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INVESTIGATION OF INDOOR ENVIRONMENTS AT ASBESTOS-CONTAMINATED SUPERFUND SITES

TECHNICAL REVIEW WORKGROUP ASBESTOS COMMITTEE

OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE

U.S. ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, DC 20408

1.0 PURPOSE AND SCOPE

The TRW Asbestos Committee developed this document to provide clarification to the Framework for Investigating Asbestos-Contaminated Superfund Sites (U.S. EPA, 2008) for indoor environments. This document provides recommended sampling methods and strategies for evaluating the nature and extent of asbestos contamination in indoor environments at Superfund sites. This document assumes that Steps 1-3 of the Framework have been completed and further evaluation is required. The sampling strategies and methods discussed are those currently employed by the Agency to estimate exposures and the associated health risk in support of risk management decisions for asbestos in indoor environments. This document is intended to provide supplemental information at sites where indoor contamination by asbestos may be of concern.

The recommended sampling strategy to inform risk-based decisions in indoor environments that may be contaminated with asbestos is to combine short-term activity-based sampling (ABS) with long-term stationary sampling. The ABS should be designed to evaluate short-term exposures associated with anticipated activities in the building. Based on Agency experience, ABS with personal samplers (usually for time periods up to a few hours) typically gives the most representative estimate of short-term, high-end exposures that may occur during dust disturbance activities. Stationary samplers may be used (usually for a time period of 8-24 hours) to characterize longer term exposure during and after ABS sampling, as well as exposure during relatively quiescent activities (*e.g.*, watching television, sleeping). The combination of these sampling techniques should provide useful information to support risk-based decisions within a building.

Applicability

This document is useful at sites where asbestos is tracked indoors or is transported indoors via ambient air from outside sources to house dust or indoor air. Site investigation under CERCLA routinely involves environmental sampling to determine the nature and extent of contamination at a site, as well as to determine the concentration of the contaminants in environmental media to assess risk associated with the site-related contaminants. Where the contaminants have spread to indoor environments, the Agency may evaluate the indoor environment to determine the extent of contamination and characterize risk to inform site risk management decisions (U.S. EPA, 1993).

Indoor sampling for asbestos generally may be needed in homes or other buildings to determine whether asbestos fibers have been transported from the outdoor environment to indoor settings through a reasonably anticipated mechanism. If so, it should be determined whether or not the asbestos in the indoor environment poses a health risk. The decision of whether or not to sample indoors should be made on a site-specific basis. Existing OSWER guidance on when indoor contamination can be addressed under CERCLA may be found in the following memos: “Response Actions at Sites with Contamination Inside Buildings” (U.S. EPA, 1993, 2009) and “Vermiculite Ore Asbestos Sites: Evaluating Potential Indoor Residential Contamination” (U.S. EPA, 2006).

2.0 COORDINATION WITH HEADQUARTERS

In general, CERCLA site investigations evaluating indoor environments to characterize the nature and extent of contamination to support site risk assessment do not require consultation with headquarters prior to or during the sampling events. Regions are, however, strongly encouraged to consult with the TRW Asbestos Committee and OSRTI when evaluating indoor asbestos exposures. For investigations under the removal program, the Office of Emergency Management (OEM) has specifically requested that Regions consult with Headquarters OEM prior to indoor residential site evaluations for homes potentially impacted by asbestos (U.S. EPA, 2006, 2009).

3.0 CONDUCTING INDOOR SAMPLING

Considerations for Sampling

Multiple lines of evidence normally should be evaluated to determine if indoor air sampling is necessary to ensure protectiveness of human health. When evaluating whether indoor sampling is appropriate for a site, the project team (*e.g.*, OSC/RPM, EPA risk assessor, ATSDR) generally should consider a number of factors, including the following:

- mechanism(s) by which asbestos may have entered and been distributed in a building,
- time elapsed since the asbestos release,
- severity of contamination found outside the building(s),
- potential presence of other (non-site related) types of asbestos that may be associated with building materials (*e.g.*, flooring, insulation, or structural materials), and
- approaches to mitigate the possible disruption of the home occupants' daily routines as a result of the sampling event(s).

The TRW Asbestos Committee can provide assistance in making a decision on whether or not indoor sampling is warranted. The recommended decision framework for assessing indoor environments is shown in Figure 1. This is based on the existing Asbestos Framework (U.S. EPA, 2008), but has been tailored for indoor sampling as described below.

