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DRAFT

Sampling and Quality Assurance Project Plan
Revision 0

New York City
Department of Environmental Health

Environmental Monitoring for Asbestos Associated with the Collapse of the World Trade Center

Evaluation of Exposure to
Airborne Asbestos Fibers and Metals
During Routine and Special Activities

Kelly McKinney, Deputy Commissioner for Health
City of New York

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A. PROJECT MANAGEMENT

A4. PROJECT/TASK ORGANIZATION

Project Directors

This project is being planned by the City of New York and funded by the Federal Emergency Management Agency (FEMA). The following individuals are the project directors with overall responsibility for the design and conduct of this project, and will be the principal data users and decision makers:

Kelly McKinney: Deputy Commissioner of Health
City of New York

Project Managers

Responsibility for implementation of the tasks specified in this project Plan has been assigned to the USPHS through Emergency Support Function (ESF) #8. The following individuals are the USPHS Managers with overall responsibility for ensuring successful performance of the tasks specified in this plan:

_____.

Quality Assurance

All Quality Assurance activities associated with the implementation of this plan will be coordinated by the following Quality Assurance Officer:

_____
_____

The Quality Assurance Officer may personally assess any aspect of this plan and require response actions as needed, or may delegate assessment responsibility to qualified staff.

A5. PROBLEM DEFINITION and BACKGROUND

Subsequent to the recent attack on the World Trade Center (WTC), concerns of wider spread environmental asbestos and other contamination have been raised. The general purpose of this communication is to recommend the development of a focused but comprehensive environmental sampling plan which will, 1) scientifically assess the nature and extent of dust and debris which

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was spread throughout the metropolitan area of lower Manhattan following the collapse of the WTC, 2) acquire specific, exposure-based environmental data specifically designed to allow for a focused human health assessment (both short and long term) for commercial business owners, city workers, and the public who may be exposed to environmental contaminants and asbestos in dust and debris as they return to their homes and places of business, 3) provide specific chemical and geographic information regarding environmental asbestos contamination if specific cleanup is required. In order to address these concerns with regard to environmental asbestos contamination beyond the immediate vicinity of the WTC collapse, which includes both outdoor and indoor (e.g., offices, apartments) situations, we suggest that the following recommendations be considered and used to refine sampling, analysis, and quality assurance project plans consistent with applicable State and Federal guidance. Of note, information concerning other potentially harmful contaminants (e.g., lead) can also be easily obtained, as indicated, as a compliment to asbestos assessment efforts.

Because human health risk from asbestos is mediated by inhalation exposure, greatest emphasis has been placed on collection and analysis of air samples. To date, most air samples at locations surrounding the WTC have been collected using stationary air monitors and the concentration of fibers has been estimated using Phase Constrast and/or Transmission Electron Microscopy (TEM). However, there are issues which exist with regard to both the collection technique (stationary air monitors) and the analytical technique (PCM/TEM).

With regard to the stationary air monitor sampling method, the potential issue is that, in a location where asbestos fibers are present in a source such as dust or debris, some types of human activities may tend to "kick-up" asbestos fibers into the air, resulting in an increase in asbestos fiber concentration in the breathing zone of the person engaged in the activity. One study has shown that asbestos concentrations in soil even well below 1% (i.e., 0.001%) by volume can generate hazardous personal airborne asbestos exposures depending on the activity (Addison 1988). Stationary air monitors are useful and appropriate for assessing the "passive" exposures of people in areas (i.e., apartments, offices) who are not engaged in dust generating activities (e..g., watching TV, sitting at a desk), but may greatly underestimate (as much as 100 to 1000 fold) exposures of the people directly engaged in activities which can generate dust (e.g, house or office cleaning work). ***Therefore, the first objective of this sampling effort is to measure asbestos levels in the breathing zone of individuals engaged in routine and special activities in businesses, apartments and near the areas impacted by the collapse of the WTC, and to compare those measurements to data collected from co-located (or near-by) stationary air monitors.*** This information will be helpful in deciding what type of air sampling method is needed to evaluate risks to individuals engaged in both routine and special activities in businesses and/or apartments.

With regard to the analytical technique, the issue is that air samples have historically been analyzed for asbestos using Phase Contrast Light Microscopy (PCM), and the EPA current slope factor for quantifying lung cancer risk from asbestos in air is expressed in units of risk per PCM fiber per cc of air (USEPA 2000a). Thus, even though it is widely recognized that TEM analyses are more accurate and more powerful than PCM analyses, measurements of asbestos

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concentration based on TEM are difficult to convert to an equivalent concentration by PCM (this is referred to as PCM equivalents, or PCME). ***Thus, the second objective of this sampling effort is to analyze a series of different air samples by both the TEM and PCM methods in order to derive a site-specific relationship between the two, and to help judge which type of measurement is most appropriate.***

As noted above, the chief reason for collecting data on asbestos fiber levels in air is to support risk assessment and risk management decision making. ***Thus, the third objective of the study is to utilize the data collected to derive preliminary assessments of the potential health risk to people who engage in the types of routine and special activities investigated during the study.*** Because the study will not span all possible exposure conditions and all exposure locations, the data will be used to help estimate the range of different exposure levels (and hence health risks) that business owners and residents of Lower Manhattan may experience from both routine and special activities.

A6. PROJECT/TASK DESCRIPTION

The basic tasks required to achieve the three main objectives of this phase of the WTC site investigation are listed below:

ATSDR, Berman

1. Collect samples of air from the breathing zone of people engaged in routine and special activities in businesses and apartments in the vicinity of the WTC where asbestos-contaminated debris or dust might result in increased concentrations of asbestos fibers in air.

2. Collect air samples from a fixed air monitor in the lobby or main living area of apartments where individuals engage in the routine or special activities referred to above.

3. Analyze each air sample by each of two methods (TEM, PCM). done EPA by OSHA DEC

4. Compare the personal air monitoring data to the data from the fixed air monitors to judge the reliability of the fixed air monitors in predicting exposures associated with routine or special activities. results not used by OSHA for our purposes

5. Compare the results of the TEM and PCM measurements and (if the data warrant) derive a site-specific empirical conversion factor that relates one to the other.

6. Using current (USEPA 2000a) and proposed (Berman and Crump 2000b) risk assessment methods for airborne asbestos, compare and contrast the risk estimates derived by each of the two approaches in order to determine whether one or more of the routine or special activities is associated with exposures that are above a level of health concern.

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A7. QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

USEPA has developed a seven-step Data Quality Objectives (DQO) procedure that is designed to ensure that sampling and analysis plans are carefully thought out and that the results of the effort will be adequate to meet the basic objectives of the program. Application of this seven step procedure to each of the three main objectives of this project are presented below.

FIRST OBJECTIVE: Personal Air Monitor vs Stationary Air Monitor

Step 1. State the Problem

The primary issue to be addressed is that asbestos levels in air collected using stationary air monitors located at outside (ambient) locations and in the central living space of apartments or occupied offices may not accurately represent exposures of people engaged in routine or special activities in locations where asbestos or other contaminants associated with the WTC collapse may be released in to the air from debris or dust.

