inside a HEPA hood.

10.4.1 Remove the upper plug from the sample cassette and carefully introduce approximately 10 mL solution of a 50/50 mixture of particle-free water and reagent alcohol into the cassette using a plastic wash bottle (7.44). If the plugged nozzle was left attached to the cassette, then remove the plug and introduce the water/alcohol solution into the cassette through the tubing, and then remove the tubing, if it is visibly clean.

10.4.2 Replace the upper plug or the sample cap and lightly shake the dust suspension by hand for 3 s.

10.4.3 Remove the entire cap of the cassette and pour the suspension through a 1.0 by 1.0 mm opening screen (7.46) into a pre-cleaned 200 mL glass specimen bottle (7.9). All visible traces of the sample contained in the cassette shall be rinsed through the screen into the specimen bottle with a plastic wash bottle containing the 50/50 solution of particle-free water and alcohol. Repeat this procedure two additional times for a total of three washings. Next, rinse the nozzle two or three times through the screen into the specimen bottle with the 50/50 mixture of water and alcohol. Typically, the total amount of the 50/50 mixture used in the rinse is 50 to 75 mL. Discard the 1.0 by 1.0 mm screen and bring the volume of solution in the specimen bottle up to the 100 mL mark on the side of the bottle with particle-free water only.

10.4.4 Adjust the pH of the suspension to 3 to 4 using a 10.0 % solution of acetic acid. Use pH paper for testing. Filter the suspension within 24 h to avoid problems associated with bacterial and fungal growth.

10.4.5 Use either a disposable plastic filtration unit or a glass filtering unit (7.14) for filtration of aliquots of the suspension. The ability of an individual filtration unit to produce a uniform distribution may be tested by the filtration of a colored particulate suspension such as diluted India ink (suspension of carbon black).

10.4.5.1 If a disposable plastic filtration unit is used, then unwrap a new disposable plastic filter funnel unit (either 25 or 47 mm diameter) and remove the tape around the base of the funnel. Remove the funnel and discard the top filter supplied with the apparatus, retaining the coarse polypropylene support pad in place. Assemble the unit with the adapter and a properly sized neoprene stopper, and attach the funnel to the 1000 mL side-arm vacuum flask (7.15). Place a 5.0 µm pore size MCE (backing filter) on the support pad. Wet it with a few mL of particle-free water and place an MCE (7.16) or PC filter (≤0.22 µm pore size) (7.17) on top of the backing filter. Apply a

that the filters are centered and pulled flat without air bubbles. Any irregularities on the filter surface requires the discard of that filter. After the filter has been seated properly, replace the funnel and reseal it with the tape. Return the flask to atmospheric pressure.

10.4.5.2 If a glass filtration unit is used, place a 5 µm pore size MCE (backing filter) on the glass frit surface. Wet the filter with particle-free water, and place an MCE or PC filter (≤0.22 µm pore size) on top of the backing filter. Apply a vacuum, ensuring that the filters are centered and pulled flat without air bubbles. Replace the filters if any irregularities are seen on the filter surface. Before filtration of each set of sample aliquots, prepare a blank filter by filtration of 50 mL of particle-free water. If aliquots of the same sample are filtered in order of increasing concentration, the glass filtration unit need not be washed between filtration. After completion of the filtration, do not allow the filtration funnel assembly to dry because contamination is then more difficult to remove. Wash any residual suspension from the filtration assembly by holding it under a flow of water, then rub the surface with a clean paper towel soaked in a detergent solution. Repeat the cleaning operation, and then rinse two times in particle-free water.

10.4.6 With the flask at atmospheric pressure, add 20 mL of particle-free water into the funnel. Cover the filter funnel with its plastic cover if the disposable filtering unit is used.

10.4.7 Briefly hand shake (3 s) the capped bottle with the sample suspension, then place it in a tabletop ultrasonic bath (7.12) and sonicate for 3.0 min. Maintain the water level in the sonicator at the same height as the solution in sample bottle. The ultrasonic bath shall be calibrated as described in 20.5. The ultrasonic bath must be operated at equilibrium temperature. After sonicating, return the sample bottle to the work surface of the HEPA hood. Preparation steps 10.4.8 through 10.4.14 shall be carried out in this hood.

10.4.8 Shake the suspension lightly by hand for 3 s, then let it rest for 2.0 min to allow large particles to settle to the bottom of the bottle or float to the surface.

10.4.9 Estimate the amount of liquid to be withdrawn to produce an adequate filter preparation. Experience has shown that a light staining of the filter surface will yield a suitable preparation for analysis. Filter at least 1.0 mL, but no more than half the total volume. If after examination in the TEM, the smallest volume measured (1.0 mL) (7.13) yields an overloaded sample, then perform additional serial dilutions of the suspension. If it is estimated that less than 1.0 mL of solution has to be filtered because of the density of the suspension, perform a serial dilution.

10.4.9.1 If serial dilutions are required, repeat step 10.4.8 before the serial dilution portion is taken. Do not re-sonicate the original solution or any serial dilutions. The recommended procedure for a serial dilution is to mix 10 mL of the sample solution with 90 mL of particle-free water in a clean sample bottle to obtain a 1:10 serial dilution. Follow good laboratory practices when performing dilutions.

10.4.10 Insert a new disposable pipette halfway into the sample suspension and withdraw a portion. Avoid pipetting any of the large floating or settled particles. Uncover the filter funnel and dispense the mixture from the pipette into the water in the funnel.

10.4.11 Apply vacuum to the flask and draw the mixture through the filter.

10.4.12 Discard the pipette.

10.4.13 Disassemble the filtering unit and carefully remove the sample filter with fine tweezers (7.11). Place the completed sample filter particle side up, into a precleaned, labeled, disposable, plastic petri dish (7.48) or other similar container.

10.4.14 In order to ensure that an optimally-loaded filter is obtained, it is recommended that filters be prepared from several different aliquots of the dust suspension. For this series of filters, it is recommended that the volume of each aliquot of the original suspension be a factor of five higher than the previous one. If the filters are prepared in order of increasing aliquot volume, all of the filters for one sample can be prepared using one plastic disposable filtration unit, or without cleaning of glass filtration equipment between individual filtration. Before withdrawal of each aliquot from the sample, shake the suspension without additional sonification and allow to rest for 2 min.

10.4.15 There are many practical methods for drying MCE filters. The following are two examples that can be used: (*1*) dry MCE filters for at least 12 h (over desiccant) in an airtight cabinet-type desiccator (7.21); (*2*) to shorten the drying time (if desired), remove a plug of the damp filter and attach it to a glass slide (7.19) as described in 12.1.2 and 12.1.3. Place the slide with a filter plug or filter plugs (up to eight plugs can be attached to one slide) on a bed of desiccant, in the desiccator for 1 h.

10.4.16 PC filters do not require lengthy drying before preparation, but shall be placed in a desiccator for at least 30 min before preparation.

10.5 Prepare TEM specimens from small sections of each dried filter using the appropriate direct transfer preparation method.

11. Blanks

11.1 Prepare sample blanks that include both a process blank (50 mL of particle-free water) for each set of samples analyzed and one unused filter from each new box of sample filters (MCE or PC) used in the laboratory. If glass filtering units are used, prepare and analyze a process blank each time the filtering unit is cleaned. Blanks will be considered contaminated, if after analysis, they are shown to contain more than 53 asbestos structures per square millimetre. This generally corresponds to three or four asbestos structures found in ten grid openings. The source of the contamination must be found before any further analysis can be performed. Reject samples that were processed along with the contaminated blanks and prepare new samples after the source of the contamination is found.

11.2 Prepare field blanks which are included with sample sets in the same manner as the samples, to test for contamination during the sampling, shipping, handling, and preparation steps of the method.

12. TEM Specimen Preparation of Mixed Cellulose Ester (MCE) Filters

NOTE 1—Use of either the acetone or the diamethylformamide-acetic acid method is acceptable.

12.1 *Acetone Fusing Method:*

12.1.1 Remove a section (a plug) from any quadrant of the sample and blank filters. Sections can be removed from the filters using a 7 mm cork borer (7.32). The cork borer must be wet wiped after each time a section is removed.

12.1.2 Place the filter section (particle side up) on a clean microscope slide. Affix the filter section to the slide with a gummed page reinforcement (7.43), or other suitable means. Label the slide with a glass scribing tool or permanent marker (7.10).

12.1.3 Prepare a fusing dish from a glass petri dish (7.37) and a metal screen bridge (7.38) with a pad of five to six ashless paper filters (7.42) and place in the bottom of the petri dish (4). Place the screen bridge on top of the pad and saturate the filter pads with acetone. Place the slide on top of the bridge in the petri dish and cover the dish. Wait approximately 5 min for the sample filter to fuse and clear.

12.2 *Dimethylformamide-Acetic Acid Method:*

12.2.1 Place a drop of clearing solution that consists of 35 % dimethylformamide (DMF), 15 % glacial acetic acid, and 50 % Type II water (v/v) on a clean microscope slide. Gauge the amount used so that the clearing solution just saturates the filter section.

12.2.2 Carefully lay the filter segment, sample surface upward, on top of the solution. Bring the filter and solution together at an angle of about 20° to help exclude air bubbles. Remove any excess clearing solution. Place the slide in an oven or on a hot plate, in a fume hood, at 65 to 70°C for 10 min.