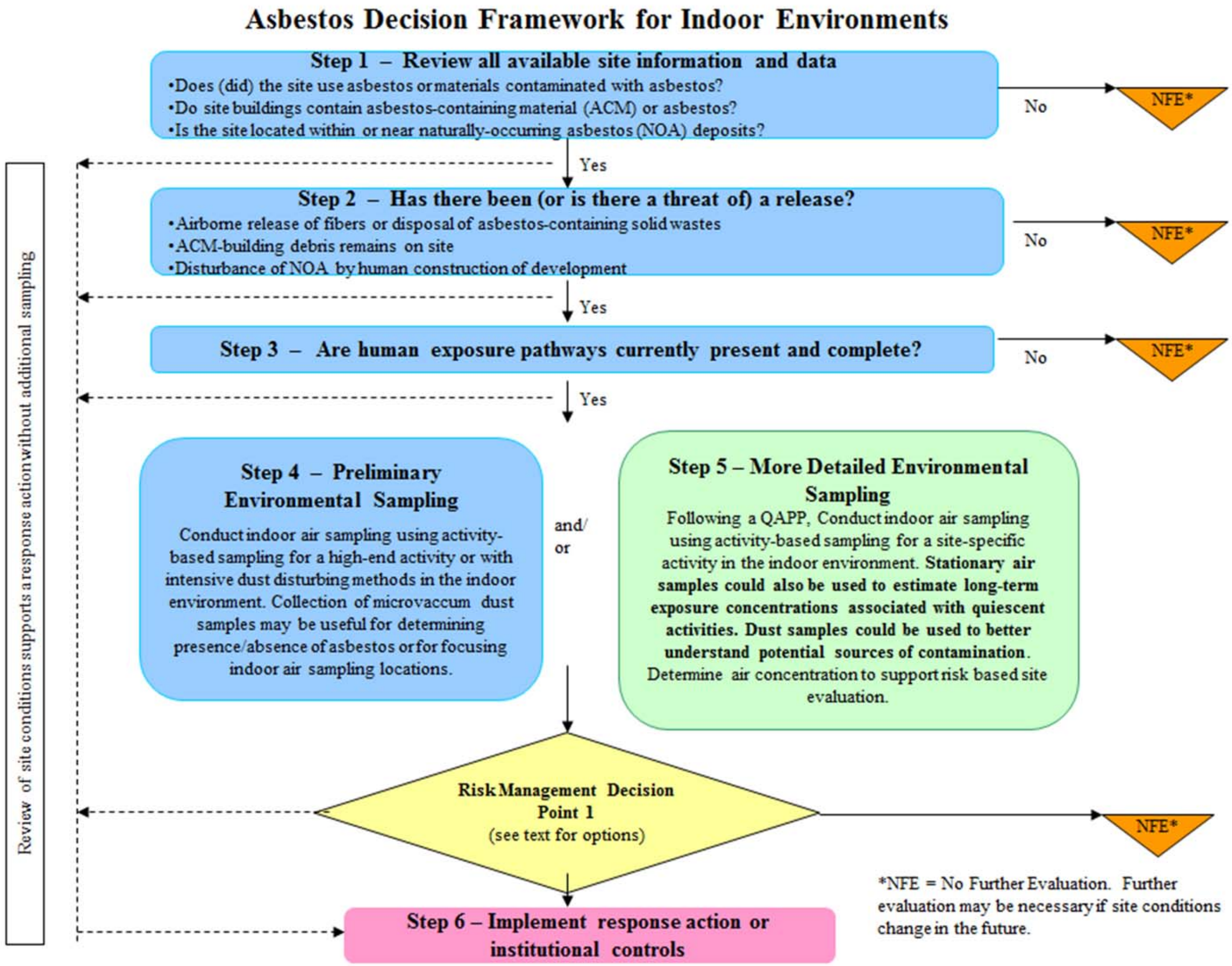

Figure 1: Asbestos Decision Framework for Indoor Environments

Sampling Objectives

Indoor sampling is similar to outdoor sampling described in Steps 4 and 5 of the Asbestos Framework (U.S. EPA, 2008); the type and number of samples collected in the indoor environment generally should be determined by the goals of the sampling event. For example, when assessing asbestos contamination in an indoor environment, dust samples may help determine if asbestos from a Superfund site is present in indoor environments, but they do not provide sufficient information to determine the risk associated with exposure from asbestos contamination. Because the primary route of exposure of concern for asbestos is inhalation, air sampling is needed to support site-specific risk calculations. Thus, a combination of sampling strategies is generally recommended to accurately characterize indoor environments for determining whether action under CERCLA is warranted.

