Agency for Toxic Substances and Disease Registry (ATSDR) Newsletter for Health Assessors, Including APPLETREE Partners

Guidance & Clearance News

May 2022

This newsletter informs you about guidance and resources you can use in your health evaluations.

What is in this Newsletter?

The following topics are included in this edition of the ATSDR Newsletter for Health Assessors. An index of all topics covered in previous newsletters has been added to the Public Health Assessment Site Tool (PHAST) resources page under the heading of ATSDR Health Assessor Newsletter.

How to be Soil Gas Savvy when Performing Vapor Intrusion Assessments

This article explains the different types of soil gas samples that are often reviewed for vapor intrusion sites and how to use them in health assessments. The two types of soil gas samples are sub-slab and exterior samples, depending on the location and depth at which they are collected. ATSDR has soil vapor intrusion (VI) sub-slab and near-source (exterior) soil gas comparison values (CVs) in PHAST that can be easily used with some types of soil gas samples to select contaminants for further evaluation. Soil gas samples that are collected from locations that are not beneath the building footprint or too shallow to be considered "near-source" should not be compared with the CVs for screening.

Sub-slab Soil Gas Samples

Sub-slab soil gas sampling is the preferred soil gas sampling method for characterizing vapor entry into buildings with a slab. Sub-slab soil gas samples are collected by using a drill to penetrate the slab and then drawing an air sample from the boring [EPA 2020]. Sometimes a sealed port is installed that can be reopened for later sampling and closed when not in use. Health assessors should screen sub-slab soil gas samples against

the SVI-soil gas CVs. Sub-slab soil gas samples collected at the same time as indoor and outdoor air samples help assessors determine the source of indoor air contaminants, because higher concentration areas such as soil gas may serve as a source to lower concentration areas such as indoor air. Health assessors should recommend multiple rounds of sub-slab gas sampling in hot and cold weather for reasonable confidence in VI characterization, if not available. Guidance recommends having one or two sub-slab gas samples for small 1,500 square feet buildings and as many as 12 or more samples for buildings larger than 1 million square feet. When reviewing sample data, pay special attention to building, subsurface, and occupancy factors that could cause variability in indoor air levels [EPA 2010, 2015; NJDEP 2021]. Note how factors might qualitatively or quantitatively affect the representativeness of sub-slab soil gas data on estimated exposures (exposure point concentrations and exposure factors) from breathing indoor air.
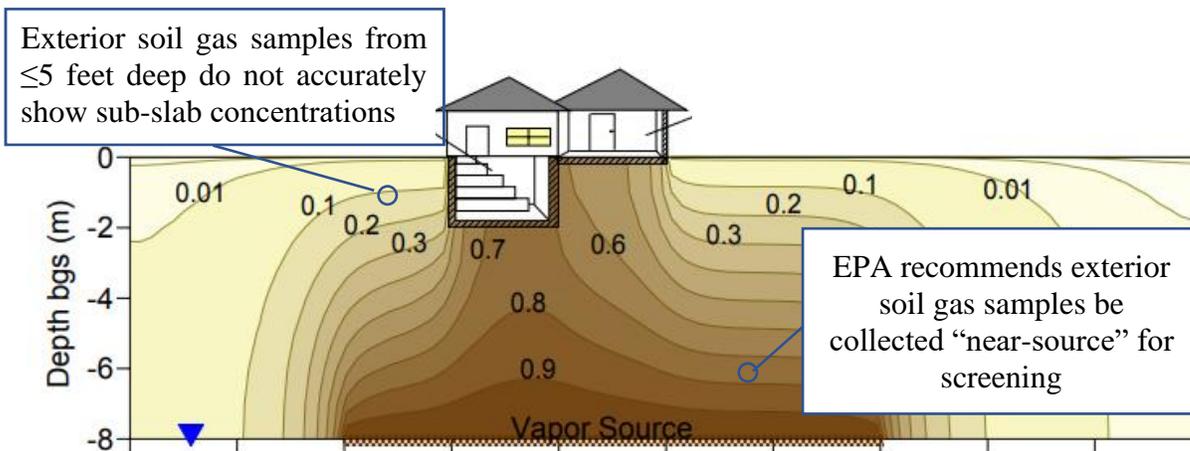
Exterior Soil Gas Samples

Exterior soil gas samples are collected from locations that are not beneath the building footprint. Soil gas samples from borings made as close to the building footprint as possible better represent vapor intrusion potential than do samples from borings made further away. Exterior soil gas samples can be used to screen "near-source" soil gas to determine if a nearby building might be susceptible to vapor intrusion and requires further evaluation. They also can be used to characterize the extent of soil gas contamination laterally and vertically within the soil column.

For screening, "near-source" exterior soil gas samples may be collected from immediately above the groundwater table (i.e., above the saturated soil) and compared with the SVI-soil gas CVs. The preferred exterior soil gas sample depth is at least 10 feet deeper than the building slab, if possible, to provide adequate representativeness of vapor intrusion potential [ITRC 2007]. Any exterior soil gas samples collected at less than 5 feet deep could under-estimate vapor intrusion potential because the soil gases might be diluted by ambient air (i.e., they might provide false negative results and should not be used for screening) [EPA 2015].