12.3 Plasma etching of the collapsed filter is required.

12.3.1 The microscope slide to which the collapsed filter pieces are attached is placed in a plasma asher (7.27). 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 exact conditions that must be used. Insufficient etching will result in a failure to expose embedded fibers, and too much etching may result in the loss of particles from the filter surface. To determine the optimum time for ashing, place an unused 25 mm diameter MCE filter in the center of a glass microscope slide. Position the slide approximately in the center of the asher chamber. Close the chamber and evacuate to a pressure of approximately 40 Pa, while admitting oxygen to the chamber at a rate of 8 to 20 cm^3/min. Adjust the tuning of the system so that the intensity of the plasma is maximized. Determine the time required for complete oxidation of the filter. Adjust the system parameters to achieve complete oxidation of the filter in a period of approximately 15 min. For etching of collapsed filters, use these operating parameters for a period of 8 min. For additional information on calibration, see the *USEPA Asbestos-Containing Materials in Schools* (4) or *NIST/NVLAP Program Handbook for Airborne Asbestos Analysis* (6) documents.

12.3.2 Place the glass slide containing the collapsed filters into the low-temperature plasma asher, and etch the filter.

12.4 Carbon coating of the collapsed and etched filters is required.

12.4.1 Carbon coating must be performed with a high-vacuum coating unit (7.4), capable of less than 10^{-4} torr (13 MPa) pressure. 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 shall not be used. Carbon rods (7.40) used for evaporators shall be sharpened with a carbon rod sharpener to a neck of about 4 mm in length and 1 mm in diameter. The rods are installed in the evaporator in such a manner that the points are approximately 100 to 120 mm from the surface of the microscope slide held in the rotating device.

12.4.2 Place the glass slide holding the filters on the rotation device, and evacuate the evaporator chamber to a vacuum of at least 13 MPa. Perform the evaporation in very short bursts, separated by 3 to 4 s to allow the electrodes to cool. An alternate method of evaporation is by using a slow continuous applied current. An experienced analyst can judge the thickness of the carbon film to be applied. Conduct tests on unused filters first. If the carbon 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.

12.4.2.1 If the coating is too thick, it will lead to a TEM image that is lacking in contrast, and the ability to obtain electron diffraction patterns will be compromised. The carbon film shall be as thin as possible and still remain intact on most of the grid openings of the TEM specimen.

12.5 *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 (7, 8). One such washer consists of a simple stainless steel bridge contained in a glass petri dish.

12.5.1 Place several pieces of lens tissue (7.41) on the stainless steel bridge. The pieces of lens tissue shall be large enough to completely drape over the bridge and into the solvent. In a fume hood, fill the petri dish with acetone (or DMF) until the height of the solvent is brought up to contact the underside of the metal bridge as illustrated in Fig. 2.

12.6 *Placing the Specimens into the Jaffe Washer:*

12.6.1 Place the TEM grids (7.39) shiny side up on a piece of lens tissue or filter paper so that individual grids can be easily picked up with tweezers.

12.6.2 Prepare three grids from each sample.

12.6.2.1 Using a curved scalpel blade (7.20), excise at least two square (3 mm by 3 mm) pieces of the carbon-coated MCE filter from the glass slide.

12.6.2.2 Place the square filter piece carbon-side up on top of a TEM specimen grid.

12.6.2.3 Place the whole assembly (filter/grid) on the saturated lens tissue in the Jaffe washer.

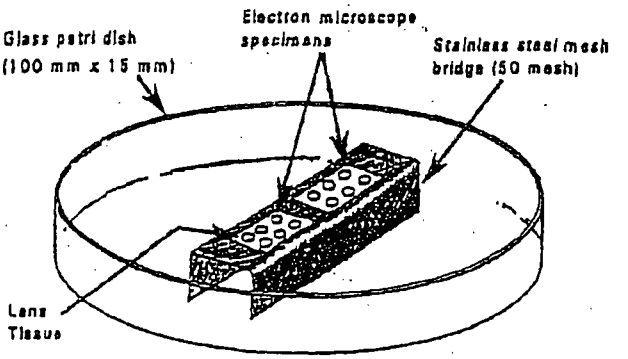


FIG. 2 Example of Design of Solvent Washer (Jaffe Washer)

12.6.2.4 Place the three TEM grid sample filter preparations on the same piece of lens tissue in the Jaffe washer.

12.6.2.5 Place the lid on the Jaffe washer and allow the system to stand for several hours.

12.7 Alternately, place the grids on a low level (petri dish filled to the ⅛ mark) DMF-Jaffe washer for 60 min. Add enough solution of equal parts DMF/acetone to fill the washer to the screen level. Remove the grids after 30 min if they have cleared, that is, all filter material has been removed from the carbon film, as determined by inspection in the TEM.

12.8 Carefully remove the grids from the Jaffe washer, allowing the grids to dry before placing them in a clean marked grid box.

13. TEM Specimen Preparation of Polycarbonate (PC) Filter

13.1 Cover the surface of a clean microscope slide with two strips of double-sided adhesive tape.

13.2 Cut a strip of filter paper slightly narrower than the width of the slide. Position the filter paper strip on the center of the length of the slide.

13.3 Using a clean, curved scalpel blade, cut a strip of the PC filter approximately 25 by 6 mm. Use a rocking motion of the scalpel blade to avoid tearing the filter. Place the PC strip particle side up on the slide perpendicular to the long axis of the slide. The ends of the PC strip must contact the double sided adhesive tape. Each slide can hold several PC strips. With a glass marker, label each PC strip with the individual sample number.

13.4 Carbon coat the PC filter strips as discussed in 12.4.2. PC filters do not require etching.

NOTE 2: Caution—Do not overheat the filter sections while carbon coating.

13.5 Prepare a Jaffe washer as described in 12.5, but fill the washer with chloroform or 1-methyl-2-pyrrolidone to the level of the screen.

13.6 Using a clean curved scalpel blade, excise three, 3-mm square filter pieces from each PC strip. Place the filter squares carbon side up on the shiny side of a TEM grid. Pick up the grid and filter section together and place them on the lens tissue in the Jaffe washer.

13.7 Place the lid on the Jaffe washer and rest the grids in place for at least 4 h. Best results are obtained with longer wicking times, up to 12 h.

13.8 Carefully remove the grids from the Jaffe washer, allowing the grids to dry before placing them in a clean, marked grid box.

14. Grid Opening Measurements

14.1 TEM grids must have a known grid opening area. Determine this area as follows:

14.2 Measure at least 20 grid openings in each of 20 random 75 to 100 µm (200-mesh) copper grids for a total of 400 grid openings for every 1000 grids used, by placing the 20 grids on a glass slide and examining them under the optical microscope. Use a calibrated graticule to measure the average length and width of the 20 openings from each of the individual grids. From the accumulated data, calculate the average grid opening area of the 400 openings.

14.3 Grid area measurements can also be made at the TEM at a calibrated screen magnification of between 15 000 and 20 000X. Typically measure one grid opening for each grid examined. Measure grid openings in both the x and y directions and calculate the area.

14.4 Pre-calibrated TEM grids are also acceptable for this test method.

15. TEM Method

15.1 Microscope settings: 80 to 120 kV, 15 000 to 20 000X screen magnification for analysis (7.2).

15.2 Analyze two grids for each sample. Analyze one-half of the sample area on one sample grid preparation and the remaining half on a second sample grid preparation.

15.3 *Determination of Specimen Suitability:*

15.3.1 Carefully load the TEM grid, carbon side facing up (in the TEM column) with the grid bars oriented parallel/perpendicular to the length of the specimen holder. Use a hand lens or loupe, if necessary. This procedure will line up the grid with the X and y translation directions of the microscope. Insert the specimen holder into the microscope.

15.3.2 Scan the entire grid at low magnification (250X to 1000X) to determine its suitability for high magnification analysis as specified in 15.3.3.

15.3.3 Grids are acceptable for analysis if the following conditions are met:

15.3.3.1 The fraction of grid openings covered by the replica section is at least 50 %.

15.3.3.2 Relative to that section of the grid covered by the carbon replica, the fraction of intact grid openings is greater than 50 %.

15.3.3.3 The fractional area of undissolved filter is less than 10 %.

15.3.3.4 The fraction of grid openings with overlapping or folded replica film is less than 50 %.

15.3.3.5 At least 20 grid openings, that have no overlapping or folded replica, are less than 5 % covered with holes and have less than 5 % opaque area due to incomplete filter dissolution.

15.4 *Determination of Grid Opening Suitability:*

15.4.1 If the grid meets acceptance criteria, choose a grid opening for analysis from various areas of the grid so that the entire grid is represented. Determine the suitability of each individual grid opening prior to the analysis.

15.4.2 The individual grid opening must have less than 5 % holes over its area.

15.4.3 Grid openings must be less than 25 % covered with particulate matter.

15.4.4 Grid openings must be uniformly loaded.

15.5 Observe and record the orientation of the grid at 80 to 150X, on a grid map record sheet along with the location of the grid openings that are examined for the analysis. If indexed grids are used, a grid map is not required, but the identifying coordinates of the grid square must be recorded.