Interaction with Building Occupants

In the case of occupied buildings, advance discussions with the owner/resident are recommended to explain the sampling process. Also, post-sampling communication is recommended to explain the results. If the asbestos concentrations are found to be elevated, the actions that EPA intends to take and/or that the owner/resident can take to reduce exposure to asbestos in dust should also be communicated so that the owner/resident has a clear understanding of the implications of sampling.

In most cases, it will not be necessary for the project team to consult with EPA's Human Subjects Research Review Official (HSRRO) or Regional Equivalent prior to sampling inside buildings that are occupied during sampling. This type of sampling does not constitute human subjects research, but is usually being done for exposure assessment purposes[1]. However, should the plan change to include information from or about human subjects – including conducting surveys or interviews with residents – the plan must be submitted to the HSRRO for review and approval, consistent with 40 CFR 26 and EPA Policy Order 1000.17 Change A1. The project team should contact the HSRRO by phone or email if questions exist on whether or not aspects of the ABS sampling project constitute human subjects research.

The determination of whether residents should be present during sampling will depend on the type of sampling being conducted. If the sampling objective is to assess exposure conditions using ABS to actively disperse asbestos fibers, then residents should not be present during the sampling events to avoid the potential for exposures that would not otherwise occur but for the sampling event. However, in cases where ABS methods can't be applied and the sampling objective is to assess exposure levels under passive conditions, then it may be appropriate to allow residents to remain during the sampling period. Regardless of the sampling methods, owners/residents should not be asked to wear personal air samplers to assess indoor exposure.

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[1] Personal correspondence between Julie Wroble (Risk Assessor, U.S. EPA Region 10) and Toby Schonfeld (Human Subjects Research Review Official, U.S. EPA Office of the Science Advisor), July 24, 2014.

Quality Assurance Project Plan (QAPP) Development

QAPPs should be developed in accordance with existing Agency guidance (see http://www.epa.gov/quality/qapps.html), including developing DQOs and having the QAPP approved by a QA officer. QAPPs for evaluating indoor asbestos contamination typically should specify a number of features, including: sampling objectives, the type of sampling (personal samplers and/or stationary devices), number of sampling events, number and location of sample points, sampling equipment, and sampling duration. Given the resources required and the likely invasive nature of indoor air sampling investigations, sampling is often limited to one sampling event and a few locations within a building. The QAPP should specify the analytical method, pertinent quality assurance/control, and sensitivity that will be used to attain site-specific data quality objectives. As part of the QAPP development, discussion among the project team to select an analytical laboratory that can meet the required analytical sensitivity is recommended to ensure that the sampling event will support site decisions. The project team should determine the time frame needed for sampling results. In some cases, very fast turnaround times may be needed if people are waiting for results to reoccupy spaces. Steps should be taken to ensure that the lab can return sample results of determined detection limits within the timeframe needed to make timely risk management decisions (see U.S. EPA, 2008).

Air Sampling

The goal of indoor air sampling is to determine an accurate estimate of the reasonable maximum exposure (RME) concentration for building occupants[2]. The general recommendation for indoor asbestos sampling to support risk-based decisions at buildings is to assess high-end, short-term exposure associated with anticipated activities in the building in combination with long-term sampling to assess ambient, long-term exposure.

For some indoor contaminants, collection of air samples with stationary monitors is adequate to assess occupant exposures. However, asbestos fibers will settle out of the air into the surface dust and greater exposures are anticipated when activities disturb this dust (suspending asbestos fibers into the air). Thus, the air sampling strategy used for asbestos-contaminated indoor environments should evaluate exposures during a range of activities to estimate relevant exposures.

The specifics of the sampling activity will be driven primarily by the needed analytical sensitivity for a reasonable exposure. The pump flow rate and sampling time should be selected to optimize the air volume collected to the analytical sensitivity needed. See ISO 10312, Table 1 (ISO, 1995) and www.epaosc.net (select Asbestos Data Management Support ERT web page).

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[2] In accordance with Risk Assessment Guidance for Superfund, Volume I (RAGS, Section 6.4.1, EPA, 1989), the exposure frequency and duration assumptions made in developing TWFs should represent reasonable maximum exposure (RME) scenarios.

Activity-Based Air Sampling

Activity-based sampling (ABS) is the recommended practice for assessing short-term exposures associated with site activities that disturb dust. Evaluating occupational exposures with breathing-zone air samples for workers during their normal tasks is a well-established sampling technique. Activity-based sampling (ABS) is an adaptation of this methodology to an environment where the tasks are everyday activities (U.S. EPA, 2008).