For characterizing the extent of contamination, exterior soil gas survey data might be available. Exterior soil gas surveys consist of samples collected at multiple locations and depth intervals between the vapor source and building(s). The surveys are designed to locate and delineate the extent of the affected area but should not be used for screening buildings.

Figure 1 shows how soil gas samples from too shallow a depth outside the building footprint might under-estimate concentrations in contact with the building slab. The figure also shows how concentrations are higher beneath the building but gradually decrease with distance and shallower depths. Samples that are laterally nearest the building and vertically nearest the source best represent sub-slab conditions. Factors such as differences in soil layers and ground cover can affect soil gas profiles [EPA 2012].

Figure 1: U.S. Environmental Protection Agency conceptual model scenario of soil gas concentrations beneath a building with a basement and a slab [EPA 2012]*
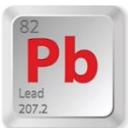

* Darker brown indicates higher soil gas concentrations in this theoretical model

Summary

Several rounds of sub-slab soil gas or well-placed exterior near-source soil gas samples may be compared with SVI-soil gas CVs to screen buildings in or out of further evaluation. Exterior soil gas samples that are shallower (i.e., not immediately above the water table, or are not from between the source and building) should only be used to understand the extent of contamination in the area. For a better understanding of specific scenarios, consult the U.S. Environmental Protection Agency's (EPA) guidance on conceptual model scenarios [EPA 2012].

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Tips for Evaluating Lead Exposures at Sites, Part 4: "Know Your Samples"

Our series continues with Part 4 of tips for evaluating lead exposures. In this part, we take a closer look at "know your samples."

As you begin to gather information about your site, you will develop your conceptual site model and pathways of exposure. You will gain an understanding of the source of contamination, the various media and migration or transport of the contamination, location of the exposed population, and various ways people might be exposed.

> **Tips for Evaluating Lead Exposures**
> - **Know your community:** Find out the factors that increase risk for lead exposure.
> - **Know your samples:** Find out site-specific exposure and sampling conditions.
> - **Know your data:** Find out environmental lead levels (soil, water, air, dust, biota).

Samples are collected in various ways to answer different questions. Preferred sampling parameters for ATSDR use might or might not be available; the site-specific exposure scenarios determine whether the sampling

parameters are adequate. One parameter might be preferred over another under certain circumstances. The examples below are not meant to be comprehensive or a complete list of possible considerations. The idea here is to understand the sampling parameters and how they relate to the exposure questions ATSDR is addressing. In this article, we discuss conditions and considerations to address the following questions for evaluating lead samples from various environmental media:

- Are the samples representative of exposures at the site?
- Do the samples over- or under-estimate exposures?

From your evaluation of the questions above, you will be able to address the higher-level questions:

- Are there gaps in the sampling that create limitations that prevent you from making public health conclusions?
- What recommendations can you make to fill data gaps sufficiently to make public health conclusions?

To help determine whether the samples are representative, you need to evaluate the samples in terms of where, what, and how. Below we provide some examples to consider.

Where: Because there are many sources of lead, you need to understand where samples were collected. Were samples collected at the point of exposure within the defined exposure units? Would the sample locations over- or under-estimate exposure?

- **Soil:** *play area, whole yard, gutter or roof dripline, garden, downgradient or near non-site-related lead source such as street, driveway, carport, or garage.*

    Samples collected from a play area would be representative of a child's exposure at the play area. Whole yard samples might under-estimate exposures. Gutter/roof dripline, near street, driveway, carport, or garage samples might over-estimate exposures if they contain lead from air deposition, lead paint, or leaded gasoline that add lead (contribute) to the baseline lead in soil.

    - **Drinking water:** *tap, wellhead, spigot, and bathroom.*

    Tap water samples best represent residential exposure. Samples from wellheads, spigots, and bathroom faucets not used for drinking might not represent exposure.

    - **Air:** *residential, commercial, site boundary, distance from source.*

    Indoor air samples best represent exposures for residences and businesses. Outdoor air samples might not represent indoor air exposure.

    - **Dust:** *indoor, door mat.*

    Indoor dust samples might better represent exposure than would door mat samples. Door mat samples might indicate the contribution of outdoor soil to indoor dust. Door mat samples might over-estimate exposures if the main contributor to indoor dust is outdoor soil, unless it is just one of several sampling locations used to provide a more complete picture of the outdoor soil-to-indoor dust relationship.

What: Understand what exactly was sampled and how that affects the representativeness of your data.

- **Soil:** *depth, ground cover, sieving, grinding, grain-size, soil pH, and moisture.*

At what depth were samples collected? ATSDR considers a depth of 0 to ≤ 3 inches as surface soil for exposure, EPA typically uses 0 to 6 inches or deeper, which might not be representative of exposure point concentrations. Deeper soil levels might add additional lead from a higher concentration that is buried and too far from the point of exposure. If deeper soil has lower lead levels, it might dilute the lead at the surface point of exposure.

Was ground cover removed for sampling? Samples collected below ground cover might over-estimate exposure levels if the cover is uniform.

Were samples sieved? Sieving soil samples removes large particles, possibly including lead fragments such as lead shot. Sieving is intended to identify the fraction of soil that adheres to the hands (less than 250 microns, <250 µm), which can be readily ingested during hand-to-mouth activity. Sieved samples might under-estimate lead exposure when ingestion of lead fragments (i.e., lead shot) is one possible lead exposure scenario. Sieved samples will be representative of exposures under most other scenarios.