16. Recording Data Rules

16.1 Record on the count sheet any continuous grouping of particles in which an asbestos fiber is detected. Classify asbestos structures as fibers, bundles, clusters, or matrices as defined in 5.2.

16.2 Use the criteria for fiber, bundle, cluster, and matrix identification, as described in the *USEPA Asbestos-Containing*

Materials in Schools document (4). Record, for each AHERA structure identified, the length and width measurements.

16.3 Record NSD (No Structures Detected) when no structures are detected in the grid opening.

16.4 Identify structures classified as chrysotile identified by either electron diffraction or X-ray analysis (7.3) and recorded on a count sheet. Verify at least one out of every ten chrysotile structures by X-ray analysis.

16.5 Structures classified as amphiboles by X-ray analysis and electron diffraction are recorded on the count sheet. For more information on identification, see Yamate, et al, (7) or Chatfield and Dillon (8).

16.6 Record a typical electron diffraction pattern for each type of asbestos observed for each group of samples (or a minimum of every five samples) analyzed. Record the micrograph number on the count sheet. Record at least one X-ray spectrum for each type of asbestos observed per sample. Attach the print-outs to the back of the count sheet. If the X-ray spectrum is stored, record the file and disk number on the count sheet.

16.7 *Counting Rules:*

16.7.1 At a screen magnification of between 15 000 and 20 000X evaluate the grids for the most concentrated sample loading; reject the sample if it is estimated to contain more than 50 asbestos structures per grid opening. Proceed to the next lower concentrated sample until a set of grids are obtained that have less than 30 asbestos structures per grid opening.

16.8 *Analytical Sensitivity*—An analytical sensitivity of approximately 1000 asbestos structures per square centimetre (calculated for the detection of a single asbestos structure) has been designed for this analysis. This sensitivity can be achieved by increasing the amount of liquid filtered, increasing the number of grid openings analyzed, or decreasing the size of the final filter. Occasionally, due to high particle loadings or high asbestos concentration, this analytical sensitivity cannot be practically achieved and stopping rules apply.

16.9 *Limit of Detection*—The limit of detection for this method is defined as, at a minimum, the counting of four asbestos structures during the TEM analysis. If less than four asbestos structures are counted during the analysis then the analytical result which will be reported will be less than the limit of detection and a "less than" sign (<) will appear before the number. All data shall be provided in the laboratory report.

16.10 *Stopping Rules:*

16.10.1 The analysis is stopped upon the completion of the grid square that achieves an analytical sensitivity of less than 1000 asbestos structures per square centimetre.

16.10.2 If an analytical sensitivity of 1000 asbestos structures per square centimetre cannot be achieved after analyzing ten grid openings then stop on grid opening No. 10 or the grid opening which contains the 100th asbestos structure, whichever comes first. A minimum of four grid squares shall be analyzed for each sample.

16.10.2.1 If the analysis is stopped because of the 100th structure rule, the entire grid square containing the 100th structure must be counted.

16.11 After analysis, remove the grids from the TEM, and replace them in the appropriate grid storage holder.

17. Sample Storage

17.1 The washed-out sample cassettes can be discarded after use.

17.2 Sample grids and unused filter sections (7.18) must be stored for a minimum of one year.

18. Reporting

18.1 Report the following information for each dust sample analyzed:

18.1.1 Concentration in structures/cm^2.

18.1.2 The analytical sensitivity.

18.1.3 Types of asbestos present.

18.1.4 Number of asbestos structures counted.

18.1.5 Effective filtration area.

18.1.6 Average size of the TEM grid openings that were counted.

18.1.7 Number of grid openings examined.

18.1.8 Sample dilution used.

18.1.9 Area of the surface sampled.

18.1.10 Listing of size data for each structure counted.

18.1.11 A copy of the TEM count sheet or a complete listing of the raw data. An example of a typical count sheet is shown in Appendix X1.

18.2 Determine the amount of asbestos in any accepted sample using the following formula:

$$\frac{EFA \times 100\ \text{mL} \times \#STR}{GO \times GOA \times V \times SPL} = \text{asbestos structures/cm}^2 \qquad (1)$$

where:

$\#STR$ = number of asbestos structures counted,
EFA = effective filter area of the final sampling filter, mm^2,
GO = number of grid openings counted,
GOA = average grid opening area, mm^2,
SPL = surface area sampled, cm^2, and
V = volume of sample filtered in step 10.4.9, representing the actual volume taken from the original 100 mL suspension, mL.

19. Quality Control/Quality Assurance

19.1 In general, the laboratory's quality control checks are used to verify that a system is performing according to specifications regarding accuracy and consistency. In an analytical laboratory, spiked or known quantitative samples are normally used. However, due to the difficulties in preparing known quantitative asbestos samples, routine quality control testing focuses on re-analysis of samples (duplicate recounts).

19.1.1 Re-analyze samples at a rate of 1/10 of the sample sets (one out of every ten samples analyzed not including laboratory blanks). The re-analysis shall consist of a second sample preparation obtained from the final filter.

19.2 In addition, quality assurance programs must follow the criteria shown in the *USEPA Asbestos-Containing Materials in Schools* document (4) and in the *NIST/NVLAP Program Handbook for Airborne Asbestos Analysis* document (6). These documents describe sample custody, sample preparation, blank checks for contamination, calibration, sample analysis, analyst qualifications, and technical facilities.

20. Calibrations

20.1 Perform calibrations of the instrumentation on a

regular basis, and retain these records in the laboratory, in accordance with the laboratory's quality assurance program.

20.2 Record calibrations in a log book along with dates of calibration and the attached backup documentation.

20.3 A calibration list for the instrument is as follows:

20.3.1 *TEM:*

20.3.1.1 Check the alignment and the systems operation. Refer to the TEM manufacturer's operational manual for detailed instructions.

20.3.1.2 Calibrate the camera length of the TEM in electron diffraction (ED) operating mode before ED patterns of unknown samples are observed. Camera length can be measured 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. Thick gold films will tend to mask weak diffraction spots from the fibrous particles. Since the unknown d-spacings of most interest in asbestos analysis are those which lie closest to the transmitted beam, multiple gold rings from thick films are unnecessary. Alternatively, a gold standard specimen can be used to obtain an average camera constant calculated for that particular instrument and can then be used for ED patterns of unknowns taken during the corresponding period.

20.3.1.3 Perform magnification calibration at the fluorescent screen. This calibration must be performed at the magnification used for structure counting. Calibration is performed with a grating replica (7.47) (for example, one containing at least 2160 lines/mm).

(*a*) Define a field of view on the fluorescent screen. The field of view must be measurable or previously inscribed with a scale or concentric circles (all scales should be metric).

(*b*) Frequency of calibration will depend on the service history of the particular microscope.

(*c*) Check the calibration after any maintenance of the microscope that involves adjustment of the power supply to the lens or the high voltage system or the mechanical disassembly of the electron optical column (apart from filament exchange).

(*d*) The analyst must ensure that the grating replica is placed at the same distance from the objective lens as the specimen.

(*e*) For instruments that incorporate a eucentric tilting specimen stage, all specimens and the grating replica must be placed at the eucentric position.

20.3.1.4 The smallest spot size of the TEM must be checked.

(*a*) At the crossover point, photograph the spot size at a screen magnification of 15 000 to 20 000X. An exposure time of 1 s is usually adequate.

(*b*) The measured spot size must be less than or equal to 250 nm.

20.4 *EDXA:*

20.4.1 The resolution and calibration of the EDXA must be verified.

20.4.1.1 Collect a standard EDXA Cu peak from the Cu grid.

20.4.1.2 Compare the X-ray energy versus channel number for the Cu peak and be certain that readings are within ±10 eV.

20.4.2 Collect a standard EDXA of crocidolite asbestos (NIST SRM 1866).

20.4.2.1 The elemental analysis of the crocidolite must resolve the Na peak.

20.4.3 Collect a standard EDXA of chrysotile asbestos.

20.4.3.1 The elemental analysis of chrysotile must resolve both Si and Mg on a single chrysotile fiber.

20.5 Ultrasonic bath calibration shall be performed as follows:

20.5.1 Fill the bath water to a level equal to the height of suspension in the glass sample container that will be used for the dust analysis. Operate the bath until the water reaches the equilibrium temperature.

20.5.2 Place 100 mL of water (at approximately 20°C) in another 200-mL glass sample container, and record its temperature.

20.5.3 Place the sample container in the water in the ultrasonic bath (with the power turned off). After 60 s, remove the glass container and record its temperature.

20.5.4 Place 100 mL of water (at approximately 20°C) in another 200-mL glass sample container, and record its temperature.

20.5.5 Place the second sample container into the water in the ultrasonic bath (with the power turned on). After 60 s, remove the glass container and record its temperature.

20.5.6 Calculate the rate of energy deposition into the sample container using the following formula:

$$R = 4.185 \times \sigma \times \rho \times \frac{(\theta_2 - \theta_1)}{t} \qquad (2)$$

where:

4.185 = Joules/cal,

R = energy deposition, watts/mL,

θ_1 = temperature rise with the ultrasonic bath not operating, °C,

θ_2 = temperature rise with the ultrasonic bath operating, °C,

t = time in seconds, 60 s (20.5.3 and 20.5.5),

σ = specific heat of the liquid in the glass sample container, 1.0 cal/g, and

ρ = density of the liquid in the glass sample container, 1.0 g/cm^3.