Indoor ABS involves simply collecting air samples during an activity that is expected to suspend asbestos fibers from indoor surface dust. Depending on how the ABS event is designed, the information obtained from ABS may relate to screening using high-end dust disturbing activities (Step 4 of the Asbestos Framework [U.S. EPA, 2008]) or site-specific exposure assessment based on a combination of short-term ABS plus longer term quiescent or passive activities (Step 5 of the Asbestos Framework [U.S. EPA, 2008]).

Figure 1 illustrates a similar approach to indoor sampling as was presented in the Asbestos Framework, but aligns Steps 4 and 5 because it may be more difficult to repeat sampling events indoors as compared with outdoors and because practically speaking, ABS is often done only once at a given site. Since you may only get one chance to sample indoors, Step 5 would be recommended in an attempt to get data for actual site-specific exposures. Data then would be used to make risk-management decisions about the need for action, additional sampling, or no further action.

Indoor ABS activities should be selected by the project team to characterize exposure from dust-disturbing activities that would normally occur in the building (*e.g.*, for residences this may include sweeping, dusting, vacuuming). The Asbestos Framework (U.S. EPA, 2008) recommends that preliminary screening (Step 4) be based on risk estimates from high-end exposure scenarios. Indoor ABS for preliminary screening should include high-energy activities anticipated to generate greater dust disturbance in an effort to create a high-end exposure scenario.

Step 5 of the Asbestos Framework (U.S. EPA, 2008) recommends that ABS be conducted to determine air concentrations to support site-specific exposure evaluation. Air sampling for Step 5 should represent exposures across a range of activities expected in the building, to include short-term dust disturbing activities (*e.g.*, for residences this may include sweeping, dusting, vacuuming) as well as some longer-term quiescent or passive activities (such as watching TV, sleeping, or cooking). In practice, exposures during several different types of activities would likely result in different exposure levels. When considered together, these may provide a more representative estimate of long-term exposure levels for residents. Given that indoor sampling at someone’s residence may result in an inconvenience to the property owner or occupants, it is likely that there would be only one opportunity for sample collection. Further, if the goal is to obtain information about likely exposures occurring at the site, then Step 5-type sampling may be more appropriate than Step 4-type sampling (see Figure 1).

Both the dust load and the asbestos content of the dust will contribute to the asbestos fibers available for release during disturbance. Thus the most conservative ABS sample representing the high-end of the exposure range would be a high energy activity, in an area with a high dust load which contains asbestos. The location that is likely to have asbestos-contaminated dust at the high end of the concentration range may be determined by site information (*e.g.*, microvac dust or wipe sampling) and/or professional judgment (*e.g.*, high-traffic areas, dust collection reservoirs, areas that are not regularly cleaned).

Indoor ABS is typically conducted by EPA or contractor personnel in protective gear using personal samplers to characterize breathing zone exposure to asbestos fibers during a disturbance activity (*e.g.*, housecleaning). The goal is to determine a more representative estimate for an exposure point concentration (EPC) (or a dust disturbance concentration differing from the quiescent concentration) that could occur during an activity (or group of activities) in a building. This exposure concentration can be compared to a risk-based level of concern (LOC, see Section IV) or calculation of an excess lifetime cancer risk (ELCR) to inform a decision based on the CERCLA risk range (see Section IV Example Calculations).

Stationary Sampling

Stationary air monitoring equipment has the capability to collect longer-duration samples (approximately 8-24 hours), and samples with a higher volume than personal samplers to achieve an improved analytical sensitivity. Thus, stationary samplers may be useful to help characterize longer term exposure during and after ABS sampling or exposure during relatively quiescent activities (*e.g.*, watching television or sleeping) or to determine whether there is risk under quiescent conditions (which may be useful for screening, since unacceptable airborne asbestos levels during quiescent periods can be used to support risk management actions). Stationary air sampling alone (*i.e.*, without dust disturbance) limits the ability to quantitatively assess higher exposures expected due to occupant activity in the building. Therefore, it is generally recommended that ABS be used in addition to stationary sampling to inform risk-based site decisions.

There may be instances where stationary air sampling with dust disturbance could be used as a surrogate for ABS and the resulting data could be used to assess risk. For example, where it is impractical to conduct ABS or where the building owner or occupants will not allow ABS, the Agency has used other methods of dust disturbance with short and long term air sampling (*e.g.*, leaf blowers[3], oscillating fans). Although these methods do provide some indication of the releasability of fibers, airborne fiber levels measured after these surrogate dust disturbance methods are not generally used to quantitatively inform risk estimates.