Step 2. Identify the Decision

The decision to be made is whether stationary air monitors can be used to evaluate exposure and risk to residents from airborne asbestos in businesses and apartments in the vicinity of the WTC, or whether personal air sampling should be used in addition to or in place of stationary air monitors. should use both

Step 3. Identify Inputs to the Decision

Data needed to achieve this objective consist of accurate and reliable measurements of asbestos levels in the breathing zone of people engaged in routine or special activities in businesses and/or apartments, paired with accurate and reliable measurements of asbestos levels in air collected using a stationary air monitor located in the main living area or workplace. Measurements of asbestos levels in breathing zone air will be collected using personal air monitors.

The number of paired samples needed for each routine or special activity that is investigated is difficult to judge, since it is expected that there could be wide variations between locations in the levels of asbestos in source material (debris or dust), and in the amount of each source material suspended in air by the activity. Thus, the range of concentration and risk estimates based on either personal or stationary air samples could vary substantially from case to case. In general, when variability is wide, more samples are needed to support risk management decisions. The objective of this effort is to identify a variety of relevant exposure categories (i.e. apartments, apartment lobbies, commercial businesses, etc) and evaluate a representative number sites (8-12) within each of these categories. If specific conditions associated with hazardous exposures are identified, this information can be communicated to the public and practical risk management decisions can be implemented (where necessary) to mitigate or abate unacceptable risks.

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Step 4. Define the Study Boundaries

There are a wide variety of routine and special human activities which might result in the generation of elevated levels of asbestos in breathing zone air. The activities selected for evaluation in this investigation are listed below:

1) Routine household activities (excluding active cleaning)
2) Active apartment cleaning (dusting, sweeping, vacuuming, etc.)
3) Simulated restoration (construction or demolition) activities that involve direct contact or handling of debris or dust.

Step 5. Develop a Decision Rule

The degree of similarity (or dissimilarity) of concentration values measured by personal air monitors and by fixed air monitors will be judged semi-quantitatively. The exact data evaluation procedure cannot be stated *a priori*, but it is expected that, for each type of activity investigated, a simple plot of the fixed station value (x-axis) versus the corresponding personal air value (y-axis) will reveal if there is a systematic pattern of differences between the two. For example, if the slope of the line is close to 1.0, it will be decided that there are no large and consistent differences, and that fixed air monitoring is adequate for assessing human exposure associated with the activity being considered. Conversely, if the slope of the line is substantially greater than 1.0, it will be concluded that fixed air monitors tend to underestimate personal exposures for individuals engaged in the specific activities investigated. In general, if significant differences exist between the two types of measurements, personal air samples will be judged to be most appropriate for assessing risks to individuals engaged in the activities, and data from stationary air monitors will be considered appropriate for individuals residing within the same apartment or working in the same location who may be passively exposed to the dust generated by the activity.

Step 6. Specify Limits on Decision Errors

With regard to the decision as to whether data from stationary air monitors are adequate for assessing personal exposure during some routine or special activity, the decision is semi-quantitative and no formal limit is imposed on decision error.

Step 7. Optimize the Design for Obtaining Results

Additional air samples or samples from different types of activities may be collected and incorporated into the study results as data become available on actual airborne exposure levels associated with specific types of activity. Samples collected on stationary or personal air monitors may also be analyzed for a variety of other environmental contaminants (e.g., metals, PCBs).

SECOND OBJECTIVE: PCM vs TEM

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Step 1. State the Problem

The second issue being addressed by this study is that most air concentration data obtained to date at the site are based on PCM and/or TEM measurements, while the current risk assessment method used by EPA for asbestos is based solely on fiber counts measured by PCM. The reasons for this dichotomy are mainly historic: most historic epidemiological studies of asbestos exposure in workers used PCM to quantify asbestos levels in air, and these studies provide the basic dose-response data used by EPA to establish the slope factor for lung cancer. However, PCM is subject to a number of limitations, and it is well recognized that TEM can identify thinner fibers than PCM, and is also able to clearly distinguish asbestos from non-asbestos fibers. For these reasons, TEM is the preferred approach, but an estimate of what the PCM result would be is also needed in order to be able to utilize the current cancer slope factor. Thus, a site-specific empiric conversion factor between TEM and PCM fiber counts is required to allow fiber counts measured by one technique to be extrapolated to the results that would have been obtained by the other technique.

Step 2. Identify the Decision

The purpose of this part of the study design is to develop an empiric conversion factor to convert from TEM to PCM fiber counts (and vice versa). No formal decision will be based on this conversion factor. Note that an empiric factor derived for the WTC or at different sites within the WTC vicinity may not be applicable to other sites.

Step 3. Identify Inputs to the Decision

Data required to establish a site-specific empirical correlation factor between PCM fibers and TEM fibers is an extensive set of samples analyzed by each method. Ideally, this set of samples should span a wide range of fiber concentrations so that the relationship is well constrained over most of the relevant range.

Step 4. Define the Study Boundaries

The bounds of the study are the same as described above.

Step 5. Develop a Decision Rule

No formal decision will be made with the correlation factor derived from this study.

Step 6. Specify Limits on Decision Errors

Since no quantitative decision will be made, no limits on decision errors are needed.

Step 7. Optimize the Design for Obtaining Results

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Additional samples may be added to this project if the original data collected do not span an adequate range of concentration values to reliably quantify the correlation between PCM and TEM counts.

THIRD OBJECTIVE: PRELIMINARY RISK EVALUATION

Step 1. State the Problem

The third question being addressed by this study is whether or not levels of asbestos fibers may reach a level of potential health concern to area residents and workers who engage in routine or special activities that may cause asbestos fibers to become resuspended in air.

Step 2. Identify the Decision

The decision to be made is whether or not cleanup action(s) are required to protect human health from asbestos exposures associated with the routine or special activities investigated during this study.

Step 3. Identify Inputs to the Decision

The key data required to estimate human health risk from airborne asbestos exposures include accurate and reliable measurements of the concentration of fibers in breathing-zone air that result from the routine and special activities being evaluated, and the approximate exposure frequency and duration associated with each type of exposure scenario.

Step 4. Define the Study Boundaries

The bounds of the study are the same as described above.

Step 5. Develop a Decision Rule

The degree of risk posed by measured air levels can be assessed using two alternative risk methods. The first is the method currently recommended by USEPA (2000a), and is based on the measured concentration of PCM fibers in air in accordance with the following equation:

$$Risk = C(\text{PCM f/cc}) * TWF * 0.23\ (\text{PCM f/cc})^{-1}$$

where:

Risk = Lifetime excess cancer risk due to exposure being evaluated
C = Concentration of asbestos fibers in air quantified using PCM

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TWF = Time-weighting factor to account for less than lifetime exposure via the activity being evaluated. For example, if the activity is sweeping the floor, and this activity is performed for 1 hour per day, three days per week for 50 years, the TWA would be 1/24*3/7*50/70 = 0.0128.