20.5.7 Adjust the operating conditions of the bath so that the rate of energy deposition is in the range of 0.08 to 0.12 MW/m^3, as defined by this procedure.

21. Precision and Bias

21.1 *Precision*—The precision of the procedure in this test method is being determined using round robin data from participating laboratories.

21.2 *Bias*—Since there is no accepted reference material suitable for determining the bias of the procedure in this test method, bias has not been determined (see Specification D 3670).

NOTE 3—Round robin data is under development and will be presented as a research report.

22. Keywords

22.1 asbestos; microvacuuming; settled dust; TEM

APPENDIX

(Nonmandatory Information)

X1. DUST SAMPLE ANALYSIS

X1.1 See Figs. X1.1 and X1.2 for the dust analysis worksheet and the TEM count sheet.

DUST SAMPLE ANALYSIS

Client: _____

Sample ID: _____

Job Number: _____

Date Sample Analyzed: ___ - ___ - ___

Number of Openings/Grids Counted: ___

Grid Accepted, 600X: Yes No

Percent Loading: ___ %

Grid Box #1: _____

Accelerating Voltage: _____

Indicated Mag: ___ KX

Screen Mag: ___ KX

Microscope: 1 2 3 4 5

Filter Type: _____

Filter Size: _____

Filter Pore Size (μm): _____

Grid Opening: 1) ___ μm x ___ μm

2) ___ μm x ___ μm

Analyst: _____

Reviewer: _____

Counting Rules: AHERA LEVEL II

Calculation Data:

Effective Filter Area in mm^2:	(EFA)	_____
Number of Grid Openings Counted:	(GO)	_____
Avderage Grid Opening Area in mm^2:	(GOA)	_____
Volume of sample Filtered in ml:	(V)	_____
Surface area Sampled in cm^2:	(SPL)	_____
Number of Asbestos Structures Counted:*	(#STR)	_____

* If the number of asbestos structures counted is less than or equal to 4, enter 4 structures as the limit of detection here.

FORMULA FOR CALCULATION OF ASBESTOS STRUCTURES "DUST" PER CM^2:

$$\frac{EFA \times 100 \times \#STR}{GO \times GOA \times V \times SPL} = \text{(Asbestos Structures per cm}^2\text{)}$$

Results for Total Asbestos Structures: _____

(Structures per cm^2)

Results for Structures ≥ microns: _____

(Structures per cm^2)

FIG. X1.1 Dust Sample Analysis Work Sheet

Job Number: _____

Structure #	Grid # Square #	Type	Structure	Length Microns	Width Microns	Confirmation		
						Morph.	SAED	EDS

Note: Keys to Abbreviations Used in Figure:

Type:

C = Chrysotile
AM = Amosite
CR = Crocidolite
AC = Actinolite
TR = Tremolite
AN = Anthophyllite
N = Non Asbestos

Structure:

F = Fiber
B = Bundle
C = Cluster
M = Matrix

Others:

NSD = No Structures Detected
Morph = Morphology
SAED = Selected Area Electron Diffraction
EDS = Energy Dispersive X-Ray Spectroscopy
ER = Inter-Row Spacing
NP = No Pattern

FIG. X1.2 TEM Count Sheet

REFERENCES

(1) Steel, E. and Wylie, A., "Mineralogical Characteristics of Asbestos," in *Geology of Asbestos Deposits*, Riordon, P. H., Ed., SME-AIME, 1981, pp. 93–101.

(2) Zussman, J., "The Mineralogy of Asbestos," in *Asbestos: Properties, Applications and Hazards*, John Wiley and Sons, 1979, pp. 45–67.

(3) Leake, B. E., "Nomenclature of Amphiboles," *American Mineralogist*, Vol 63, 1978, pp. 1023–1052.

(4) "*USEPA Asbestos-Containing Materials in Schools: Final Rule and Notice*," *Federal Register*, 40 CFR Part 763, Appendix A to Sub-part E., Oct. 30, 1987.

(5) OSHA, *OSHA Technical Manual, OSHA Instruction CPL 2-20B*, Directorate of Technical Support, U.S. Department of Labor, Washington, DC 20210, Feb. 5, 1990, pp. 1–8 to 1–11.

(6) *NIST/NVLAP Program Handbook for Airborne Asbestos Analysis*, NISTIR, August 1989, pp. 89–4137.

(7) Yamate, G., Agarwall, S. C., and Gibbons, R. D., "Methodology for the Measurement of Airborne Asbestos by Electron Microscopy," EPA Draft Report, Contract No. 68-02-3266, 1984.

(8) Chatfield, E. J., and Dillon, M. J., "Analytical Method for the Determination of Asbestos in Water," EPA No. 600/4-83-043, 1983.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

ASBESTOS and OTHE

7400

Various MW: Various CA: S: Various

METHOD: 7400, Issue 2 EVALUATION: FULL Issue 1: Rev. 3 on 15 May 1989
Issue 2: 15 August 1994

OSHA : 0.1 asbestos fiber (> 5 µm long)/cc; 1 f/cc/30 min excursion; carcinogen
MSHA: 2 asbestos fibers/cc
NIOSH: 0.1 f/cc (fibers > 5 µm long)/400 L; carcinogen
ACGIH: 0.2 crocidolite; 0.5 amosite; 2 chrysotile and other asbestos, fibers/cc; carcinogen

PROPERTIES: solid, fibrous, crystalline, anisotropic

SYNONYMS [CAS #]: actinolite [77536-66-4] or ferroactinolite [15669-07-5]; amosite [12172-73-5]; anthophyllite [77536-67-5]; *chrysotile* [12001-29-5]; *serpentine* [18786-24-8]; *crocidolite* [12001-28-4]; *tremolite* [77536-68-6]; *amphibole asbestos* [1332-21-4]; refractory ceramic fibers [142844-00-6]; fibrous glass.

SAMPLING

SAMPLER:	FILTER (0.45- to 1.2-µm cellulose ester membrane, 25-mm; conductive cowl on cassette)
FLOW RATE*:	0.5 to 16 L/min
VOL-MIN*: -MAX*:	400 L @ 0.1 fiber/cc (step 4, sampling) *Adjust to give 100 to 1300 fiber/mm^2
SHIPMENT:	routine (pack to reduce shock)
SAMPLE STABILITY:	stable
BLANKS:	2 to 10 field blanks per set

ACCURACY

RANGE STUDIED:	80 to 100 fibers counted
BIAS:	see EVALUATION OF METHOD
OVERALL PRECISION ($\hat{S}_{rT}$):	0.115 to 0.13 [1]
ACCURACY:	see EVALUATION OF METHOD

MEASUREMENT

TECHNIQUE:	LIGHT MICROSCOPY, PHASE CONTRAST
ANALYTE:	fibers (manual count)
SAMPLE PREPARATION:	acetone - *collapse/triacetin* - immersion method [2]
COUNTING RULES:	described in previous version of this method as "A" rules [1,3]
EQUIPMENT:	1. positive phase-contrast microscope 2. Walton-Beckett graticule (100-µm field of view) Type G-22 3. phase-shift test slide (HSE/NPL)
CALIBRATION:	HSE/NPL test slide
RANGE:	100 to 1300 fibers/mm^2 filter area
ESTIMATED LOD:	7 fibers/mm^2 filter area
PRECISION ($\hat{S}_r$):	0.10 to 0.12 [1]; see EVALUATION OF METHOD

APPLICABILITY: The quantitative working range is 0.04 to 0.5 fiber/cc for a 1000-L air sample. The LOD depends on sample volume and quantity of interfering dust, and is <0.01 fiber/cc for atmospheres free of interferences. The method gives a n index of airborne fibers. It is primarily used for estimating asbestos concentrations, though PCM does not differentiate betwe en asbestos and other fibers. Use this method in conjunction with electron microscopy (e.g., Method 7402) for assistance in identifi cation of fibers. Fibers < ca. 0.25 µm diameter will not be detected by this method [4]. This method may be used for other materia ls such as fibrous glass by using alternate counting rules (see Appendix C).

INTERFERENCES: If the method is used to detect a specific type of fiber, any other airborne fiber may interfere since all particles meeting the counting criteria are counted. Chain-like particles may appear fibrous. High levels of non-fibrous dust part icles may obscure fibers in the field of view and increase the detection limit.

OTHER METHODS: This revision replaces Method 7400, Revision #3 (dated 5/15/89).

REAGENTS:

1. Acetone,* reagent grade.
2. Triacetin (glycerol triacetate), reagent grade.

* See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: field monitor, 25-mm, three-piece cassette with ca. 50-mm electrically conductive extension cowl and cellulose ester filter, 0.45- to 1.2-µm pore size, and backup pad.

   NOTE 1: Analyze representative filters for fiber background before use to check for clarity and background. Discard the filter lot if mean is ≥5 fibers per 100 graticule fields. These are defined as laboratory blanks. Manufacturer-provided quality assurance checks on filter blanks are normally adequate as long as field blanks are analyzed as described below.