Were samples ground? Grinding soil samples releases the inner contents of soil components such as rocks. Depending on the composition of the soil components, ground samples might not be representative of exposures and could over- or under-estimate lead exposures. Other factors that can influence bioavailability of lead in soil include size of soil grains, soil pH, and moisture content. Soil pH could play a significant role in lead bioavailability and transport. Low pH or high acid levels in soil increases the solubility of lead [Oxtoby 2019]. Soil moisture content can interfere with accuracy of x-ray fluorescence spectroscopy (XRF) results [Bastos 2012].

- **Drinking Water:** *first draw, flushed.*

Was water collected as "first draw," or after water was flushed from the lines? First draw usually represents the worst-case scenario because water has been allowed to sit in the plumbing. Plumbing can be a source of lead, increasing the baseline level of lead in the water. Factors that can influence bioavailability of lead in water include water pH and cation exchange capacity.

- **Air:** *height, total suspended particles (TSP), particulate matter 10 (PM 10), particulate matter 2.5 (PM2.5)*

At what height were samples collected (breathing zone, activity height, lower, or higher)? Samples collected at the breathing zone can be representative of breathing during static conditions, but they might under-estimate suspended particles stirred-up during activities or windy conditions. Samples collected at higher heights might indicate potential for deposition at some distance away from the sample location, but they might not be representative of exposure at that point. EPA's National Ambient Air Quality Standards (NAAQS) for lead are based on TSP and not PM 10 or PM 2.5. We currently do not have standards for the lead fraction of PM 10 or PM 2.5 samples.

NOTE: Even though several factors might affect bioavailability, we would not change the default bioavailability in EPA's Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) unless we have site-specific bioavailability information.

How: Understand the sampling method, strategy, and number.

- **Soil:** *core, spoon, x-ray fluorescence spectroscopy (XRF), incremental, composite, discrete (individual), grid, biased, unbiased.*

What method was used to collect and test the samples: core, spoon, XRF with or without laboratory confirmation, or laboratory analysis only? Soil strategy[1] can include incremental, composite, discrete (individual), grid, biased, and unbiased. Biased strategy is what we often see when the source and its location is known or suspected. Samples are collected based on that knowledge or bias. Samples where there may be multiple sources or where the source is unknown may use a grid strategy or incremental strategy and be unbiased as to the source. Does the strategy characterize the extent of contamination? Are there enough samples to characterize exposure? Typically, a minimum of eight samples are needed to apply statistical methods. Are the samples representative of the exposures or do they over- or under-estimate exposures?

- **Drinking water:** *filtered, unfiltered, discrete or blended, flushed, first draw.*

What method was used to collect the samples: filtered, unfiltered, discrete, or blended? What strategy was used: worst case or maximum (first draw), average (flushed, or several sampling intervals from first draw to flush for 3 minutes), or multiple samples collected over time? Typically, the unfiltered samples are more closely representative of exposures. Lead levels in tap water can be highly variable and influenced by things such as an early morning toilet flush or other draws, even from a different faucet. Are the samples representative of the exposures or do they over- or under-estimate exposures?

- **Air:** *discrete, collected over time 8-hr, 24-hr, rolling average.*

What method and strategy were used: discrete, collected over time 8-hr, 24-hr, 3-month rolling average[2] (averaged over time)? Are the samples representative of the exposures or do they over- or under-estimate exposures?

- **Dust:** *vacuum, wipe.*

What method and strategy were used: vacuum, wipe samples, area sampled (e.g., centimeters per square foot [cm^2], square feet [ft^2])? Are the samples representative of the exposures or do they over- or under-estimate exposures?

When you "know your samples," you will have a more comprehensive understanding of whether the site sampling produces results that allow you to

- make sound, evidence-based public health conclusions,
- determine the limitations of the sampling,

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[1] Refer to ATSDR's non-discrete sampling guidance for help in determining how to determine their lead EPCs.
[ATSDR] Agency for Toxic Substances and Disease Registry. 2022. Exposure point concentration guidance for non-discrete sampling. Atlanta, GA: US Department of Health and Human Services, Public Health Service. Note that our discrete sampling EPC guidance does not apply to lead. EPA's IEUBK model uses the arithmetic average (mean).

[2] The 3-month rolling average is the metric used in EPA's IEUBK model and to compare to the EPA's national ambient air quality standards (NAAQS). Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection.

- highlight gaps needed to make public health conclusions, and
- make needed recommendations.

You can capture your evaluation of the sampling with statements in the data and limitations sections of your document. Gaps or information needed for public health conclusions can be requested in the recommendations section of your document.

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Evaluating Noncancer and Cancer Multi-Route Exposures from the SHOWER Model

When household water is contaminated with volatile and semi-volatile organic chemicals and pesticides, health assessors will need to evaluate inhalation and dermal exposures separately from the ingestion of drinking water. Thus, inhalation and dermal exposures associated with household water use cannot be eliminated from further evaluation by screening with drinking water CVs. We have developed dermal and inhalation CVs and plan to incorporate them in PHAST later in 2022. This article briefly reviews the noncancer evaluation steps and explains how to calculate a total cancer risk from the three pathways (inhalation, dermal, and oral routes).