The second method is currently under development by the USEPA (Berman and Crump 2000b) to provide a state-of-the-art protocol to assess human-health risks associated with airborne asbestos exposures. This method has not yet been peer reviewed, but a formal review is planned for Spring, 2001. The basic equation is as follows:

$$Risk = [C_{5\text{-}10} * UR_{5\text{-}10} + C_{>10} * UR_{>10}] * TWF$$

where:

Risk = Lifetime excess risk due to exposure being evaluated
$C_{5\text{-}10}$ = Concentration of amphibole asbestos fibers in air that are 5-10 um in length and thinner than 0.5 um, quantified using TEM
$C_{>10}$ = Concentration of amphibole asbestos fibers in air that are greater than 10 um in length and thinner than 0.5 um, quantified using TEM
$UR_{5\text{-}10}$ = Unit risk $(f/cc)^{-1}$ for amphibole fibers in the 5-10 um size range
$UR_{>10}$ = Unit risk $(f/cc)^{-1}$ for amphibole fibers in the >10 um size range
TWF = Time-weighting factor to account for less than lifetime exposure via the activity being evaluated

Risk coefficients stratified by effect (lung cancer, mesothelioma), gender, smoking status, fiber size, and asbestos type (amphibole, chrysotile) are given in Berman and Crump (2000b). The mean unit risks for lung cancer plus mesothelioma combined due to asbestos exposure, averaged across gender and smoking status, are as follows:

Fiber Size	Unit Risk (TEM f/cc)$^{-1}$
5-10 um	5.74E-02
> 10 um	1.89E+01

As seen, the unit risk is much higher for fibers longer than 10 um than for fibers between 5-10 um, so in this approach the risk to a person is largely determined by the level of exposure to these long fibers (thought to be more toxicologically potent).

The level of risk that is unacceptable is a matter of risk management judgement. In general, USEPA considers excess lifetime risks that are below 1E-04 (1/10,000) to 1E-06 (1/1,000,000) to be sufficiently small that remedial action is usually not warranted. Risks created by the WTC collapse that are greater than urban background concentrations and that are above 1E-04 are

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generally considered by USEPA to warrant some sort of action or intervention, to the extent feasible.

Step 6. Specify Limits on Decision Errors

It is standard EPA policy to provide a margin of safety in risk management decisions regarding health risk from environmental contamination. Generally, this is achieved by basing risk calculations on the 95% upper confidence limit (95% UCL) of the arithmetic mean concentration of contaminants in the environment. In the case of asbestos concentrations in air measured by counting the number of fibers present on a filter, the 95% UCL of concentration is derived by using the 95% UCL of the fiber count, based on the Poisson distribution (e.g., see ISO 10312). However, since the data collected during this investigation are not intended to serve as the basis of final risk management decision-making at any specific residence or sampling location, but rather to serve as a preliminary assessment of the range of exposures and risks that may be associated with certain types of activities, preliminary judgements regarding risk will take both the mean and the 95% UCL into account.

Step 7. Optimize the Design for Obtaining Results

Additional sampling of air or source media and/or investigation of other types of activities may be added to this project as data on asbestos levels in air generated by the original activities investigated become available.

B. MEASUREMENT/DATA ACQUISITION

B1. SAMPLING PROCESS DESIGN

Information to be collected during this program includes three types of data:

1) Concentrations of asbestos in various types of environmental media (see Appendix B for applicable Standard Operating Procedures).
2) Attributes of the apartments, businesses, or other buildings that participate in the program
3) Details of the specific activities engaged in during the sampling program

The following sections present the methods to be used for collection of each of these types of information.

B1a. Environmental Samples

Overview

Environmental samples to be collected during this program include samples of air (drawn through a filter) and samples of potential asbestos source materials (debris or dust). With regard to the air

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samples, analytical sensitivity is controlled by two key variables: the volume of air drawn through the filter, and the number of grids openings or fields examined by the microscopist. Appendix G presents calculations that estimate the target volume of air needed for each activity scenario, assuming the goal is to be able to quantify cancer risk at the 1E-04 level, and assuming that 50 TEM grid openings or 100 PCM fields will be evaluated. The precise combination of flow rate and sampling time needed to approach or exceed these target volumes will be selected by the field teams based on the specific requirements for each scenario.

We suggest that at least 8-12 individual sites be evaluated for each type of scenario that is investigated (i.e., routine business or household activities, active cleaning of a household or business, active restoration of a residence or facility). The sites chosen for each scenario should also be representative of differing levels of exposure (i.e., dusty vs. non-dusty, asbestos found in dust vs. absent) and locations in proximity to the WTC (i.e., lower floors vs.. higher floors, less than a block away vs. greater distances). The following scenarios are suggestions and should be modified to better fit the conditions and situations encountered around the WTC area, as indicated.

Scenario 1: Sampling During Routine Business or Household Activities
Eight to twelve residences in the vicinity of the WTC should be selected for sampling during routine household or business activities. To the extent possible, sites chosen should based on the results of previous environmental assessments and asbestos sampling (i.e., dusty conditions, dust samples, IR spectroscopy, air samples) to provide a range of expected conditions and exposures.

Resident and/or business participation in the investigation should be strictly voluntary. Preference should be given to volunteers who are non-smokers, since smoke particles in air collect on filters and could tend to reduce analytical sensitivity of air samples collected.

Air samples for asbestos analysis should be collected using both personal and stationary air sampling pumps.

The personal air sampler will be worn by an adult resident in the apartment or business, who will engage in all normal activities except active cleaning. The participant will need to remain indoors as much as possible throughout the sampling period. As discussed in Appendix G, the target volume of air needed to obtain a detection limit equivalent to a 95% UCL risk level of 1E-04 is quite large (4,900 L for the IRIS method and over 80,000 L for the Berman and Crump method). Thus, every effort should be taken to maximize flow rates and collection times. To this end, collection may be extended across two or more days, if the resident is willing. Due to the presumed length of the sampling period, the sampling team will return to the apartment periodically (about every 4 hours) to ensure the pumps are operating properly. To ensure the battery does not run down during sampling, the team will change the personal air sampling pump every visit (about 4 hours apart).

The location of the stationary air sampler will be the main living area of the apartment or work area of the business (see USEPA 2000b). A high volume pump will be used to collect the

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stationary sample. The sampling time for the stationary air monitor should be the same as for the personal air monitor. Flow rates may be higher than for the personal pump in order to increase sensitivity.

Whenever feasible, all pumps (high volume and low volume) will be programed, calibrated, and placed at the sampling location on the evening prior to the sampling event.

Scenario 2: Sampling During Active Household or Business Cleaning Activities

The investigation of airborne levels during active cleaning activities should be conducted at the same 12 locations as were selected for the routine household or business activities investigation above. In cases where visible dust is NOT evident, residents or workers will be asked to NOT engage in cleaning activities for one week prior to this event. Due to the possibility that such activities might be associated with increased exposure to asbestos fibers, the cleaning activities should be performed not by the residents of the apartment, but by a trained staff member or consultant with appropriate health and safety training and wearing adequate personal protective equipment (PPE).