[3] Leaf blowers are used for clearance sampling under AHERA (40 CFR Part 763, Subpart E—Asbestos-Containing Materials in Schools).

There may be instances where this is the only exposure information available to support site decisions. In those instances, consideration should be given to the following: 1) exposures due to actual human activity may be higher or lower than estimated by these surrogate methods, and 2) air sampling with no dust disturbance may underestimate the potential indoor exposures. These should be included as uncertainties in the risk assessment where appropriate.

Air Sampling Recommendations

The data obtained from stationary air sampling in an occupied building may not necessarily be equivalent to ABS using breathing zone measurements of exposure. **Therefore, the general recommendation and preferred approach for indoor sampling to support decisions within buildings is to use ABS with personal samplers to assess short-term exposure in combination with long-term stationary sampling to assess quiescent, long-term exposure.**

Dust Sampling

Dust samples may be collected on solid, nonporous surfaces to identify areas where asbestos is present or absent. **At this time, there is limited information available to correlate asbestos content in dust with human exposure to support risk-based decisions at Superfund sites; however, dust information may be used to support risk management decisions when exterior high-level sources are present that result in high indoor dust levels (i.e., dust data alone may trigger removal actions such as indoor cleaning in some instances).** Dust samples can be collected to provide a fiber loading per surface area in structures per square centimeter (s/cm^2). See Appendix C and ASTM D5755-09 and ASTM D6480-05 for descriptions of dust sampling[4] (Kominsky and Millette, 2010).

Where a limited number of dust samples are available, the user should exercise caution in extrapolating those results to areas not sampled. Dust sample results can overestimate as well as underestimate asbestos levels. The selection of sample locations is usually biased to suspected higher level areas, so these results may not necessarily represent the indoor space as a whole, but rather only represent the 100 square centimeters that was actually sampled. Additionally, the dust analytical methods rely upon analyzing only a small portion of the sample. The results of this analysis are then used to calculate the final result for the sample. Since asbestos is unlikely to be distributed evenly across the sample, the final result being based on analysis of only a portion of the sample is a source of substantial uncertainty.

Since the dust methods follow counting rules described in Asbestos Hazard Emergency Response Act (AHERA) rules[5], fibers that are too short to be included in the PCMe count of

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[4] The ASTM method provides AHERA counts unless otherwise specified. See Appendix C for more information.

[5] See www.epa.gov/superfund/health/contaminants/asbestos/compendium/download/response_actions/table_4-2_%20comparison_of_applicable_methods_for_measuring_asbestos_air.pdf

corresponding air samples will be counted in the dust results. Correlation of dust and PCMe air results will be particularly difficult for chrysotile, since chrysotile tends to have more short fibers than amphiboles. The dust methods also involve indirect preparation of filters for analysis. For chrysotile asbestos, indirect preparation often tends to substantially increase structure counts due to dispersion of bundles and clusters (Hwang and Wang, 1983; HEI-AR, 1991; Breysse, 1991). For amphibole asbestos, the effects of indirect preparation are generally much smaller (Bishop et al., 1978; Sahle and Laszlo, 1996; Harris, 2009). For example, Libby-specific studies on the effect of indirect preparation on reported Libby Amphibole (LA) air concentrations show that indirect preparation usually increased reported PCME LA air concentrations, but these concentrations were within a factor of about 2-4 compared to direct preparation LA (Berry et al., 2014; Goldade and O'Brien, 2014).

Dust Sampling Considerations

As discussed in Section 8 of the Asbestos Framework (U.S. EPA, 2008), asbestos concentrations in settled dust can be used for screening to inform risk management responses (such as early removal actions like cleanup activities) when high-level sources are present. Analogous to a situation where very high levels of asbestos are detected in residential soil and provide a basis for a cleanup action, the project team may decide in the planning phase of the indoor assessment that the presence of elevated concentrations of asbestos in indoor dust is sufficient for initiating a cleanup action. For example, asbestos-contaminated indoor dust samples having greater than 10,000 structures/cm² (total fibers) were identified as unacceptably elevated Millette and Hays (1994)[6]. Lower screening numbers for dust have also been used as the basis for site-specific cleanup: dust results greater than 5,000 structures/cm² (total fibers) were considered sufficiently high to warrant a response action at indoor environments impacted by the World Trade Center collapse (U.S. EPA, 2003a, 2005) and Libby (U.S. EPA, 2003b).