Evaluating Exposure Using the SHOWER Model

The PHA process for evaluating exposures using the SHOWER model consists of several steps. First, health assessors will use the maximum concentration in household water to run the SHOWER model and use the air results to screen a contaminant using ATSDR's air CVs screening process. If a contaminant is selected as a contaminant of concern because the 24-hr air concentration estimated by the model exceeds the recommended air CV in PHAST, health assessors will identify the exposure point concentration (EPC) for household water. If the EPC is different from the maximum water concentration, health assessors will run the model again to generate EPC-based air concentrations and dermal doses. These concentrations and doses will be compared with health guidelines, such as minimal risk levels (MRLs), reference doses (RfDs), or reference concentrations (RfCs). If these guidelines are exceeded, health assessors will conduct a toxicological evaluation to determine whether noncancer harmful effects might be possible. The EPC-based results also will be used to estimate cancer risk for carcinogens. What follows is a more detailed description of the next steps to further evaluate the potential for noncancer and cancer effects from the SHOWER model results.

Combining inhalation, dermal, and oral exposures for noncancer evaluation

For scenarios where residents are showering or bathing in contaminated water and drinking contaminated water, health assessors may consider combining the exposure from multiple routes (ingestion, inhalation, dermal) to get a total exposure dose. To combine doses from different routes, the chemical must have the same toxic endpoints via the oral and inhalation routes. If, and only if, these conditions are met, health assessors can combine the inhalation dose with the oral and dermal doses to get a total dose from all routes

of exposure. Examples include 1) trichloroethylene, 2) tetrachloroethylene, 3) benzene, 4) carbon tetrachloride, 4) chloroform, 5) mixed xylenes, 6) trans-1,2-dichloroethene, and 7) chlordane. Health assessors should consult with the Associate Director of Science (ADS) when using this approach. For all other chemicals where the oral exposures and inhalation exposures have different target organs or systems, these routes will need to be evaluated separately. Studies cited in ATSDR's toxicological profiles, EPA's Integrated Risk Information System (IRIS), and other appropriate sources must support this approach.

Combining inhalation, dermal, and oral exposures for <u>cancer</u> evaluation

- **Drinking water and household use exposures.** For scenarios where residents are showering or bathing in contaminated water and drinking contaminated water, health assessors should ***not*** combine the inhalation dose with the ingestion and dermal doses when estimating cancer risk. The reason for this is that the slope factor based on oral exposure could be different from the slope factor for inhalation exposure. Thus, the oral cancer slope factor (CSF) should only be used with the combined oral plus dermal dose and the inhalation unit risk (IUR) should only be used for inhalation exposure. If you combine the oral and inhalation doses, you might over- or under-estimate the cancer risk. The separate cancer risks estimated for oral and dermal and for inhalation can then be combined (added together) into one cancer risk that represents all three pathways.

- **Household use exposures only.** For scenarios where residents are only showering or bathing in contaminated water, health assessors should ***not*** combine the dermal dose with the inhalation exposures to get a total exposure dose. The reason for this is the same as above. Health assessors should estimate separate inhalation and dermal cancer risks using the IUR and CSF, respectively. These individual cancer risks from inhalation and dermal exposure can then be combined into one cancer risk from showering or bathing in household water.

The cancer risk approach described above is used for all carcinogens that have a CSF and IUR. Unlike the noncancer approach, there is no exception for certain chemicals based on targeting the same organ or system.

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Exceptions for Adjusting Intermittent to Continuous Exposure for the Air Inhalation Pathway

Now that the PHAST Air Module is functional, you need to know some important facts about exposure factors and the role they have in estimating exposure concentrations. Exposures that occur at home have a default exposure factor (EF) of 1 because we assume that exposure occurs daily, 24 hours a day, every day of the year. However, when exposure occurs at work or school, the EF will be less than 1 because it's a function of how many hours each day and how many days per week people are exposed. For several chemicals, however, exceptions exist to applying exposure factors that convert intermittent exposures to continuous exposures. These exceptions result from the toxicology of the chemical. Health assessors should be mindful of how EFs affect EPCs for these chemicals. These exceptions are described in greater detail below.

Guidance Documents About Exposure Factors

Two exposure dose guidance (EDG) documents provide a detailed explanation for how standard EF adjustments are typically made when estimating exposure:

- The Exposure Dose Guidance for Determining Life Expectancy and Exposure Factor [ATSDR 2016]
- The Guidance for Inhalation Exposures [ATSDR 2020]

These EDG documents provide a detailed explanation of the standard formulas used to make EF adjustments for acute, intermediate, and chronic durations. They also include examples of converting intermittent (e.g., <24 hours) to continuous (daily) exposure using EFs.

In general, EFs are calculated by multiplying the exposure frequency with the exposure duration and dividing by the time during which the dose or concentration is to be averaged (the averaging time). Although EFs are typically 1 for residential scenarios, when exposures are intermittent, EFs can be less than 1. EFs are often less than 1 for occupational and school scenarios where exposure is typically 5 days a week. For certain inhalation scenarios (work and schools), exposures are typically less than 24 hours per day, which also requires an adjustment (e.g., 8.5 hr/24 hr).

As an example, the parameters used to estimate EF for a daycare are shown in the following screenshot from the PHAST Air Module.