   NOTE 2: The electrically conductive extension cowl reduces electrostatic effects. Ground the cowl when possible during sampling.

   NOTE 3: Use 0.8-µm pore size filters for personal sampling. The 0.45-µm filters are recommended for sampling when performing TEM analysis on the same samples. However, their higher pressure drop precludes their use with personal sampling pumps.

   NOTE 4: Other cassettes have been proposed that exhibit improved uniformity of fiber deposit on the filter surface, e.g., bellmouthed sampler (Envirometrics, Charleston, SC). These may be used if shown to give measured concentrations equivalent to sampler indicated above for the application.
2. Personal sampling pump, battery or line-powered vacuum, of sufficient capacity to meet flow-rate requirements (see step 4 for flow rate), with flexible connecting tubing.
3. Wire, multi-stranded, 22-gauge; 1", hose clamp to attach wire to cassette.
4. Tape, shrink- or adhesive-.
5. Slides, glass, frosted-end, pre-cleaned, 25 x 75-mm.
6. Cover slips, 22- x 22-mm, No. 1-1/2, unless otherwise specified by microscope manufacturer.
7. Lacquer or nail polish.
8. Knife, #10 surgical steel, curved blade.
9. Tweezers.

EQUIPMENT:

10. Acetone flash vaporization system for clearing filters on glass slides (see ref. [5] for specifications or see manufacturer's instructions for equivalent devices).
11. Micropipets or syringes, 5-µL and 100- to 500-µL.
12. Microscope, positive phase (dark) contrast, with green or blue filter, adjustable field iris, 8 to 10X eyepiece, and 40 to 45X phase objective (total magnification ca. 400X); numerical aperture = 0.65 to 0.75.
13. Graticule, Walton-Beckett type with 100-µm diameter circular field (area = 0.00785 mm^2) at the specimen plane (Type G-22). Available from Optometrics USA, P.O. Box 699, Ayer, MA 01432 [phone (508)-772-1700], and McCrone Accessories and Components, 850 Pasquinelli Drive, Westmont, IL 60559 [phone (312) 887-7100].
    NOTE: The graticule is custom-made for each microscope. (see APPENDIX A for the custom-ordering procedure).
14. HSE/NPL phase contrast test slide, Mark II. Available from Optometrics USA (address above).
15. Telescope, ocular phase-ring centering.
16. Stage micrometer (0.01-mm divisions).

SPECIAL PRECAUTIONS: Acetone is extremely flammable. Take precautions not to ignite it. Heating of acetone in volumes greater than 1 mL must be done in a ventilated laboratory fume hood using a flameless, spark-free heat source.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. To reduce contamination and to hold the cassette tightly together, seal the crease between the cassette base and the cowl with a shrink band or light colored adhesive tape. For personal sampling, fasten the (uncapped) open-face cassette to the worker's lapel. The open face should be oriented downward.
   NOTE: The cowl should be electrically grounded during area sampling, especially under conditions of low relative humidity. Use a hose clamp to secure one end of the wire (Equipment, Item 3) to the monitor's cowl. Connect the other end to an earth ground (i.e., cold water pipe).
3. Submit at least two field blanks (or 10% of the total samples, whichever is greater) for each set of samples. Handle field blanks in a manner representative of actual handling of associated samples in the set. Open field blank cassettes at the same time as other cassettes just prior to sampling. Store top covers and cassettes in a clean area (e.g., a closed bag or box) with the top covers from the sampling cassettes during the sampling period.
4. Sample at 0.5 L/min or greater [6]. Adjust sampling flow rate, Q (L/min), and time, t (min), to produce a fiber density, E, of 100 to 1300 fibers/mm^2 ($3.85 \cdot 10^4$ to $5 \cdot 10^5$ fibers per 25-mm filter with effective collection area A_c = 385 mm^2) for optimum accuracy. These variables are related

to the action level (one-half the current standard), L (fibers/cc), of the fibrous aerosol being sampled by:

$$t = \frac{A_c \cdot E}{Q \cdot L \cdot 10^3}, \text{ min.}$$

NOTE 1: The purpose of adjusting sampling times is to obtain optimum fiber loading on the filter. The collection efficiency does not appear to be a function of flow rate in the range of 0.5 to 16 L/min for asbestos fibers [7]. Relatively large diameter fibers (>3 µm) may exhibit significant aspiration loss and inlet deposition. A sampling rate of 1 to 4 L/min for 8 h is appropriate in atmospheres containing ca. 0.1 fiber/cc in the absence of significant amounts of non-asbestos dust. Dusty atmospheres require smaller sample volumes (≤400 L) to obtain countable samples. In such cases take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres, where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3000 to 10000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If ≥ 50% of the filter surface is covered with particles, the filter may be too overloaded to count and will bias the measured fiber concentration.

NOTE 2: OSHA regulations specify a minimum sampling volume of 48 L for an excursion measurement, and a maximum sampling rate of 2.5 L/min [3].

5. At the end of sampling, replace top cover and end plugs.
6. Ship samples with conductive cowl attached in a rigid container with packing material to prevent jostling or damage.

   NOTE: Do not use untreated polystyrene foam in shipping container because electrostatic forces may cause fiber loss from sample filter.

SAMPLE PREPARATION:

NOTE 1: The object is to produce samples with a smooth (non-grainy) background in a medium with refractive index ≤1.46. This method collapses the filter for easier focusing and produces permanent (1 - 10 years) mounts which are useful for quality control and interlaboratory comparison. The aluminum "hot block" or similar flash vaporization techniques may be used outside the laboratory [2]. Other mounting techniques meeting the above criteria may also be used (e.g., the laboratory fume hood procedure for generating acetone vapor as described in Method 7400 - revision of 5/15/85, or the non-permanent field mounting technique used in P&CAM 239 [3,7,8,9]). Unless the effective filtration area is known, determine the area and record the information referenced against the sample ID number [1,9,10,11].

NOTE 2: Excessive water in the acetone may slow the clearing of the filter, causing material to be washed off the surface of the filter. Also, filters that have been exposed to high humidities prior to clearing may have a grainy background.

7. Ensure that the glass slides and cover slips are free of dust and fibers.
8. Adjust the rheostat to heat the "hot block" to ca. 70 °C [2].

   NOTE: If the "hot block" is not used in a fume hood, it must rest on a ceramic plate and be isolated from any surface susceptible to heat damage.
9. Mount a wedge cut from the sample filter on a clean glass slide.
   a. Cut wedges of ca. 25% of the filter area with a curved-blade surgical steel knife using a rocking motion to prevent tearing. Place wedge, dust side up, on slide.

      NOTE: Static electricity will usually keep the wedge on the slide.

b. Insert slide with wedge into the receiving slot at base of "hot block". Immediately place tip of a micropipet containing ca. 250 µL acetone (use the minimum volume needed to consistently clear the filter sections) into the inlet port of the PTFE cap on top of the "hot block" and inject the acetone into the vaporization chamber with a slow, steady pressure on the plunger button while holding pipet firmly in place. After waiting 3 to 5 sec for the filter to clear, remove pipet and slide from their ports.

CAUTION: Although the volume of acetone used is small, use safety precautions. Work in a well-ventilated area (e.g., laboratory fume hood). Take care not to ignite the acetone. Continuous use of this device in an unventilated space may produce explosive acetone vapor concentrations.

c. Using the 5-µL micropipet, immediately place 3.0 to 3.5 µL triacetin on the wedge. Gently lower a clean cover slip onto the wedge at a slight angle to reduce bubble formation. Avoid excess pressure and movement of the cover glass.

NOTE: If too many bubbles form or the amount of triacetin is insufficient, the cover slip may become detached within a few hours. If excessive triacetin remains at the edge of the filter under the cover slip, fiber migration may occur.

d. Mark the outline of the filter segment with a glass marking pen to aid in microscopic evaluation.

e. Glue the edges of the cover slip to the slide using lacquer or nail polish [12]. Counting may proceed immediately after clearing and mounting are completed.

NOTE: If clearing is slow, warm the slide on a hotplate (surface temperature 50 °C) for up to 15 min to hasten clearing. Heat carefully to prevent gas bubble formation.

CALIBRATION AND QUALITY CONTROL:

10. Microscope adjustments. Follow the manufacturers instructions. At least once daily use the telescope ocular (or Bertrand lens, for some microscopes) supplied by the manufacturer to ensure that the phase rings (annular diaphragm and phase-shifting elements) are concentric. With each microscope, keep a logbook in which to record the dates of microscope cleanings and major servicing.

a. Each time a sample is examined, do the following:

(1) Adjust the light source for even illumination across the field of view at the condenser iris. Use Kohler illumination, if available. With some microscopes, the illumination may have to be set up with bright field optics rather than phase contract optics.

(2) Focus on the particulate material to be examined.

(3) Make sure that the field iris is in focus, centered on the sample, and open only enough to fully illuminate the field of view.

b. Check the phase-shift detection limit of the microscope periodically for each analyst/microscope combination:

(1) Center the HSE/NPL phase-contrast test slide under the phase objective.

(2) Bring the blocks of grooved lines into focus in the graticule area.