Because of limitations in predicting the release of asbestos fibers from settled dust, sampling of dust (such as microvac sampling) is not typically recommended as a stand-alone means of assessing indoor exposures to asbestos. Also, asbestos-contaminated dust concentrations less than the screening level generally require further evaluation (*i.e.*, air sampling) since there is insufficient information to conclude that levels below the screening level would not present a health concern if the dust is disturbed by occupants during routine activities. When conducting dust sampling, it is recommended that the project team establish a target analytical detection limit for the samples and, if necessary, discuss this issue with the selected laboratory.

4.0 EXAMPLE CALCULATIONS

Risk calculations can be used to estimate potential site risks or in the development of generic screening levels and/or site-specific action levels. Generic screening levels and site-specific

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[6] This is also known as the Millette and Hays experience standard for asbestos in dust.

action levels are used to determine the analytical sensitivity necessary to support decisions at the site. Site-specific action levels and generic screening levels can be derived for ABS or stationary air samples. In some cases, such as removal sites where decisions must be made quickly, risk management decisions include comparing action levels to measured levels as described below. Estimates of potential risks, as described in Section 5.5 of the Framework (U.S. EPA, 2008), involves calculating excess lifetime cancer risks (ELCRs) for exposed individuals using data obtained from ABS and stationary air samples and site-specific assumptions about exposure. An example showing this type of calculation is presented below. The examples shown are for residences; however, the concepts and considerations also can be applied to other buildings (*e.g.*, commercial buildings) by modifying the exposure factors.

A risk-based level of concern (LOC) for asbestos in quiescent indoor air may be calculated by rearranging the standard risk equation to compute the concentration of asbestos in air that corresponds to a CERCLA specified risk level for an appropriate exposure scenario as follows:

Equation 1:

$$\textit{LOC for Asbestos in Air (f/cc)} = \textit{Target Risk} \div [IUR_{LTL} \cdot TWF]$$

The standard Superfund residential exposure scenario (U.S. EPA, 1989) would apply to this example. The LOC for asbestos[7] in air was calculated using the time weighting factor for Baseline Residential Exposures (TWF = 350/365 = 0.96, see Table 1 of the Framework [U.S. EPA, 2008]), the 0-30 year age interval[8] IUR_{LTL} ([IUR_{LTL} = 0.17 $(f/cc)^{-1}$], see Table 2 of the Framework [U.S. EPA, 2008]), along with the target risk levels of $1x10^{-4}$ and $1x10^{-6}$:

Equation 2:

LOC for Long-term Residential Asbestos Exposures for 1 in 10,000 risk (f/cc)

$$= 1x10^{-4} \div [0.17\ (f/cc)^{-1} \cdot 0.96]$$

$$= 0.0006\ f/cc$$

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[7] This example is for asbestos forms other than Libby Amphibole Asbestos. For sites where there is exposure to Libby Amphibole Asbestos in the indoor environment, please contact the TRW Asbestos Committee.

[8] In this example, it is assumed that this age group represents receptors who are first exposed to asbestos at the site at birth and for a duration of 30 years. In the absence of a 26-year IUR (residential exposure in accordance with Superfund assumption of 26 years of duration), the 30-year IUR 0.17 f/cc was used to err on the side of conservatism.

Equation 3:

LOC for Long-term Residential Asbestos Exposures for 1 in 1,000,000 risk (f/cc)

$= 1x10^{-6} \div [0.17\ (f/cc)^{-1} \bullet 0.96]$

$= 0.000006\ f/cc$

The inputs to the LOC calculation shown are generic screening values (though these may match site-specific information in some cases). The LOC calculation can be made site-specific by modifying the TWF and/or the age and duration associated with the IUR_{LTL}. The sampling results (airborne fiber concentrations in f/cc) from the stationary 24-hour (total) samples for each decision unit could be compared to these risk-based LOC values for $1x10^{-4}$ and $1x10^{-6}$ risk levels to inform site decisions and determine whether there is a basis for action under CERCLA. Note that the LOC calculation from stationary air samples could trigger a response if the LOC is exceeded.