Exposure Group	Daily (hours/day)			Weekly (days/week)			Annually ⓘ (weeks/year)			Exposure Duration (years)		
	CTE	RME	Site-specific	CTE	RME	Site-specific	CTE	RME	Site-specific	CTE	RME	Site-specific
Birth to < 1 year	5.2	11.8		5	5	Select... ⌄	50	52.14		1	1	
1 to < 2 years	4.8	9.9		5	5	Select... ⌄	50	52.14		1	1	
2 to < 6 years	6.4	9.6		5	5	Select... ⌄	50	52.14		4	4	
Full time worker	8.5	11.8		5	5	Select... ⌄	50	52.14		5	20	
Part time worker	5.1	NA		5	NA	Select... ⌄	50	NA		3.1	NA	

CTE = central tendency exposure; RME = reasonable maximum exposure

Exceptions to Standard EF Adjustments

Exceptions exist to these standard rules for adjusting intermittent to continuous exposure because of the inherent toxicity of some chemicals. So far, we've identified seven chemicals for which EF exceptions apply: 1) hydrogen sulfide, 2) ammonia, 3) acetone, 4) 2-butanone, 5) sulfur dioxide, 6) chloroform, and 7) formaldehyde. Table 1 provides a summary of how EFs are applied by duration to each of the seven chemicals.

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For acute exposure, the EF is one for these seven chemicals. This means that for intermittent exposure scenarios, the site-specific EPC should not be adjusted to a continuous 24-hr exposure because the acute inhalation MRL was derived using the unadjusted study concentration. That is, the toxicity value used to derive the MRL was not adjusted to a continuous 24-hr exposure. For these seven chemicals, the MRL worksheet provides one of two explanations for why the study concentration was not adjusted to a 24-hr concentration. The chemical was either a point-of-contact (POC) irritant or quickly reached steady state and was quickly eliminated when exposure stopped. For example, the MRL for sulfur dioxide is based on effects in exercising asthmatics for durations of 5–10 minutes. If health assessors adjust their EPC to 24 hours, they could miss the window of peak exposure captured by the MRL and potentially make an incorrect health determination.

The same reasoning is true for intermediate and chronic exposure for chloroform, formaldehyde, and sulfur dioxide. The site-specific EPC for these three chemicals should not be adjusted from intermittent to continuous exposure because the intermediate and chronic MRLs for these chemicals used the unadjusted study concentration to derive the MRL. Thus, the noncancer EF for these chemicals should be one for acute, intermediate, and chronic durations. However, when calculating cancer risk, the chronic cancer EF for chloroform and formaldehyde should be adjusted.

Table 1. Exceptions to the Standard EF Rule by Chemical and Duration

Chemical	Acute		Intermediate		Chronic				EF = 1 Justification
	HG	EF	HG	EF	HG	EF$_{nonancer}$	IUR	EF$_{cancer}$	
Hydrogen sulfide	Y	1	Y	Standard	Y	Standard	N	NA	POC irritant
Ammonia	Y	1	N	Standard	Y	Standard	N	NA	POC irritant
Acetone	Y	1	N	Standard	N	Standard	N	NA	Evenly distributed; Fast steady state, fast elimination
2-butanone	Y	1	N	Standard	N	Standard	N	NA	POC irritant
Sulfur dioxide	Y	1	N	1	N	1	N	NA	POC irritant
Chloroform	Y	1	Y	1	Y	1	Y	Standard	Fast steady state fast elimination
Formaldehyde	Y	1	Y	1	Y	1	Y	Standard	POC irritant

HG = health guideline (e.g., minimal risk level or reference concentration); EF = exposure factor; IUR = inhalation unit risk; POC = point of contact.

NOTE: For hydrogen sulfide (intermediate and chronic) and for ammonia (chronic), the MRL worksheet adjusted the critical study concentration to a 24-hr concentration. Therefore, intermittent exposure should be adjusted to a 24-hr concentration when evaluating intermediate (hydrogen sulfide) and chronic (hydrogen sulfide and ammonia) durations. For acetone and 2-butanone, no health guidelines are available to guide whether to adjust intermittent to continuous exposure. However, a review of the toxicology shows that intermittent exposures should be adjusted to a 24-hr concentration when evaluating intermediate and chronic exposures for acetone and 2-butanone.

The Good News

The good news is that PHAST automatically calculates and applies the correct EF for each of these seven chemicals. Because the EF can sometimes vary by duration, depending on the chemical, we recommend that you enter information on the exposure factors screen in PHAST based on your scenario. For example, if your scenario is exposure at work, you will select standard defaults (e.g., 8.5 hr/day, 5 days/week) or enter site-specific defaults (e.g., 4 hr/day; 3 days/week) and PHAST will automatically apply the correct EF.

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GROW: Enhancing Data Analysis and Geospatial Support for ATSDR's Site Documents

GROW Overview

The Geospatial Research, Analysis, and Services Program (GRASP), located in ATSDR's Office of Innovation and Analytics (OIA), uses geospatial science, analysis, technology, and visualization to examine the relationship between place and health. For more than 20 years, GRASP has supported ATSDR site work, routinely developing maps for public health assessments, health consultations, and exposure investigations. Requests for GRASP services can be entered through the GRASP Service Request Form on the intranet for ATSDR staff in the Office of Community Health and Hazard Assessment (OCHHA) or by making a request through a technical project officer (TPO) in the Office of Community Development and Applied Prevention Science (OCDAPS) for APPLETREE staff. One common service GRASP provides is the introductory map series, which is a rapidly generated collection of maps that provides information on community demographics, natural features, and transportation.