As before, both personal and stationary air samples will be collected. The personal air sample will be collected using a portable high-volume air sampler worn by the person performing active cleaning activities such as sweeping, vacuuming, and dusting. This activity will be conducted for a time period of approximately 2 hours. To the extent possible, the cleaning activities performed in each apartment or business will be standardized as follows:

Vacuuming. This will be done using the vacuum cleaner owned by the resident. If the resident does not own a suitable vacuum cleaner, then a vacuum will be provided. This will be a standard commercial cleaner, not a HEPA device. Vacuuming should be performed for approximately 40 minutes, and should cover carpets, rugs that a resident might normally vacuum.

Sweeping. This will be done using a straw or plastic broom. If possible, this will be a broom owned by the resident, but a broom may also be used. Sweeping should be done mainly on uncarpeted floors. Sweeping should be from the edges toward the center. If the sweeping generates a visible pile of dust or dirt, this should be sampled using the microvac method (SOP ASTM 5755-95), and the remainder picked up with a dust pan and discarded as IDW. Total time spent sweeping should be approximately 40 minutes.

Dusting. Dusting will be done with a clean dry rag provided. Dusting may be done on any surface that might normally be dusted by a resident, including table tops, counters, window sills, picture frames, lamp shades, etc. Total time spent dusting should be approximately 40 minutes.

The stationary air sampler will be a high volume pump located in the same central living area of the main apartment as was used during the routine activity investigation (above). The sampling

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time will be the same for the stationary sampler as for the personal sampler. To the extent feasible, pump flow rates will be adjusted to approach or exceed the target volumes specified in Appendix G.

In order to help quantify the impact of the activity (active cleaning) on asbestos levels in air, the stationary air monitor will also be used to collect a pre-activity and a post activity sample as well as the sample during the activity. The sampling duration for these samples should be approximately 3 hours. An example sampling scheme is summarized below:

Activity	Example Clock time	Minimum Target Volume[a] (L)	
		Personal Air Monitor	Stationary Air Monitor
Pre-sampling	8:00-11:00		690
Active cleaning	11:30-1:30	690	690
Post activity	2:00-5:00		690

a If feasible, collection of volumes greater than the minimum should be achieved since this will increase sensitivity.

The stationary air sample collected post activity will be analyzed using the AHERA method (USEPA 1987). A property will be considered suitable for re-habitation if this sample complies with the AHERA standard (or a more stringent standard, as directed by the NYC Health Department). If the clearance sample fails this standard, either more clearance samples may be collected, or alternatively, the pre-activity sample may be analyzed. In this case, the residence will be considered suitable for re-habitation if the final clearance sample does not have a fiber concentration higher than the pre-activity sample.

Immediately prior to initiation of the cleaning activities, a composite dust sample will be collected from the apartment in accord with SOP ASTM 5755-95. This sample is intended to provide a representative composite of the dust inside the apartment, especially in living areas. As noted above, if sweeping or dusting activities results in the generation of a pile of dust, a sample of this material will also be collected using the microvac technique in order to provide a second sample to evaluate for fiber content.

If preliminary practice sessions reveal that active cleaning generates sufficient dust to be detectable by real-time aerosol monitors, then two such aerosol monitors will be used to quantify the level of dust particles in the air before, during, and after the cleaning activities. One will be located in close proximity to the stationary air monitor in the main living area of the apartment, and one will be located in close proximity to the cleaning activity. Real-time aerosol monitoring will not be used during Scenario 2 if trial runs indicate that no useful data will be collected.

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Scenario 3: Sampling During Simulated Apartment Restoration Activities

Apartments or businesses selected for inclusion in this category will be selected based on previously obtained data on asbestos levels in dust or debris. One apartment will be selected where the dust or debris is not believed to contain asbestos, and three apartments and/or businesses will be selected where the dust is known to contain detectable levels of asbestos.

The simulated restoration activities performed will be relatively simple in nature, and will be representative of activities which an apartment dweller might undertake that could lead to direct exposure to contaminated dust or asbestos insulation. For example, this might include removing or bagging debris or dust from a floor, wall, or ceiling, moving (bagging, sweeping) dust or debris an attic to gain access to plumbing or wiring, replacing or repairing drywall or paneling on an insulated wall, etc. Specific activities will be selected on an apartment-by-apartment basis, depending on the location and accessability to contaminated dust.

Because of the possibility that this type of activity might lead to increased exposure to asbestos fibers in air, all simulated restoration activities will be performed by trained staff or contractors with adequate health and safety training and wearing adequate PPE.

Apartments or businesses selected for this scenario may be either vacant or occupied. In the case of apartments that are currently occupied, the residents will be asked to leave the apartment until activities are completed and airborne levels of fibers are returned to acceptable levels.

This scenario will be carefully monitored by air sampling both in the vicinity of the simulated restoration activity and in the main living area of the apartment. These samples are described below.

Personal Air Monitor for Simulated Worker

The individual performing the simulated restoration will engage in simulated activities for a period of approximately one hour. This individual will wear a portable low-volume air sampling pump. Because it is expected that this activity will be associated with high airborne dust levels, the flow rate will be set at a low value (e.g., 0.5 L/min). If overloading does not occur, the entire sampling activity will be collected on one filter. If pilot studies suggest that 60 minutes of sample collection will result in filter overload, then a series of sequential samples will be collected (e.g., two 30-minutes samples or four 15-minute samples, etc.).

Fixed Air Monitor at the Work Area

One 3-hour air sample will be collected from the simulated work area before simulated restoration begins, and a set of three sequential 3-hour samples will be collected after the work is completed to monitor the time course of fiber disturbance and settling. The pre- and post-activity sampling will be done using a stationary high volume pump, placed in a convenient position within the work area that can be accessed by the sampling team without re-disturbing the dust. The flow rate for

these pre- and post-activity samples will be selected to yield a volume that meets or exceeds the minimum target volume specified in Appendix G without causing filter overload.

Stationary Air Monitor in the Main Business or Apartment

The stationary air sampler will be located in the main living area of the apartment or work area of the business. These samples will serve to measure the impact of the simulated restoration on "passive" air exposure at locations remote from the simulated restoration. In addition, these samples will serve as "clearance" samples to establish when the apartment or business is suitable for re-occupation by the owner or resident. Samples will be collected before, during and for three sequential time periods after simulated restoration work is completed. Pump flow rates will be set to ensure that a minimum volume of at least 1,200 L will be collected during each 3-hour sampling period (e.g., 7-8 L/min). Analysis of these samples will be done using the AHERA method (USEPA 1987). A property will be considered suitable for re-habitation if the final clearance sample complies with the AHERA standard or a more stringent standard, as directed by the NYC Department of Health. If the final clearance sample fails this standard, either more clearance samples may be collected, or alternatively, the pre-activity sample may be analyzed. In this case, the residence will be considered suitable for re-habitation if the final clearance sample does not have a fiber concentration higher than the pre-activity sample.