Site screening: Step 4 to Risk Management Decision Point

After ensuring that the desired analytical sensitivity was achieved, the project team should compare the air sampling results to the risk-based LOC based on the CERCLA risk range for asbestos in air to help determine the appropriate next step, specifically whether action is warranted under CERCLA (air concentrations above the LOC for a 10^{-4} risk level, no further action (NFA) decision (air concentrations below the LOC for a 10^{-6} risk level), or additional sampling is necessary to characterize risk (air concentrations within or close to the LOC for 10^{-4} to 10^{-6} risk range). While action is generally warranted when the carcinogenic risk level exceeds a 10^{-4} excess lifetime cancer risk, action may also be warranted within the risk range based on site-specific factors such as multiple contaminants, applicable or relevant and appropriate requirements (ARARs), uncertainty, sensitive populations, etc. Specific considerations for determining the potential for unacceptable risks from inhalation of asbestos fibers include sampling and analytical constraints, the presence of multiple exposure scenarios (*e.g.*, different activities that may disturb dust), and scenarios characterized with ABS.

Preferred Indoor Sampling Approach Example: Simulating Residential Exposure using Long-Term and Short-Term Sampling in an Unoccupied Residence

A single sampling event may be used to assess short- and long-term exposures that may occur in the residence due to disturbance of settled dust. The short-term ABS event simulated housecleaning by residents. Trained personnel[9] conducted housecleaning activities (vacuuming, dusting, and sweeping) for a total of 4 hours in areas with suspected asbestos contamination.

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[9] All persons with potential airborne exposure to asbestos should have appropriate training and use appropriate personal protective equipment (PPE), consistent with a properly developed health and safety plan (HASP) that follows EPA policies and Occupational Health and Safety Administration regulations.

Personal samplers were placed on those conducting the ABS activities, and air samples were collected during the event. Five stationary air samples were collected inside each residence during the ABS event and for an additional 20 hours (for a total time was 24 hours.) This approach only intrudes on a single day for the owners/occupants and should provide sufficient information to support a decision for the building.

The short-term air samples may be used to evaluate whether risks are acceptable during the disturbance activity through comparison to risk-based criteria for time-weighted exposure scenarios. While these exposures are intermittent, there is the potential that cleaning activities may result in a higher exposure level (*i.e.,* greater chance for disturbing and inhaling fibers in settled dust during cleaning). Assuming the 4-hour ABS represents weekly housecleaning, this is a small fraction of the 168-hour week. Because of this, the ABS activity was supplemented with long-term stationary sampling to assess exposure to ambient air in the building. The long-term air samples may be used to evaluate whether risks are acceptable through comparison to risk-based criteria for long-term exposure scenarios. In this example, risk-based LOCs are calculated for both short-term, higher exposure (*i.e.*, house cleaning) and longer term exposure when dust is not being disturbed.

<u>First Phase: Establishing Risk Based LOC for Comparison of Sampling Results</u>

A risk-based LOC for asbestos in quiescent indoor air may be calculated as shown above with site-specific substitutions. To determine a risk-based cleanup LOC for the house cleaning scenario, exposures are assumed to be intermittent (4 hours per day once per week). As a result, the LOC for asbestos in air was calculated using an assumed time weighting factor for cleaning (*TWF = 4/24 hours per day, 50/365 days per year = 0.023*), the 20-50 year age interval[10] IUR_{LTL} ((0.075 $(f/cc)^{-1}$), see Table 2 of Framework [U.S. EPA, 2008]), along with the target risk levels of $1x10^{-4}$ and $1x10^{-6}$:

Equation 4:

LOC for Housecleaning Asbestos Exposures for 1 in 10,000 Risk (f/cc)

$$= 1x10^{-4} \div [0.023\ (f/cc)^{-1} \bullet 0.075]$$

$$= 0.06\ f/cc$$

[10] In this example, it is assumed that this age group represents receptors who are first exposed to asbestos at the site at the age of 20 and for a duration of 30 years until they are 50 years old. It is also assumed that a person would start doing housecleaning at the age of 20 and not younger; hence, they would first be exposed to asbestos at the age of 20.

Equation 5:

LOC for Housecleaning Asbestos Exposures for 1 in 1,000,000 Risk (f/cc)

$= 1x10^{-6} \div [0.023\ (f/cc)^{-1} \bullet 0.075]$

$= 0.0006\ f/cc$

The sampling results (airborne fiber concentrations in f/cc) from the 4 hour housecleaning samples for each decision unit should be compared to these risk-based LOC values for $1x10^{-4}$ and $1x10^{-6}$ risk levels to inform site decisions and determine whether there is a basis for action under CERCLA (see U.S. EPA, 2008 section 5.2). Caution may be needed for cases where several activities that are near the LOC, but none exceed the LOC (*e.g.*, multiple activities within a home or exposure to asbestos indoors and outdoors).

The LOCs for long-term residential exposure as calculated above (see Equations 2 & 3) should be used for assessing stationary air sample data.