The GRASP OCHHA Working Group (GROW) seeks to expand the use of GRASP services in ATSDR projects by increasing the number of documents that use routine services, such as the introductory map, and expanding the use of custom geospatial and analytical services provided by GRASP. GROW provides a collaboration venue and technical assistance for projects that advance data analytics and geospatial support of ATSDR's site work.

GROW includes representatives from GRASP, OCHHA's Exposure Investigation Section, OCHHA health assessors, and OCDAPS TPOs. This meeting series follows a multi-year GRASP effort to provide geospatial and statistical outreach to OCHHA staff and regional teams, which included conducting a needs assessment. The 2020 needs assessment identified an opportunity to further engage GRASP's capabilities in the health assessment process by expanding data analytics support. OCHHA and GRASP created this working group as a first step toward increasing collaboration and creating new products.

GROW aims to

1. Create a culture of collaboration between OCHHA, OCDAPS TPOs, and OIA to explore new ideas and bring additional data analysis and visualization expertise to health assessments and health consultations
2. Promote mutual understanding of the strengths and capabilities between environmental health scientists and spatial and statistical analysis experts across the agency
3. Empower OCHHA staff, GRASP staff, and APPLETREE partners working through their TPOs to participate in expanding collaboration through capacity development or technical projects

GROW members hold monthly meetings featuring projects and topics that provide resources and lessons learned for staff seeking to elevate the analytical and geospatial complexity of ATSDR site work. GROW is also available to provide connections or technical assistance for health assessors, TPOs, or GRASP professionals with project ideas that meet the aims of the workgroup. ATSDR staff who want to bring ideas about data analysis or visualization to GROW's monthly meeting should contact Lydia Hoadley (MHoadley@cdc.gov) or David Rickless (opv1@cdc.gov). APPLETREE partners with project ideas may contact their TPOs.

Project example: mobility data pilot

Population mobility data refer to the geospatial and device information captured from mobile devices, such as smart phones. Device data are aggregated by data source providers across space and time to generate various indicators of population movement. These data provide a unique opportunity to better understand population movement in and out of areas of interest in near real time. However, the utility and validity of mobility data during environmental health emergencies is not well understood or documented.

On June 14, 2021, an industrial fluid and grease manufacturing facility caught fire, prompting local authorities to issue a 1-mile evacuation order and a 3-mile masking advisory for 4 days. In response to this event, the local health authorities worked with ATSDR to initiate an Assessment of Chemical Exposures (ACE) investigation of a chemical fire in Rockton, Illinois (Chemtool Plant). An ACE investigation involves the deployment of an EPI-Aid team led by CDC Epidemic Intelligence Service (EIS) officers to assess effects on the health of the community after a chemical event. The Chemtool ACE investigation was led by EIS officers Krishna Surasi and Jasmine Nakayama, with additional support from ATSDR Region 5, local and state health authorities, GRASP, and ATSDR's Registries and Surveillance Section. The findings of an electronic survey administered to assess the health effects of the Chemtool fire were published in *MMWR* [Surasi 2021].

During a GROW meeting in July 2021, GRASP Population Mobility Data Coordinator Kelly Fletcher (kfletcher@cdc.gov) presented the basics of population mobility data and opportunities for use in environmental health research and practice. In this meeting, GROW members involved in the Chemtool ACE investigation suggested the ACE investigation as a useful case to explore the utility and validity of these data for an evaluation of population mobility in response to an environmental health emergency. GRASP, EIS officers, and ATSDR then designed a pilot project assessing the use of mobility data to estimate population movement before, during, and after such an emergency. The pilot is in the final stages of analysis and the findings will soon be available to the ACE Investigation Team.

Key preliminary findings show a significant number of nonresident mobile devices in the evacuation zone on the day of the event and on days afterward, indicating that more people might have been exposed than were identified in health impact surveys of local residents. A notable limitation of the study is that the underlying population in the evacuation zone and subsequent device penetration were too small to generate stable evacuation statistics.

Future site investigations might benefit from population mobility data to understand movement in and around areas of environmental health importance. However, these investigations might be limited in areas with lower device counts, such as nonurban areas, smaller relative evacuation zones, and areas with aging populations. GRASP plans to share findings with partners in ATSDR and identify additional sites that might benefit from population mobility data.

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How to Make Equations in Public Health Documents 508 Compliant

The 508 Section of the Rehabilitation Act of 1973 says that the electronic information shared by federal agencies needs to be accessible to people with disabilities. As a result, ATSDR and APPLETREE public health documents that are placed on an ATSDR public-facing website must be 508-compliant. These instructions on how to make equations 508-compliant are for documents in Word.

The use of non-Roman characters and symbols in equations can be problematic. For example, an equation typed into the document using characters with a line separating numerators and denominators cannot be made 508 compliant. This article describes how to make 508-compliant equations in documents.