NOTE: The slide contains seven blocks of grooves (ca. 20 grooves per block) in descending order of visibility. For asbestos counting the microscope optics must completely resolve the grooved lines in block 3 although they may appear somewhat faint, and the grooved lines in blocks 6 and 7 must be invisible when centered in the graticule area. Blocks 4 and 5 must be at least partially visible but may vary slightly in visibility between microscopes. A microscope which fails to meet these requirements has resolution either too low or too high for fiber counting.

(3) If image quality deteriorates, clean the microscope optics. If the problem persists, consult the microscope manufacturer.

11. Document the laboratory's precision for each counter for replicate fiber counts.

a. Maintain as part of the laboratory quality assurance program a set of reference slides to be used on a daily basis [13]. These slides should consist of filter preparations including a range of loadings and background dust levels from a variety of sources including both field

and reference samples (e.g., PAT, AAR, commercial samples). The Quality Assurance Officer should maintain custody of the reference slides and should supply each counter with a minimum of one reference slide per workday. Change the labels on the reference slides periodically so that the counter does not become familiar with the samples.

b. From blind repeat counts on reference slides, estimate the laboratory intra- and intercounter precision. Obtain separate values of relative standard deviation (S_r) for each sample matrix analyzed in each of the following ranges: 5 to 20 fibers in 100 graticule fields, >20 to 50 fibers in 100 graticule fields, and >50 to 400 fibers in 100 graticule fields. Maintain control charts for each of these data files.

NOTE: Certain sample matrices (e.g., asbestos cement) have been shown to give poor precision [9]

12. Prepare and count field blanks along with the field samples. Report counts on each field blank.

NOTE 1: The identity of blank filters should be unknown to the counter until all counts have been completed.

NOTE 2: If a field blank yields greater than 7 fibers per 100 graticule fields, report possible contamination of the samples.

13. Perform blind recounts by the same counter on 10% of filters counted (slides relabeled by a person other than the counter). Use the following test to determine whether a pair of counts by the same counter on the same filter should be rejected because of possible bias: Discard the sample if the absolute value of the difference between the square roots of the two counts (in fiber/mm^2) exceeds 2.77 (X)S'_r, where X = average of the square roots of the two fiber counts (in fiber/mm^2) and $S'_r = \frac{S_r}{2}$, where S_r is the intracounter relative standard deviation for the appropriate count range (in fibers) determined in step 11. For more complete discussions see reference [13].

NOTE 1: Since fiber counting is the measurement of randomly placed fibers which may be described by a Poisson distribution, a square root transformation of the fiber count data will result in approximately normally distributed data [13].

NOTE 2: If a pair of counts is rejected by this test, recount the remaining samples in the set and test the new counts against the first counts. Discard all rejected paired counts. It is not necessary to use this statistic on blank counts.

14. The analyst is a critical part of this analytical procedure. Care must be taken to provide a non-stressful and comfortable environment for fiber counting. An ergonomically designed chair should be used, with the microscope eyepiece situated at a comfortable height for viewing. External lighting should be set at a level similar to the illumination level in the microscope to reduce eye fatigue. In addition, counters should take 10-to-20 minute breaks from the microscope every one or two hours to limit fatigue [14]. During these breaks, both eye and upper back/neck exercises should be performed to relieve strain.

15. All laboratories engaged in asbestos counting should participate in a proficiency testing program such as the AIHA-NIOSH Proficiency Analytical Testing (PAT) Program for asbestos and routinely exchange field samples with other laboratories to compare performance of counters.

MEASUREMENT:

16. Center the slide on the stage of the calibrated microscope under the objective lens. Focus the microscope on the plane of the filter.

17. Adjust the microscope (Step 10).

NOTE: Calibration with the HSE/NPL test slide determines the minimum detectable fiber diameter (ca. 0.25 µm) [4].

18. Counting rules: (same as P&CAM 239 rules [1,10,11]: see examples in APPENDIX B).

a. Count any fiber longer than 5 µm which lies entirely within the graticule area.

(1) Count only fibers longer than 5 µm. Measure length of curved fibers along the curve.

(2) Count only fibers with a length-to-width ratio equal to or greater than 3:1.

b. For fibers which cross the boundary of the graticule field:

(1) Count as 1/2 fiber any fiber with only one end lying within the graticule area, provided that the fiber meets the criteria of rule a above.
(2) Do not count any fiber which crosses the graticule boundary more than once.
(3) Reject and do not count all other fibers.

c. Count bundles of fibers as one fiber unless individual fibers can be identified by observing both ends of a fiber.

d. Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields. Stop at 100 graticule fields regardless of count.

19. Start counting from the tip of the filter wedge and progress along a radial line to the outer edge. Shift up or down on the filter, and continue in the reverse direction. Select graticule fields randomly by looking away from the eyepiece briefly while advancing the mechanical stage. Ensure that, as a minimum, each analysis covers one radial line from the filter center to the outer edge of the filter. When an agglomerate or bubble covers ca. 1/6 or more of the graticule field, reject the graticule field and select another. Do not report rejected graticule fields in the total number counted.

NOTE 1: When counting a graticule field, continuously scan a range of focal planes by moving the fine focus knob to detect very fine fibers which have become embedded in the filter. The small-diameter fibers will be very faint but are an important contribution to the total count. A minimum counting time of 15 seconds per field is appropriate for accurate counting.

NOTE 2: This method does not allow for differentiation of fibers based on morphology. Although some experienced counters are capable of selectively counting only fibers which appear to be asbestiform, there is presently no accepted method for ensuring uniformity of judgment between laboratories. It is, therefore, incumbent upon all laboratories using this method to report total fiber counts. If serious contamination from non-asbestos fibers occurs in samples, other techniques such as transmission electron microscopy must be used to identify the asbestos fiber fraction present in the sample (see NIOSH Method 7402). In some cases (i.e., for fibers with diameters >1 µm), polarized light microscopy (as in NIOSH Method 7403) may be used to identify and eliminate interfering non-crystalline fibers [15].

NOTE 3: Do not count at edges where filter was cut. Move in at least 1 mm from the edge.

NOTE 4: Under certain conditions, electrostatic charge may affect the sampling of fibers. These electrostatic effects are most likely to occur when the relative humidity is low (below 20%), and when sampling is performed near the source of aerosol. The result is that deposition of fibers on the filter is reduced, especially near the edge of the filter. If such a pattern is noted during fiber counting, choose fields as close to the center of the filter as possible [5].

NOTE 5: Counts are to be recorded on a data sheet that provides, as a minimum, spaces on which to record the counts for each field, filter identification number, analyst's name, date, total fibers counted, total fields counted, average count, fiber density, and commentary. Average count is calculated by dividing the total fiber count by the number of fields observed. Fiber density (fibers/mm ^{2}) is defined as the average count (fibers/field) divided by the field (graticule) area (mm ^{2}/field).

CALCULATIONS AND REPORTING OF RESULTS

20. Calculate and report fiber density on the filter, E (fibers/mm ^{2}), by dividing the average fiber count per graticule field, F/n_f, minus the mean field blank count per graticule field, B/n_b, by the graticule field area, A_f (approx. 0.00785 mm ^{2}):

$$E = \frac{\left(\frac{F}{n_f} - \frac{B}{n_b}\right)}{A_f}, \text{ fibers/mm}^2.$$

NOTE: Fiber counts above 1300 fibers/mm ^{2} and fiber counts from samples with >50% of filter area covered with particulate should be reported as "uncountable" or "probably biased." Other fiber counts outside the 100-1300 fiber/mm ^{2} range should be reported as having "greater than optimal variability" and as being "probably biased."

21. Calculate and report the concentration, C (fibers/cc), of fibers in the air volume sampled, V (L), using the effective collection area of the filter, A_c (approx. 385 mm ^{2} for a 25-mm filter):

$$C = \frac{(E)(A_c)}{V \cdot 10^3}.$$

NOTE: Periodically check and adjust the value of A_c, if necessary.

22. Report intralaboratory and interlaboratory relative standard deviations (from Step 11) with each set of results.

NOTE: Precision depends on the total number of fibers counted [1,16]. Relative standard deviation is documented in references [1,15-17] for fiber counts up to 100 fibers in 100 graticule fields. Comparability of interlaboratory results is discussed below. As a first approximation, use 213% above and 49% below the count as the upper and lower confidence limits for fiber counts greater than 20 (Fig. 1).

EVALUATION OF METHOD:

A. This method is a revision of P&CAM 239 [10]. A summary of the revisions is as follows:
   1. Sampling:
      The change from a 37-mm to a 25-mm filter improves sensitivity for similar air volumes. The change in flow rates allows for 2-m ^{3} full-shift samples to be taken, providing that the filter is not overloaded with non-fibrous particulates. The collection efficiency of the sampler is not a function of flow rate in the range 0.5 to 16 L/min [10].
   2. Sample Preparation Technique:
      The acetone vapor-triacetin preparation technique is a faster, more permanent mounting technique than the dimethyl phthalate/diethyl oxalate method of P&CAM 239 [2,4,10]. The aluminum "hot block" technique minimizes the amount of acetone needed to prepare each sample.
   3. Measurement:
      a. The Walton-Beckett graticule standardizes the area observed [14,18,19].
      b. The HSE/NPL test slide standardizes microscope optics for sensitivity to fiber diameter [4,14].
      c. Because of past inaccuracies associated with low fiber counts, the minimum recommended loading has been increased to 100 fibers/mm ^{2} filter area (a total of 78.5 fibers counted in 100 fields, each with field area = .00785 mm ^{2}.) Lower levels generally result in an overestimate of the fiber count when compared to results in the recommended analytical range [20]. The recommended loadings should yield intracounter S_r in the range of 0.10 to 0.17 [21,22,23].