The following tables provides an example schedule summarizing the that will be collected for this scenario:

Time Period	Example Clock time	Work area		Main living area	
		Type	Min Vol (L)	Type	Min Vol (L)
Pre-sampling	8:00AM-11:00AM	Fixed	1200	Fixed	1200
Simulated restoration	11:00AM-12:00PM	Personal	14	Fixed	400
Post activity 1	12:00PM-3:00PM	Fixed	1200	Fixed	1200
Post activity 2	3:00PM-6:00PM	Fixed	1200	Fixed	1200
Post Activity 3	6:00 PM-9:00 PM	Fixed	1200	Fixed	1200

Dust Monitors

In addition to sampling for asbestos, two real-time aerosol monitors will be used to quantify the level of dust particles in the air before, during, and after the simulated restoration activities. One aerosol monitor will be located in close proximity to the stationary air monitor, and the other will be located in the enclosed area where the simulated restoration is occurring.

NYC 9/11 Public Portal Document

Bulk Dust

In all locations where simulated restoration activities are performed, samples of the bulk dust will be collected and analyzed for asbestos in accordance with NIOSH Method 9002, or using improved methods currently being developed by USEPA for use on this project.

Scenario 4: Sampling During Exterior Cleanup Activities

Sites will be selected for inclusion in this test scenario based on the results of previous solid media and ambient air sampling results. One area will be selected where debris and/or dust does not contain visible fiber and where PLM and/or Infrared analyses do not reveal the presence of asbestos material. Two areas will be selected where fibrous dust or debris is visible and/or where PLM analysis reveals the presence of asbestos fibers. Sampling will be performed when weather is drier (and hence more likely to release dust and fibers). In addition, Project managers may direct that a second (optional) sample be collected in wet weather by way of comparison. In order to help reduce variability between sites, the same cleanup or remediation tasks will be used at all locations (with appropriate decontamination between locations).

Because of the possibility that outside restoration activities might lead to increased exposure to asbestos fibers in air, this activity will be performed by trained staff or contractors with adequate health and safety training and wearing adequate PPE.

Stationary air monitors will be used to collect ambient air samples at two locations: either 5 meters upwind and 5 meters downwind of the restoration area, or the upwind and downwind perimeter of the property (whichever is closer). The direction and speed of the wind will be recorded throughout the restoration event. The equipment operator will wear a personal air sampling pump. Flow rate for both the stationary and personal air pumps will be approximately equal and will be sufficient to collect the minimum target volume specified in Appendix G (70 L), and the sampling durations will also be equal (about 1 hour).

In order to help quantify the impact of the restoration activity on asbestos levels in ambient air, the down-wind stationary air monitor will also be used to collect a pre-activity and a post activity sample as well as a sample during the activity. Both the pre- and the post activity samples will be at a flow rate adequate to yield a minimum volume of 1200 L, collected over a sampling duration of about 3 hours. This sampling scheme is summarized in the following example schedule:

Activity	Example Clock time	Minimum Target Volume (L)	
		Personal Sampler	Stationary Monitor
Pre-sampling	8:00-11:00		1200
Restoration activity	11:30-12:30	70	70

Post activity	1:00-4:00		1200

A downwind aerosol monitor will also be used to monitor dust generation before, during and after the simulated or actual restoration activity.

One dust or debris sample will be collected from each restoration location before activity occurs. This will be accomplished by collecting a 5 point composite (grab samples) of dust or debris in the immediate vicinity of the work. These grab samples will then be composited into a single sample representative of the garden as a whole. Grab samples will be collected from the surface. Sampling and analysis for asbestos will be performed in accordance with methods available for solid media analysis, including PLM, infrared, and scanning electron microscopy (SEM).

Summary of Sampling Design

Field samples and other data items scheduled for collection during this investigation are summarized in Table B-1. Flow charts tracing the path and handling of the air samples collected in Scenarios 1-4 are shown in Figures B-1 to B-4, respectively.

B1b. Housing Characteristics

For Scenarios 1, 2, and 3, potentially relevant attributes of the apartment or building where samples are collected will be recorded using the Housing Attributes field data sheet provided in Appendix A. In addition, videotape will be used to record the appearance of the structure (inside and out), and to record qualitative information on airflow direction and rate (as assessed using a smoke generator). This data collection and recording will be done prior to the initiation of any environmental sampling activities.

B1c. Documentation of Activities

Scenario 1

Each volunteer who participates in Scenario 1 will be instructed that they should remain indoors to the maximum extent possible, and that they should engage in all normal activities except active cleaning. Each time that a project team member comes to the apartment to check or change pumps, the activities of the resident during the preceding time interval will be recorded on an activity log (see Appendix D). Videotaping of the resident during routine activities will not usually be performed, but any special activities that are judged to be a likely source of increased exposure to airborne asbestos fibers may be videotaped to document the activity.

Scenarios 2, 3, and 4

The activities specified in Scenario 2 (active cleaning), Scenario 3 (simulated restoration), and Scenario 4 (site restoration/remediation) will all be documented using video exposure monitoring.

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The activities specified in Scenario 2 (active cleaning), Scenario 3 (simulated restoration), and Scenario 4 (site restoration/remediation) will all be documented using video exposure monitoring.

B2. SAMPLING METHODS REQUIREMENTS

Air Samples

All air samples (both personal air and fixed station) to be analyzed for asbestos will be collected by drawing air through a cellulose acetate filter at the flow rates and times specified above. All samples collected using a high-volume pump will employ filters that have pores that are 0.45 um in diameter. For personal air samples using a low volume pump, filters with pores that are 0.8 um in diameter may be used, since this decreases back-pressure and increases flow rate without significant impact on the quality of the sample. The details of the air sampling method for personal and stationary air monitors are provided in SOP EPA-LIBBY 01.

Because some of the activities being investigated in this project may generate significant concentrations of airborne dust, it is important to ensure that air filters collected during the

activity do not become overloaded with particulate material. This is not a concern for air filters collected during routine apartment activities, and is not likely to be of concern for filters collected during active cleaning activities (sweeping, dusting), or during restoration / remediation (unless the weather is very dry). The chief concern is for personal air samples collected during simulated apartment restoration activities that involve active disturbance of visible dust. For this scenario, it may be necessary to use a low flow (e.g., 0.5 L/min) and to collect several sequential samples during the activity to avoid filter overload.

Dust Samples

As noted above, dust samples will be collected at each of the eight apartments in which routine and active cleaning activities are investigated. All dust samples for evaluation of asbestos content will be collected using a Microvac method as detailed in SOP ASTM 5755-95, as modified for this project.

Ornamental or Vegetable Garden Soil Samples (if applicable)

All garden soil samples will be collected in accordance with SOP CDM SOP 1-3. After collection, each soil sample will be prepared in accordance with SOP ISSI-Libby-01.

Dust Samples

Bulk dust sampling locations will be determined based on the amount of visible overburden within each building and the location of dust contamination within the building. At least one bulk dust sample will be collected within each building. This sample will normally be collected from the windowsills, walls, or ventilating system of the building, depending on the location of the dust or debris. In the case of larger buildings or buildings which have been renovated, it may be necessary to collect more than one dust sample to get a more representative sampling of the building.