Simple Equations

The simplest approach to achieve a 508-compliant equation is to insert an image (e.g., a screenshot using Snagit) of the equation into the document. The screenshot can be tagged with alternative text (alt text) that describes the equation. The limitation of this approach is that the alt text has to be equal to or less than 120 characters. If 120 characters are not sufficient to describe the equation, you can have the alt text refer the reader to an appendix or to a new page you add to the "end" of your document (e.g., titled something like "Detailed Alt Text Descriptions") where you can provide a more detailed explanation of the equation. What follows are several examples showing the different methods.

Example 1: Screenshot with alt text embedded in the image

The equation for estimating the dose from drinking contaminated water follows:

$$D = \frac{C * IR * EF}{BW}$$

The alt text associated with this equation can be written in several ways:

- D equals C times IR times EF over BW
- Dose equals concentration times intake rate times exposure factor divided by body weight.
- D equals C times IR times EF divided by BW where D is dose, C is concentration, IR is intake rate, EF is exposure factor, and BW is body weight.

If the text in the first or second bullet, which meets the character limit, is used to define the terms in the equation, it can be inserted into the alt text box associated with the screenshot. To open the alt text for the image, right click on the image and select "edit alt text." A window opens on the right screen, which is where you type the alt text.

What follows is a screenshot of the equation with the alt text embedded in the image along with explanatory text for the sighted reader following the image:

$$D = \frac{C * IR * EF}{BW}$$

where

>>> D = exposure dose
>>> C = contaminant concentration
>>> IR = ingestion rate of contaminated water
>>> EF = exposure factor
>>> BW = body weight

The alt text embedded in the screenshot would say either "D equals C times IR times EF over BW" or "Dose equals concentration times intake rate times exposure factor divided by body weight."

However, if you were to use the third bullet, you'll notice that the letter and space count exceeds 120 characters. Therefore, the alt text for the screenshot would read something like, "See Appendix A, equation 1 for an explanation of this equation." In addition, you could add a link that takes the visually impaired reader to Appendix A, equation 1. This can be done as shown below where you insert text to the right or below the image that has been set up as a link. Steps for creating this link are provided in Appendix B. The screenshot of the equation, followed by "Equation 1" as the link, will look like this:

$$D = \frac{C * IR * EF}{BW}$$

[Equation 1](#)

where

>>> D = exposure dose
>>> C = contaminant concentration
>>> IR = ingestion rate of contaminated water
>>> EF = exposure factor
>>> BW = body weight

The visually impaired reader would then know to click on "Equation 1" to go to Appendix A and read the accessible text for equation 1.

Complex Equations

Describing complex equations, however, can be challenging. One option is to describe the components of the equations rather than each individual symbol. Because complex equations will often have more than 120 characters, the alt text will have to be linked to a detailed explanation in the appendix or another page at the end of your document. Here's an example showing normal text before and after the image with the alt text along with a link to the more detailed explanation in the appendix.

Example 2: Screenshot with link to alt text in an appendix or special page

If $t_{event} > t^*$ (i.e., for longer-term exposures where the duration of the exposure is longer than the time it takes to reach steady state), then:

$$DA_{event} = FA \times K_p \times C_w \times \left[\frac{t_{event}}{1 + B} + 2 \times \tau_{event} \times \left(\frac{1 + 3B + 3B^2}{(1 + B)^2} \right) \right]$$

Equation 2

Parameters used to estimate DA_{event}

Parameter	Definition (units)
DA_{event}	= Absorbed dose per event (mg per cm^2-event)
FA	= Fraction absorbed through skin (dimensionless)
K_p	= Dermal permeability coefficient of compound in water (cm per hr)
C_w	= Chemical concentration in water (mg per cm^3)
τ_{event}	= Lag time per event (hr per event)
t_{event}	= Site-specific event duration (hr per event)
t^*	= Chemical-specific time to reach steady state (hr) = 2.4 τ_{event}
B	= Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless)

Source: EPA RAGS Part E [EPA 2004] and EPA EFH [EPA 2011].
Abbreviations: cm = centimeters; hr = hour; mg = milligrams.

The alt text for the screenshot above will read as, "This equation is for calculating the dermal dose. See Appendix A, equation 2 for a detailed description." In addition, you can add a link (bookmark) after the screenshot (shown above as "Equation 2"). Visually impaired persons can click on this link, which will take them to equation 2 at the end of the document.

The image in the document will still be followed by text (in this case, a table, as shown above) defining the components in the complex equation.

Where to Find More Information

The U.S. Department of Health and Human Services has accessibility training resources available at: https://www.hhs.gov/web/section-508/os-training-resources/index.html.

The National Oceanic and Atmospheric Administration (NOAA) has a central library with several links to information about how to make equations and other document features 508 compliant (e.g., figures, images, charts, graphs) Here's the link: https://libguides.library.noaa.gov/Section508/CreatingDocs.

Another useful website explains how to create links within a Word document: https://www.techwalla.com/articles/how-to-create-an-internal-document-link-in-microsoft-word.

Acknowledgements

In writing this article, we worked with Michelle Scott in the Office of Communication to ensure we were giving you ATSDR's current approach for making equations 508 compliant. Thanks also go to Liz Bertelsen in Eastern Research Group for instructions on how to create links within the document. If you have suggestions for other approaches, please contact the authors.