B. Interlaboratory comparability:
   An international collaborative study involved 16 laboratories using prepared slides from the asbestos cement, milling, mining, textile, and friction material industries [9]. The relative standard deviations (S_r) varied with sample type and laboratory. The ranges were:

	Intralaboratory S_r	Interlaboratory S_r	Overall S_r
AIA (NIOSH A Rules)*	0.12 to 0.40	0.27 to 0.85	0.46
Modified CRS (NIOSH B Rules)**	0.11 to 0.29	0.20 to 0.35	0.25

* Under AIA rules, only fibers having a diameter less than 3 µm are counted and fibers attached to particles larger than 3 µm are not counted. NIOSH A Rules are otherwise similar to the AIA rules.
** See Appendix C.

A NIOSH study conducted using field samples of asbestos gave intralaboratory S_r in the range 0.17 to 0.25 and an interlaboratory S_r of 0.45 [21]. This agrees well with other recent studies [9,14,16].

At this time, there is no independent means for assessing the overall accuracy of this method. One measure of reliability is to estimate how well the count for a single sample agrees with the mean count from a large number of laboratories. The following discussion indicates how this estimation can be carried out based on measurements of the interlaboratory variability, as well as showing how the results of this method relate to the theoretically attainable counting precision and to measured intra- and interlaboratory S_r. (NOTE: The following discussion does not include bias estimates and should not be taken to indicated that lightly loaded samples are as accurate as properly loaded ones).

Theoretically, the process of counting randomly (Poisson) distributed fibers on a filter surface will give an S_r that depends on the number, N, of fibers counted:

$$S_r = 1/(N)^{1/2} \qquad (1)$$

Thus S_r is 0.1 for 100 fibers and 0.32 for 10 fibers counted. The actual S_r found in a number of studies is greater than these theoretical numbers [17,19,20,21].

An additional component of variability comes primarily from subjective interlaboratory differences. In a study of ten counters in a continuing sample exchange program, Ogden [15] found this subjective component of intralaboratory S_r to be approximately 0.2 and estimated the overall S_r by the term:

$$\frac{[N + (0.2 \cdot N)^2]^{1/2}}{N} \qquad (2)$$

Ogden found that the 90% confidence interval of the individual intralaboratory counts in relation to the means were +2 S_r and - 1.5 S_r. In this program, one sample out of ten was a quality control sample. For laboratories not engaged in an intensive quality assurance program, the subjective component of variability can be higher.

In a study of field sample results in 46 laboratories, the Asbestos Information Association also found that the variability had both a constant component and one that depended on the fiber count [14]. These results gave a subjective interlaboratory component of S_r (on the same basis as Ogden's) for field samples of ca. 0.45. A similar value was obtained for 12 laboratories analyzing a set of 24 field samples [21]. This value falls slightly above the range of S_r (0.25 to 0.42 for 1984-85) found for 80 reference laboratories in the NIOSH PAT program for laboratory-generated samples [17].

A number of factors influence S_r for a given laboratory, such as that laboratory's actual counting performance and the type of samples being analyzed. In the absence of other information, such as from an interlaboratory quality assurance program using field samples, the value for the subjective component of variability is chosen as 0.45. It is hoped that the laboratories will carry out the recommended interlaboratory quality assurance programs to improve their performance and thus reduce the S_r.

The above relative standard deviations apply when the population mean has been determined. It is more useful, however, for laboratories to estimate the 90% confidence interval on the mean count from a single sample fiber count (Figure 1). These curves assume similar shapes of the count distribution for interlaboratory and intralaboratory results [16].

For example, if a sample yields a count of 24 fibers, Figure 1 indicates that the mean interlaboratory count will fall within the range of 227% above and 52% below that value 90% of the time. We can apply these percentages directly to the air concentrations as well. If, for instance, this sample (24 fibers counted) represented a 500-L volume, then the measured concentration is 0.02 fibers/mL (assuming 100 fields counted, 25-mm filter, 0.00785 mm^2 counting field area). If this same sample were counted by a group of laboratories, there is a 90% probability that the mean would fall between 0.01 and 0.08 fiber/mL. These limits should be reported in any comparison of results between laboratories.

Note that the S_r of 0.45 used to derive Figure 1 is used as an estimate for a random group of laboratories. If several laboratories belonging to a quality assurance group can show that their interlaboratory S_r is smaller, then it is more correct to use that smaller S_r. However, the estimated S_r of 0.45 is to be used in the absence of such information. Note also that it has been found that S_r can be higher for certain types of samples, such as asbestos cement [9].

Quite often the estimated airborne concentration from an asbestos analysis is used to compare to a regulatory standard. For instance, if one is trying to show compliance with an 0.5 fiber/mL standard using a single sample on which 100 fibers have been counted, then Figure 1 indicates that the 0.5 fiber/mL standard must be 213% higher than the measured air concentration. This indicates that if one measures a fiber concentration of 0.16 fiber/mL (100 fibers counted), then the mean fiber count by a group of laboratories (of which the compliance laboratory might be one) has a 95% chance of being less than 0.5 fibers/mL; i.e., $0.16 + 2.13 \times 0.16 = 0.5$.

It can be seen from Figure 1 that the Poisson component of the variability is not very important unless the number of fibers counted is small. Therefore, a further approximation is to simply use +213% and -49% as the upper and lower confidence values of the mean for a 100-fiber count.

Figure 1. Interlaboratory Precision of Fiber Counts

The curves in Figures 1 are defined by the following equations:

$$UCL = \frac{2X + 2.25 + [(2.25 + 2X)^2 - 4(1 - 2.25 S_r^2) X^2]^{1/2}}{2(1 - 2.25 S_r^2)} \quad (3)$$

$$LCL = \frac{2X + 4 - [(4 + 2X)^2 - 4(1 - 4 S_r^2) X^2]^{1/2}}{2(1 - 4 S_r^2)} \quad (4)$$

where S_r = subjective interlaboratory relative standard deviation, which is close to the total interlaboratory S_r when approximately 100 fibers are counted.
X = total fibers counted on sample
LCL = lower 95% confidence limit.
UCL = upper 95% confidence limit.
Note that the range between these two limits represents 90% of the total range.

REFERENCES:

[1] Leidel, N. A., S. G. Bayer, R. D. Zumwalde, and K. A. Busch. USPHS/NIOSH Membrane Filter Method for Evaluating Airborne Asbestos Fibers, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 79-127 (1979).

[2] Baron, P. A. and G. C. Pickford. "An Asbestos Sample Filter Clearing Procedure," Appl. Ind. Hyg., 1:169-171, 199 (1986).

[3] Occupational Safety and Health Administration, U.S. Department of Labor, Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite Asbestos; Final Rules, 29 CFR Part 1910.1001 Amended June 20, 1986.

[4] Rooker, S. J., N. P. Vaughn, and J. M. LeGuen. "On the Visibility of Fibers by Phase Contrast Microscopy," Amer. Ind. Hyg. Assoc. J., 43, 505-515 (1982).

[5] Baron, P. and G. Deye, "Electrostatic Effects in Asbestos Sampling," Parts I and II Amer. Ind. Hyg. Assoc. J., 51, 51-69 (1990).

[6] Johnston, A. M., A. D. Jones, and J. H. Vincent. "The Influence of External Aerodynamic Factors on the Measurement of the Airborne Concentration of Asbestos Fibers by the Membrane Filter Method," Ann. Occup. Hyg., 25, 309-316 (1982).

[7] Beckett, S.T., "The Effects of Sampling Practice on the Measured Concentration of Airborne Asbestos," Ann. Occup. Hyg., 21, 259-272 (1980).

[8] Jankovic, J. T., W. Jones, and J. Clere. "Field Techniques for Clearing Cellulose Ester Filters Used in Asbestos Sampling," Appl. Ind. Hyg., 1, 145-147 (1986).

[9] Crawford, N. P., H. L. Thorpe, and W. Alexander. "A Comparison of the Effects of Different Counting Rules and Aspect Ratios on the Level and Reproducibility of Asbestos Fiber Counts," Part I: Effects on Level (Report No. TM/82/23), Part II: Effects on Reproducibility (Report No. TM/82/24), Institute of Occupational Medicine, Edinburgh, Scotland (December, 1982).

[10] NIOSH Manual of Analytical Methods, 2nd ed., Vol. 1., P&CAM 239, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-A (1977).

[11] Revised Recommended Asbestos Standard, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-169 (1976); as amended in NIOSH statement at OSHA Public Hearing, June 21, 1984.

[12] Asbestos International Association, AIA Health and Safety Recommended Technical Method #1 (RTMI). "Airborne Asbestos Fiber Concentrations at Workplaces by Light Microscopy" (Membrane Filter Method), London (1979).