All bulk dust samples will be collected in accordance with NIOSH Method 9002, Asbestos (bulk) by TEM. There will be no modifications to this method for the purposes of collecting bulk samples for this project.

The samples will be collected by placing approximately 2 ounces of dust into a plastic zip-top bag. The bag will then be placed into a second plastic zip-top bag. All samples will be double bagged The bulk material will preferably be collected from several locations in order to obtain a homogenized sample of the material. Sampling personnel will wear disposable nitrile gloves while sampling the dust. A new pair of gloves will be donned prior to each sample being collected. Sampling personnel will also wear appropriate respiratory protection at all times while collecting bulk dust samples.

Airborne Dust Monitoring

Airborne dust levels will be measured using a real-time aerosol monitor in accord with the

method contained within SOP EPA-LIBBY-03. In general, one aerosol monitor will be located in close proximity to the stationary air monitor, and another will be located in close proximity to the person engaged in the activity.

Deviations from SOPs

Every reasonable effort will be made to adhere strictly to specified SOPs for sample and data collection. Where deviation from an SOP is unavoidable, documentation of the deviation and its potential impact on the outcome of the data collection effort will be clearly indicated in field notes and subsequent reports.

B3. SAMPLE DOCUMENTATION, HANDLING AND CUSTODY REQUIREMENT

Documentation of sample collection, handling, and shipment will include completion of chain-of-custody forms in the field, use of field maps and field data forms, and entry of data into a field logbook. Each sample will be properly labeled with the a unique sample identifier. A chain-of-custody form shall accompany every shipment of samples to the analytical laboratory. The purpose of the chain-of-custody form is to establish the documentation necessary to trace possession from the time of collection to final disposal.

Field Log Book

Each sampling team will maintain a field log book in which the following information is recorded for each location visited:

- Names of team members
- Location (address) of sample collection site
- Date and time of sample collection
- Number and type of samples collected
- Any special circumstances that influenced sample collection

Field Data Sheets

Detailed information on each sample collected will be entered onto a field data sheet. Minimally, the field data sheet will have the following information:

- Site name or project number
- Type of medium sampled (air, dust, soil, insulation)
- Sample type (field, QA)
- Sample collection method (SOP number)
- Sample location
- Date and time of sample collection
- Unique sample identification number

- Sampler's signature

Field data sheets to be used for each medium are presented in Appendix A.

Sample Numbering System

All environmental samples collected during this investigation will be assigned a unique sample number of the following format:

WTC-xxxxx (e.g., WTC-00458)

These sample numbers may be assigned to samples of any medium in any order that is convenient for field supervisors and sampling crews. In order to minimize the chance of error in number assignment, pre-printed sheets of adhesive labels with sequential sample numbers will be prepared and provided to field crews. Each sheet will have two identical labels for each sample number. Once a sample is collected, one adhesive label will be attached to the sample, and the second adhesive label with the same number will be attached to the appropriate field data sheet (see Appendix A).

Sample Handling and Custody Requirements

All samples collected must be handled in accordance with the methods specified in the sampling SOP and must be maintained under chain of custody.

The chain-of-custody for all samples will be prepared using the form presented in Appendix E, in accordance with CDM SOP 1-2. All corrections to the chain-of-custody record will be initialed and dated by the person making the corrections. Each chain-of-custody form will include signatures of the appropriate individuals indicated on the form. The originals will accompany the samples to the laboratory, and copies documenting each custody change will be recorded and kept on file.

When shipping samples from field team custody to an analytical laboratory, the shipping forms or transmittal memo from the field team will describe:

- Number of containers
- Sample preservative (N/A)
- Date and time of sample shipments

All required paper work, including sample container labels, chain-of-custody forms, custody seals and shipping forms will be fully completed in ink (or printed from a computer) prior to shipping of the samples to the laboratory. Shipping from sample storage to laboratory will be by overnight delivery.

Upon receipt, the samples will be given to the laboratory sample custodian. The coolers will be

opened and the contents inspected. Chain-of custody forms will be reviewed for completeness, and samples will be logged and assigned a unique laboratory sample number. Any discrepancies or abnormalities in samples will be noted and the Project Director will be promptly notified.

Record Keeping

Chain-of-custody will be maintained until final disposition of the samples by the laboratory and acceptance of analytical results by NYC. One copy of the chain-of-custody will be kept by field personnel.

Following completion of the project, the NYC Department of Health or a designated representative will consolidate and maintain all original log books, field data sheets, analytical data packages and reports, and any other information required to document and support the findings of the investigation.

B4. ANALYTICAL METHODS REQUIREMENTS

The Appendix B included here provides the names of the SOPs for each analytical method used in this project.

Air and Dust Samples

As discussed above, all air and dust samples collected during this study will be analyzed using both PCM and TEM methods.

Direct vs Indirect Preparation Methods

For both TEM and PCM, two alternative approaches are available: "direct" and "indirect" analysis. In direct analysis, the sample is prepared with minimal handling, generally by placing the test material directly under the microscope for examination. However, this approach may sometimes be inadequate because a) the fibers are accompanied by an excessive level of non-asbestos material, or b) the concentration of asbestos fibers is either too low or too high for reliable quantification. In these cases, an indirect approach may be used. In the indirect method, the sample is generally diluted, concentrated, and/or treated to remove interferences, such that the asbestos fibers can be more reliably quantified. However, because indirect preparation steps may alter fiber morphology and/or may alter fiber recovery, indirect sampling may introduce uncertainty into the results.

For the purposes of this study, direct preparations are strongly preferred for all air filters, and a direct preparation will be made and examined for all air samples. When reliable fiber counts cannot be obtained for one or both methods due to interfering materials, an indirect preparation will be made and the indirect preparation will be re-analyzed by both methods. For dust, only the secondary preparation method will be used.

Counting Rules

The microscopist will record all observations on a TEM or PCM Laboratory Microscopy Results Form, which are included in Appendix C. For TEM, for each fiber that is characterized in accord with the applicable counting rules, the microscopist will record the size (length, thickness) and type (chrysotile, amosite, amphibole, or non-asbestos) of the fiber. These data will then serve to support calculation of fiber counts in specified size and type categories ("bins"). For PCM, only the number (and not the dimensions or type) of fibers which meet the counting rules will be recorded.

For TEM, the counting rules specified in ISO 10312 will be used for all air and dust samples. In addition, air samples collected by the stationary air filter in the central location of the apartment before, during and after the active cleaning and simulated restoration scenarios will be analyzed according to the AHERA method by a nearby field laboratory. This analysis is needed is to shorten the analytical turn-around time for these samples, since the results from these samples are required to ensure that levels in the apartment are safe before allowing the residents to return.

For PCM, the counting rules established by NIOSH 7400 (Revision 2) will be used for all samples. Differential counting (i.e., excluding fibers which the analyst suspects are not asbestos) will not be used.