Appendix A: Alt Text Explanation of Equations for 508 Compliance

Equation 1

D equals C times IR times EF divided by BW where D equals dose, C equals concentration, IR equals intake rate, EF equals exposure factor, and BW equals body weight.
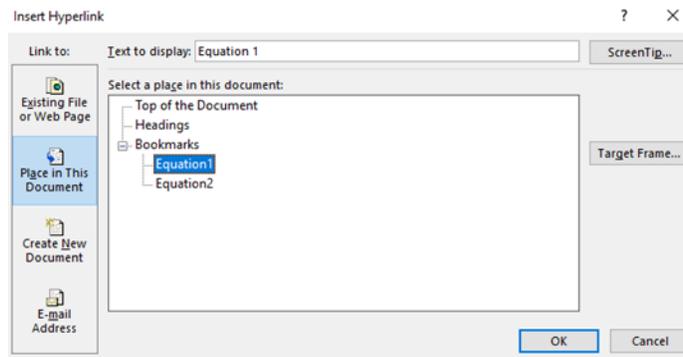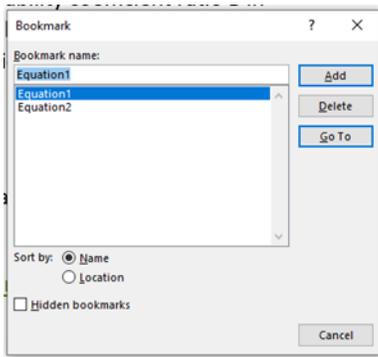
Equation 2

This equation identifies the absorbed contaminant dose per dermal event. The left side of the equation is a single variable representing the absorbed dose per event, and the right side contains a summation of two terms. The first term is the product of the following variables: fraction absorbed water, dermal permeability coefficient, average chemical concentration, and a fraction consisting of the site-specific event duration in the numerator and a function of the dimensionless permeability coefficient ratio B in the denominator. The second term is equal to two times the product of the lag time per event and another fraction that is a function of the dimensionless permeability coefficient ratio B.

Appendix B: Creating Links Within a Word Document

Steps for creating a link between an equation in the body of the document and the explanatory accessible text in an appendix or at the end of the document on a separate page.

1. In the Appendix or separate page, highlight the word or words you want to link (e.g., Equation 1).
2. In the Word ribbon, go to Insert>Links>Bookmark.
3. In the Bookmark popup, type in Equation 1 (no spaces between letters).
4. Click "Add."
5. In the main text, highlight the word or words you want to link (e.g., Equation 1).
6. Right click and choose "link."
7. From the menu that appears, choose "Placement in this Document" from the left-hand side.

8. Under "Bookmarks" in "Select a place in this document," choose "Equation 1" from the list.
9. Click OK.
10. The text (Equation 1) will now appear as a hyperlink.
11. To edit an existing hyperlink, right click on the link and follow the prompts for editing or deleting the hyperlink.

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How to Get Trained on the New ATSDR Guidance Documents and Tools

Do you know how to get trained on all the new ATSDR guidance documents and PHA tools?

ATSDR Health Assessor Training Series

ATSDR will be releasing several new guidance documents and tools in 2022. New guidance includes the web-based Public Health Assessment Guidance Manual (PHAGM), EPC guidance for non-discrete sampling, and calculating benzo(a)pyrene equivalents for polycyclic aromatic hydrocarbons (PAHs). ATSDR will also be releasing version 3.0 of the SHOWER model and a new ATSDR EPC Tool. PHAST has been updated to include a new air pathway and will be updated with a new module for integrating the SHOWER model results into PHAST. This training series is designed to familiarize health assessors with ATSDR's new guidance and tools as they are released.

Go to https://www.zoomgov.com/webinar/register/WN_8j-BW46SQry9VCHXyZdpHg to register for any of the webinars in the series. These webinars will be recorded and posted for viewing if you cannot attend the "live" training session.

Date 12:30-1:30 PM	Title	Description
April 13, 2022	**PHAST Air Pathway Demo**	Demonstrate how to use the new air pathway to calculate exposure, hazard quotients, and cancer risks.
April 27, 2022	**EPC Guidance for Non-discrete Sampling**	Train health assessors how to calculate EPCs for non-discrete sampling data.
May 11, 2022	**Web-based PHAGM Demo**	Introduce the web based PHAGM and show health assessors how to navigate through the site's layout and use its features.
May 25, 2022	**SHOWER Model v3.0**	Demonstrate how to use SHOWER model v3.0 to estimate CTE and RME inhalation concentrations and dermal doses associated with volatile contaminants in household water.
June 8, 2022	**Guidance for PAHs**	Train health assessors how to calculate benzo(a)pyrene equivalents for PAH cancer evaluations.
June 15, 2022	**ATSDR EPC Tool**	Introduce the ATSDR EPC Tool, train health assessors how to use it to calculate EPCs and demonstrate how to integrate the results into PHAST.
June 22, 2022	**PHAST SHOWER Model Module**	Demonstrate how to export results from the SHOWER model into PHAST and how to use the new PHAST SHOWER model module to calculate exposure, hazard quotients, and cancer risks.

A Few Closing Notes

Note 1: Is it noncancerous or noncancer? In ATSDR public health assessments, the preferred term to use is "noncancer health effects" **not** "noncancerous health effects"

Note 2: Is there a new ATSDR SME list for PHA work? Yes, ATSDR has updated the SME list with new topics and chemicals. Please see the updated list in the PHAST Resources section.

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