Second Phase: Excess Lifetime Cancer Risk Calculation Using Sampling Results

Using the preferred approach, we assume data are available both for ABS and stationary samples. Using assumed EPCs, we can calculate excess lifetime cancer risks by making reasonable assumptions about exposure. If only stationary data are collected, then a comparison to the long-term LOC as calculated above could be appropriate.

As noted in the general equation presented in Section 5.0 of the Framework (U.S. EPA, 2008), the basic equation for estimating ELCR resulting from exposure to asbestos is:

Equation 6:

$$\text{Risk (ELCR)} = EPC \bullet TWF \bullet IUR$$

As noted above, when applying this equation to a less-than-lifetime exposure, TWF_i and IUR_{LTLi} values specific to the exposure scenario(s) must be used to calculate the appropriate $ELCR_i$ as follows:

Equation 7:

$$ELCR_i = EPC_i \bullet TWF_i \bullet IUR_{LTLi}$$

Where:

$ELCR_i$ = excess lifetime cancer risk for less-than-lifetime scenario i

EPC_i = the scenario-specific exposure point concentration generated from activity-based sampling

TWF_i = the scenario-specific time weighting factor

IUR_{LTLi} = the Inhalation Unit Risk corresponding to the age at first exposure and exposure duration for the exposure scenario

Because CERCLA risk assessors may also need to characterize the cumulative risk to an individual resulting from exposure to several environments (*e.g.*, different operable units across a site) or several scenarios (*e.g.*, playing in the dirt, mowing the lawn, and indoor exposures), the cumulative excess lifetime asbestos cancer risk can be summarized as follows:

Equation 8:

$$ELCR_c = \sum EPC_i \cdot TWF_i \cdot IUR_{LTLi}$$ [11]

Where:

$ELCR_c$ = the cumulative excess cancer risk attributed to exposure to multiple environments or multiple scenarios over the course of the exposure duration of the individual.

For the purposes of this example, we assume the EPC for housecleaning ABS is 0.03 f/cc. We then calculate the ELCR calculation as follows:

Equation 9:

$$ELCR_1 = 0.03 \text{ f/cc} * 0.023 * 0.075 \text{ (per f/cc)} = 5.2E\text{-}05$$

The EPC for ambient air is assumed to be 0.0005 f/cc. The TWF should account for the fact that some of the time in the residence is spent cleaning.

Where:

Adult scenario (ages 20-50)

TWF for cleaning is (4/24) * (50/365) = 0.023

Remainder of time at stationary: 24 hours/d – 4 hours/d (50/365) = 23.45 hours/day

Stationary TWF: 23.45/24 * 350/365 = 0.94

[11] Note that in this context, “lifetime” refers to the risk of developing cancer sometime during one’s lifetime from an exposure of duration specific to the activity being assessed; it does not refer to risk from a lifetime of exposure.

The ELCR for the remaining portion of the exposure is calculated as follows:

Equation 10:

$$ELCR_2 = 0.0005 \text{ f/cc} * 0.94 * 0.075 \text{ per f/cc} = 3.5 \text{ E-05}$$

The combined $ELCR_c$ is simply the sum of $ELCR_1$ and $ELCR_2$ or 8.7E-05. At this risk level, remedial managers may decide that action is not warranted as the calculated risk is less than the level where action needs to be taken. However, in some instances or at some sites, action may be determined to be necessary if this level of risk is considered to be unacceptable due to uncertainty or applicable and relevant or appropriate requirements (ARARs). This decision is usually made on a site-specific basis and involves risk managers and potentially regional management.

For children who live at the residence, the stationary air data can be used to assess the risks to children. The EPC for ambient air is assumed to be 0.0005 f/cc. In this example, we assume a child lives in the house until age 20. The TWF would be the same as for the long-term residential scenario (TWF = 350/365 = 0.96, see Table 1 of the Framework [U.S. EPA, 2008]), but the toxicity value must reflect the 0-20 year age interval[12] IUR_{LTL} ([IUR_{LTL} = 0.14 $(f/cc)^{-1}$], see Table 2 of the Framework [U.S. EPA, 2008])

Equation 11:

$$ELCR_2 = 0.0005 \text{ f/cc} * 0.96 * 0.14 \text{ per f/cc} = 6.7 \text{ E-05}$$

The child-specific ELCR should not be combined with the adult risk calculated above, but should be presented separately.

REFERENCES

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[12] In this example, it is assumed that this age group represents receptors who are first exposed to asbestos at the site at birth and for a duration of 20 years. The 20-year IUR 0.14 f/cc was used for children.

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