Stopping Rules

The analytical sensitivity and detection limit of microscopic methods such as TEM and PCM are a function of the volume of air drawn through the filter and the number of grids openings or fields counted. In principle, any required sensitivity or detection limit can be achieved simply by increasing number of grid openings or fields examined. Likewise, statistical uncertainty around the number of fibers observed can be reduced simply by counting more and more fibers. Because of the open-ended nature of this situation, stopping rules are needed to specify when microscopic examination should end, both at the low end (zero or very few fibers observed) and at the high end (many fibers observed). For the purposes of this investigation, the following stopping rules will be employed:

Method	**Count Until**
TEM	Number of structures longer than 5 um counted is ^{3} 20 OR number of grid openings equals 50
PCM	100 fields are viewed OR 100 fibers are counted (but not less than 20 fields must be counted)

At the low end, based on the assumed flow rates and sampling durations described previously, these rules will allow quantification of combined cancer risks (lung cancer plus mesothelioma) at or below a level of 1E-04 for all scenarios and methods except for routine exposures of residents based on the Berman and Crump risk assessment methodology (assuming 30% of the protocol structures are longer than 10 um). In this case, it would be necessary to count 500-1000 grids to establish a 95% UCL on low fiber counts that approaches 1E-04.

At the high end, a plot of the ratio of the 95% UCL on fiber count as a function of the number of fibers counted reveals that there is relatively little reduction in uncertainty after the number of fibers reaches 15-20. Thus, for the TEM method, counting will stop if 20 structures are observed. For PCM, because counting is faster than for TEM, the stopping point is 100 fibers.

Flower or Vegetable Garden Soil Samples

Where applicable garden soil samples will be evaluated for asbestos content using one or more methods to be specified after completion of a study specifically designed to evaluate the relative advantages and limitations of a number of alternative methods for measuring asbestos in soil and other solid media (EPA 2000c).

Bulk Dust Samples

Bulk dust samples will be evaluated for asbestos content using polarized light microscopy (PLM), in accord with SOP NIOSH 9002. Other methods may also be used, as needed, and considering the results of a study designed to evaluate the relative strengths and weaknesses of a number of alternative methods for measuring asbestos in dust and other solid media (EPA 2000c).

B5. QUALITY CONTROL

Quality Control (QC) is a component of the QA Plan, and consists of the collection of data that allow a quantitative evaluation of the accuracy and precision of the field data collected during the project. QC samples that will be collected during this project include the following types of samples.

Laboratory-Based QC Samples
These are samples prepared in or re-analyzed by the laboratory.

Recount (same) (Code = RS)	This is a TEM grid or a PCM slide that is re-examined by the same microscopist who performed the initial examination. In the case of a TEM grid, the microscopist returns to the same grid openings as were counted in the original examination. In the case of PCM, the microscopist simply re-counts the slide at randomly selected fields
Recount (different)	This is a TEM grid or a PCM slide that is re-examined by a different

(Code = RD) microscopist in the same laboratory than the individual who performed the initial examination. In the case of a TEM grid, the microscopist returns to the same grid openings as were counted in the original examination. In the case of PCM, the microscopist re-counts the slide at randomly selected fields.

Re-preparation (Code = RP) This is a grid or a slide that is prepared from a new aliquot of the same field sample as was used to prepare the original grid or slide. This is often referred to as a laboratory duplicate. Typically this is done within the same lab as did the original analysis, but a different lab may also prepare grids from a new piece of filter. If the re-preparation is done within a laboratory, the re-preparation and re-analysis should be done by a different person than did the original, whenever possible.

Verified analysis (Code = VA) This is a re-count of a TEM grid (same openings) or a PCM slide (random fields) by a different laboratory than performed the original analysis. A detailed protocol for verified analysis in provided in NIST (1994).

For the purposes of this project, air samples will undergo re-preparation at a rate of at least 5% and re-analysis (different) at a rate of at least 5%. When a laboratory does not have sufficient trained analysts available to perform the needed re-analysis (different), re-analysis (same) may be used, but the re-analysis (same) must be performed at least 24 hours after the initial analysis.

Field-Based QC Samples

These are samples that are prepared in the field and submitted to the laboratory in a blind fashion. That is, the laboratory is not aware the sample is a QC sample, and should treat the sample in the same way as a field sample.

QC Sample Type	Description
Field Blank (Code = FB)	This is a filter that is placed in a collection cassette for either a personal or a stationary air monitor or a microvac, but through which no air is drawn. There is no field blank for dust.
Field Duplicate (Code = FD) or Field Replicate (Code = REP)	This is a second sample of environmental medium collected at the same place and at the same time as the primary sample. Field duplicates may be collected for each type of medium (air, dust) . For the purposes of this study, duplicate samples of air (i.e., two filters collected at the same time and same location using different pumps and cassettes) are referred to as replicates rather than duplicates.
Performance	These are samples of a medium in which the concentration of the target

Evaluation Standards (Code = PE-xx)	analyte is known. In the case of asbestos, there are no adequate PE samples available for air (as a primary medium)[1], soil, dust, or debris. At present, the USEPA is working to develop PE samples for asbestos in soil, and these will be included in the study if they become available in time.

For the purposes of this project, field blanks will be submitted for air samples and dust samples at a rate of 5% (minimum number = 2). There are no field blanks for soil or dust.

Field replicates of air samples will also collected at a rate of approximately 5%. This will include samples from co-located stationary air monitors, and may also include samples obtained from personal air monitors using a flow splitter, when feasible.

Although filed duplicate samples of debris or dust will be collected from some locations as part of this program, it is important to stress that these will not be evaluated as QC samples, since there are no criteria to judge whether the agreement between samples is within some pre-define acceptance limit. Rather, duplicate samples of these media will be used to gain understanding of the inter-sample variability.

The number of each type of QC and related types of samples to be included in this study is summarized in Table B-2.

B6. INSTRUMENT CALIBRATION and FREQUENCY

Field Instruments

Pumps used for air sampling will be calibrated in accord with SOP ASTM D 3195 -90 prior to sampling and again at the termination of sampling to determine average air flow rates during the sampling.

Laboratory Instruments

SOPs will identify requirements needed to be met by the laboratories to meet adequate instrument calibration frequency, and QA/QC for raw data and reports.

B7. DATA MANAGEMENT

Data generated during this project will be managed using the same basic methods and procedures established for Phase 1 (USEPA 2000b). In brief, all data are entered into a project-specific database by appropriately trained data entry staff. The data entered into the database includes all relevant field information regarding each environmental samples collected, as recorded on the Field data Sheets and in the field log book, as well as the analytical results provided by the

[1] Samples of asbestos deposited on MCE filters are available from NIST (NVLAP), but these filters contain chrysotile fibers only, and have a size distribution that is not similar to that observed for amphiboles.

laboratory. All data entries are reviewed and validated for accuracy by the data entry manager or his/her delegate. All original data records (both hard copy and electronic) will be cataloged and stored in their original form by the Project Director.