[13] Abell, M., S. Shulman and P. Baron. The Quality of Fiber Count Data, Appl. Ind. Hyg., 4, 273-285 (1989).

[14] "A Study of the Empirical Precision of Airborne Asbestos Concentration Measurements in the Workplace by the Membrane Filter Method," Asbestos Information Association, Air Monitoring Committee Report, Arlington, VA (June, 1983).
[15] McCrone, W., L. McCrone and J. Delly, "Polarized Light Microscopy," Ann Arbor Science (1978).
[16] Ogden, T. L. "The Reproducibility of Fiber Counts," Health and Safety Executive Research Paper 18 (1982).
[17] Schlecht, P. C. and S. A. Schulman. "Performance of Asbestos Fiber Counting Laboratories in the NIOSH Proficiency Analytical Testing (PAT) Program," Am. Ind. Hyg. Assoc. J., 47, 259-266 (1986).
[18] Chatfield, E. J. Measurement of Asbestos Fiber Concentrations in Workplace Atmospheres, Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos in Ontario, Study No. 9, 180 Dundas Street West, 22nd Floor, Toronto, Ontario, CANADA M5G 1Z8.
[19] Walton, W. H. "The Nature, Hazards, and Assessment of Occupational Exposure to Airborne Asbestos Dust: A Review," Ann. Occup. Hyg., 25, 115-247 (1982).
[20] Cherrie, J., A.D. Jones, and A.M. Johnston. "The Influence of Fiber Density on the Assessment of Fiber Concentration Using the membrane filter Method." Am. Ind. Hyg. Assoc. J., 47(8), 465-74 (1986).
[21] Baron, P. A. and S. Shulman. "Evaluation of the Magiscan Image Analyzer for Asbestos Fiber Counting." Am. Ind. Hyg. Assoc. J., (in press).
[22] Taylor, D. G., P. A. Baron, S. A. Shulman and J. W. Carter. "Identification and Counting of Asbestos Fibers," Am. Ind. Hyg. Assoc. J. 45(2), 84-88 (1984).
[23] "Potential Health Hazards of Video Display Terminals," NIOSH Research Report, June 1981.
[24] "Reference Methods for Measuring Airborne Man-Made Mineral Fibers (MMMF)," WHO/EURO Technical Committee for Monitoring an Evaluating Airborne MMMF, World Health Organization, Copenhagen (1985).
[25] Criteria for a Recommended Standard...Occupational Exposure to Fibrous Glass, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-152 (1977).

METHOD WRITTEN BY:

Paul A. Baron, Ph.D., NIOSH/DPSE.

APPENDIX A: CALIBRATION OF THE WALTON-BECKETT GRATICULE:

Before ordering the Walton-Beckett graticule, the following calibration must be done to obtain a counting area (D) 100 µm in diameter at the image plane. The diameter, d_c (mm), of the circular counting area and the disc diameter must be specified when ordering the graticule.

1. Insert any available graticule into the eyepiece and focus so that the graticule lines are sharp and clear.
2. Set the appropriate interpupillary distance and, if applicable, reset the binocular head adjustment so that the magnification remains constant.
3. Install the 40 to 45X phase objective.
4. Place a stage micrometer on the microscope object stage and focus the microscope on the graduated lines.
5. Measure the magnified grid length of the graticule, L_o (µm), using the stage micrometer.
6. Remove the graticule from the microscope and measure its actual grid length, L_a (mm). This can best be accomplished by using a stage fitted with verniers.
7. Calculate the circle diameter, d_c (mm), for the Walton-Beckett graticule:

$$d_c = \frac{L_a}{L_o} \times D. \quad (5)$$

Example: If L_o = 112 µm, L_a = 4.5 mm and D = 100 µm, then d_c = 4.02 mm.

8. Check the field diameter, D (acceptable range 100 µm ± 2 µm) with a stage micrometer upon receipt of the graticule from the manufacturer. Determine field area (acceptable range 0.00754 mm^2 to 0.00817 mm^2).

APPENDIX B: COMPARISON OF COUNTING RULES:

Figure 2 shows a Walton-Beckett graticule as seen through the microscope. The rules will be discussed as they apply to the labeled objects in the figure.

Figure 2. Walton-Beckett graticule with fibers.

These rules are sometimes referred to as the "A" rules.

FIBER COUNT

Object	Count	DISCUSSION
1	1 fiber	Optically observable asbestos fibers are actually bundles of fine fibrils. If the fibrils seem to be from the same bundle the object is counted as a single fiber. Note, however, that all objects meeting length and aspect ratio criteria are counted whether or not they appear to be asbestos.
2	2 fiber	If fibers meeting the length and aspect ratio criteria (length >5 µm and length-to-width ratio >3 to 1) overlap, but do not seem to be part of the same bundle, they are counted as separate fibers.
3	1 fiber	Although the object has a relatively large diameter (>3 µm), it is counted as fiber under the rules. There is no upper limit on the fiber diameter in the counting rules. Note that fiber width is measured at the widest compact section of the object.
4	1 fiber	Although long fine fibrils may extend from the body of a fiber, these fibrils are considered part of the fiber if they seem to have originally been part of the bundle.
5	Do not count	If the object is ≤5 µm long, it is not counted.
6	1 fiber	A fiber partially obscured by a particle is counted as one fiber. If the fiber ends emanating from a particle do not seem to be from the same fiber and each end meets the length and aspect ratio criteria, they are counted as separate fibers.
7	1/2 fiber	A fiber which crosses into the graticule area one time is counted as 1/2 fiber.
8	Do not count	Ignore fibers that cross the graticulate boundary more than once. count
9	Do not count	Ignore fibers that lie outside the graticule boundary.

APPENDIX C. ALTERNATE COUNTING RULES FOR NON-ASBESTOS FIBERS

Other counting rules may be more appropriate for measurement of specific non-asbestos fiber types, such as fibrous glass. These include the "B" rules given below (from NIOSH Method 7400, Revision #2, dated 8/15/87), the World Health Organization reference method for man-made mineral fiber [24], and the NIOSH fibrous glass criteria document method [25]. The upper diameter limit in these methods prevents measurements of non-thoracic fibers. It is important to note that the aspect ratio limits included in these methods vary. NIOSH recommends the use of the 3:1 aspect ratio in counting fibers.

It is emphasized that hybridization of different sets of counting rules is not permitted. Report specifically which set of counting rules are used with the analytical results.

"B" COUNTING RULES:

1. Count only ends of fibers. Each fiber must be longer than 5 µm and less than 3 µm diameter.
2. Count only ends of fibers with a length-to-width ratio equal to or greater than 5:1.
3. Count each fiber end which falls within the graticule area as one end, provided that the fiber meets rules 1 and 2 above. Add split ends to the count as appropriate if the split fiber segment also meets the criteria of rules 1 and 2 above.
4. Count visibly free ends which meet rules 1 and 2 above when the fiber appears to be attached to another particle, regardless of the size of the other particle. Count the end of a fiber obscured by another particle if the particle covering the fiber end is less than 3 µm in diameter.
5. Count free ends of fibers emanating from large clumps and bundles up to a maximum of 10 ends (5 fibers), provided that each segment meets rules 1 and 2 above.
6. Count enough graticule fields to yield 200 ends. Count a minimum of 20 graticule fields. Stop at 100 graticule fields, regardless of count.
7. Divide total end count by 2 to yield fiber count.

APPENDIX D. EQUIVALENT LIMITS OF DETECTION AND QUANTITATION

fiber density on filter*		fiber concentration in air, f/cc	
fibers per 100 fields	fibers/mm^2	400-L air sample	1000-L air sample
200	255	0.25	0.10
100	127	0.125	0.05
LOQ.....80	102	.....0.10	.....0.04
50	64	0.0625	0.025
25	32	0.03	0.0125
20	25	0.025	0.010
10	12.7	0.0125	0.005
8	10.2	0.010	0.004
LOD.....5.5	7	.....0.00675	.....0.0027

* Assumes 385 mm^2 effective filter collection area, and field area = 0.00785 mm^2, for relatively "clean" (little particulate aside from fibers) filters.

Appendix F

Site Photographs

Photograph 1. Woodchip pile on former nursery lot.

Photograph 2. Gravel parking lot (former popping plant location).

Photograph 3. Railroad spur and former popping plant location.

Plate 1

Stimson Lumber Company
Libby Operations Site Plan

TARGET SHEET

EPA REGION VIII

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 1000188

SITE NAME: Libby Asbestos

DOCUMENT DATE: November 2001

DOCUMENT NOT SCANNED

Due to one of the following reasons:

- ☐ PHOTOGRAPHS
- ☐ 3-DIMENSIONAL
- ☑ OVERSIZED
- ☐ AUDIO/VISUAL
- ☐ PERMANENTLY BOUND DOCUMENTS
- ☐ POOR LEGIBILITY
- ☐ OTHER
- ☐ NOT AVAILABLE
- ☐ TYPES OF DOCUMENTS NOT TO BE SCANNED
  (Data Packages, Data Validation, Sampling Data, CBI, Chain of Custody)

DOCUMENT DESCRIPTION:

Map: Libby Operations Site Plan, Dated November 13, 1999

Contact the Superfund Records Center to view available document.
(303) 312-6473