C. ASSESSMENT AND OVERSIGHT

C1. ASSESSMENTS AND RESPONSE ACTIONS

Quality Assurance assessments performed during this project will include the following:

1) Oversight of field sampling activities
2) Oversight of sample handling and chain of custody procedures
3) Laboratory inspections

The following individuals or their delegates are authorized to perform any of the assessments above:

- Project Manager
- Technical Lead
- NYC QA Coordinator

Assessment of field sampling and other project activities may occur at any time and without prior notification. The frequency of such assessments will be no less than once per week during active field work, and may be more often, especially if issues or problems are detected during an assessment. Each of the individuals above has authority to specify any appropriate response action that may be deemed necessary to resolve problems detected during the assessments. This could range from a simple review of approved SOPs with field staff to address minor problems, up to a temporary stop work order to provide time for senior project managers to address more significant issues.

C2. REPORTS TO MANAGEMENT

The Project Director will provide regular verbal reports on project status. These reports will cover data quality assessment issues, and will identify any significant problems and recommended solutions. The Project Director will prepare a complete written QA report at the end of the project, and may prepare interim written reports at any time during the project, as needed to document important issues and actions.

D. DATA VALIDATION AND USABILITY

D1. DATA REVIEW, VERIFICATION, and VALIDATION

Data Verification

Data verification is a consistent and systematic process that determines whether the data have been collected in accordance to the specifications as listed in the approved Quality Assurance Project Plan (QAPP). This process is independent of data validation, and is conducted at various levels both internal and external to the data generator (laboratory).

Data Validation

Data validation is an evaluation of the technical usability of the verified data with respect to planned objectives. Data validation is performed external to the data generator (laboratory) by applying a defined set of performance criteria to the body of data in the evaluation process. This may include checks of some or all of the calculations in the data set, and reconstruction of some or all final reported data from initial laboratory data (e.g., chromatograms, instrument printouts). It is in the data validation process that data qualifiers for each verified datum are evaluated and assigned. It extends beyond the analytical method or contractual compliance to protocols to address the overall technical usability of the generated data.

D2. VERIFICATION AND VALIDATION METHODS

Data Verification

Data verification will include a review of the findings of all QA assessment activities (see Section C), including assessments of field collection procedures, sample labeling methods, chain-of-custody procedures, and all assessments of analytical data collection, recording and reporting. If any deviations are identified, the potential impact of those deviations on the reliability of the data will be assessed, and that information will be provided to the EPA On-Scene Coordinator and the Science Support Coordinator.

Data Validation

The data validation process consists of evaluation of all individual samples collected and analyzed to determine if results are within acceptable limits. These quantitative or qualitative limits of acceptability are defined for Precision, Accuracy, Representativeness, Comparability, and Completeness (PARCC), as discussed below.

Precision: Precision is defined as the agreement between a set of replicate measurements without assumption or knowledge of the true value. Agreement is expressed as either the relative percent difference (RPD) for duplicate measurements, or the range and standard deviation for larger numbers of replicates. Data on precision are obtained by analyzing

duplicate or replicate samples.

Accuracy: Accuracy is a measure of the closeness of a sample analysis result to the "true" value. The accuracy of an analytical method is generally assessed by inserting a series of blind "performance evaluation" (PE) samples into the laboratory sample stream, where the "true" concentration of analyte in each PE sample is known. With regard to asbestos, PE samples are not available for most of the media being analyzed in this project, so accuracy will be determined primarily by an evaluation of agreement between repeat analyses, both within a laboratory and between laboratories.

Representativeness: Representativeness is the degree to which data accurately and precisely represent characteristics of a population, parameter variations at a sampling point, or an environmental condition. For this QAPP, representativeness is ensured by the selection of sampling locations in accordance with the sampling design requirements presented above.

Comparability: Data are comparable if collection techniques, measurement procedures, methods, and reporting units are equivalent for the samples within a sample set. These criteria allow comparison of data from different sources. Comparable data will be obtained by specifying standard units for physical measurements and standard procedures for sample collection, processing, and analysis. These requirements are specified in the attached SOPs for sample analysis procedures.

Completeness: Data are considered complete when a prescribed percentage of the total intended measurements and samples are obtained. Analytical completeness is defined as the percentage of valid analytical results requested. For this sampling program, a minimum of 90% percent of the planned collection of individual samples for quantification must be obtained to achieve a satisfactory level of data completeness.

Validation of QC Samples for TEM

Re-Analysis. All re-analysis samples (either different or same) will be validated by comparing the raw data sheets prepared by each analyst. The following acceptance criteria will be used to identify cases where results are not within acceptable limits:

Measurement parameter	**Acceptance Criterion**
Number of fibers within each grid opening	Must be the same
Type of fiber	Must be the same
Fiber length	0.5 um or 10% (whichever is less stringent)
Fiber width	0.1 um or 10% (whichever is less stringent)

Whenever an exception is identified, the sample will undergo validated analysis as described by NIST (1994), and the senior laboratory analyst will use the results of the validated analysis to determine the basis of the discrepancy, and will then take appropriate remedial action as needed (e.g., re-training in counting rules, quantification of size, identification of types, etc).

Re-Preparation. Re-preparation samples will be evaluated by binning the results from each of the two analyses into the following categories:

Fiber Size			Fiber Type		
Code	diam (um)	length (um)	Amphibole (L)	Amosite (O)	Chrysotile (C)
a	aspect ratio < 5:1		L-a	O-a	C-a
b		< 0.5	L-b	O-b	C-b
c	>0.5		L-c	O-c	C-c
d	< 0.5	< 5	L-d	O-d	C-d
e	< 0.5	5-10	L-e	O-e	C-e
f.	< 0.5	> 10	L-f	O-f	C-f

The results for bins L-d, L-e, and L-f must not be statistically different from each other at the 90% confidence interval, tested using the statistical procedure documented in Appendix F. No formal test will be performed for other bins, but it is expected that there should be no more than about 5% of all bins that differ at the 95% confidence level using the statistical comparison approach in Appendix F.

Validation of QC Samples for PCM

All QA samples for PCM analysis (both re-analysis and re-preparation) must conform with the acceptance criteria specified in NIOSH Method 7400. In brief, the coefficient of variation between the original and the re-preparation sample must not be greater than 0.45. If the laboratory has established values more stringent than this (as described in NIOSH 7400), these more stringent standards will apply.

Validation of Field Data

Data validation for field samples will be performed by ensuring that each sample is accompanied by a complete chain of custody record, a complete field data sheet, and a properly completed and signed laboratory data sheet. Any sample that lacks one or more of the required sets of documentation will be excluded unless the missing sample identification and documentation can reliably be obtained. In addition, the field log book and the analytical report for each sample will be reviewed to determine if there are any notations which indicate that the sample may not

be reliable. Any sample with a notation which indicates that the result may not be reliable will be considered unreliable unless a subsequent review determines that the datum is reliable. Data points determined to be unreliable or invalid will be permanently flagged with an "R" qualifier in the original raw data set and excluded from subsequent data analyses, summaries, and reports.

D3. RECONCILIATION with DQOs

The data reports will be reviewed by the Program Director for the City of New York, and appropriate State and Federal officials to assess data quality in accordance with DURA (1992), and to determine whether the data are adequate to meet the project objectives. In particular, the project team will review any results which fall outside the DQOs and decide (per DURA 1992 and RAGS 1992) the extent of useability of results for risk assessment.

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