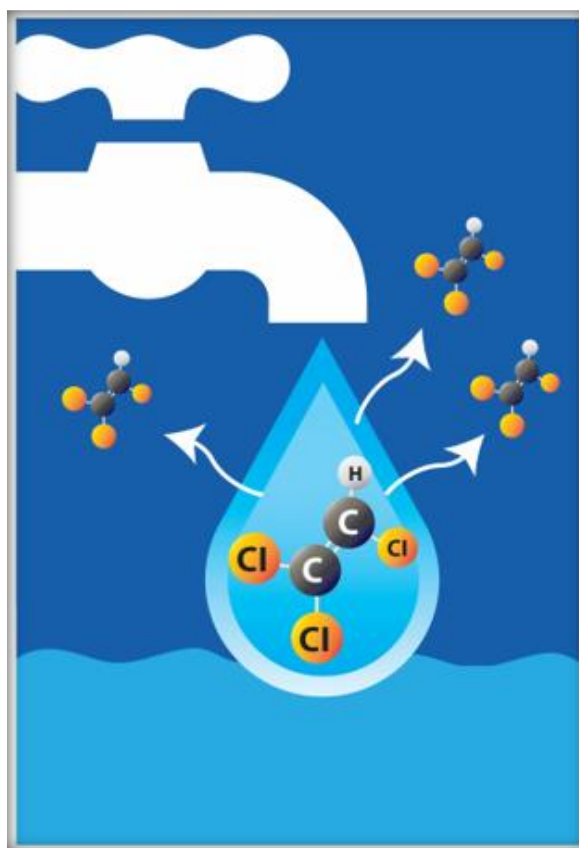




Agency for Toxic Substances and Disease Registry Shower and Household Water-use Exposure (SHOWER) Model v4.0 User's Guide

Version 4.0
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1 Introduction

The ATSDR SHOWER model allows health assessors to rapidly evaluate inhalation and dermal exposures to volatile contaminants from various indoor water sources. Using only the name of a contaminant, its concentration in water, and basic simulation parameters, health assessors can quickly determine daily air concentrations, dermal doses, and, if appropriate, inhalation doses for exposed persons.

ATSDR has released four major versions of the SHOWER model:

- SHOWER model v1.0 was released in May 2018. It required the user to enter only a contaminant name and concentration to obtain results for a representative household. The model's default report provided exposure results for households with 1, 2, 3, and 4 persons in which family members sequentially took 8-minute showers followed by 5-minute bathroom stays.
- SHOWER model v2.0 was released in February 2020. In addition to the default scenario from v1.0, SHOWER model v2.0 allowed health assessors to answer specific questions from residents and evaluate the sensitivity of simulation results to changes in model parameters. It expanded upon the functionality of v1.0 by allowing the user to customize many of the model parameters, including:
 - the number of bathrooms,
 - the activity sequence and duration for each household member,
 - the size and layout of the house, and
 - household appliance parameters (e.g., appliance flow rate, use duration).
- SHOWER model v3.0 was released in May 2022 and included three major changes.
 - The default scenario was modified to include central tendency exposure (CTE) and reasonable maximum exposure (RME) results for households with 1, 2, 3, and 4 persons.
 - The effects of contaminant saturation in air were incorporated into the SHOWER model's governing equations.
 - An export function was added that allowed health assessors to import and analyze SHOWER model data within ATSDR's Public Health Assessment Site Tool (PHAST).
- SHOWER model v4.0 was released in September 2024. In addition to the residential scenario, SHOWER model v4.0 allows health assessors to model communal shower and bathroom scenarios using Monte Carlo methods. The default scenario requires the user to select the building type (commercial gym, office, etc.), facility type (shower and locker room facility or bathroom facility), the number of people using the facility, and the contaminant's name and concentration. Custom scenarios allow users to modify many of the model parameters, including the parameter distributions used to generate random activity patterns for facility users.

This document describes the steps to install and use SHOWER model v4.0. Section 2 of this document outlines the SHOWER model's basic system requirements and provides instructions on how to install and uninstall the program. Section 3 includes a walkthrough of how to use each screen in the SHOWER model, and Section 4 summarizes the output data that the model generates. Throughout the document, screenshots are provided showing relevant aspects of the installation procedure and steps to run the program.

The guide does not include information on the mathematical equations underlying the SHOWER model, nor does it include information on how to interpret the model results. For further information on the model's physical and mathematical basis, see the accompanying technical document (ATSDR 2024b). For further information on interpreting and using the program's output, see the accompanying guidance for evaluating inhalation and dermal exposure using the SHOWER model (ATSDR 2024a).

Contact

Users may send questions or comments about the SHOWER model to
showermodel@cdc.gov.

2 Installation

This section describes the steps for downloading and installing the SHOWER model. We highly recommend that you read through the entire section before attempting to install the program. If you are unable to download or install the program after reading through the entire section, contact showermodel@cdc.gov for assistance.

2.1 System Requirements

The current version of the SHOWER model is compatible with the following:

- Windows 7, Windows 8, Windows 10, or Windows 11 (32-bit or 64-bit)
- Microsoft Office 2007 or later (32-bit or 64-bit)
- A hard disk with at least 100 MB of free space

The installation procedure will also check if your computer has the following components installed. If not, it will retrieve these files from Microsoft's website and install them as part of the program installation:

- Microsoft .NET Framework 4.8.1 (x86 and x64)

Finally, to minimize computation time and to ensure that the program runs smoothly, it is recommended that your computer have each of the following:

- A processor with two or more cores
- At least 2 GB of available RAM

The SHOWER model is a Windows-only application and does not run in macOS. If you use an Apple Mac computer, you can run the SHOWER model by installing either Apple Boot Camp or a third-party program that runs Windows on a Mac.

2.2 Download Instructions

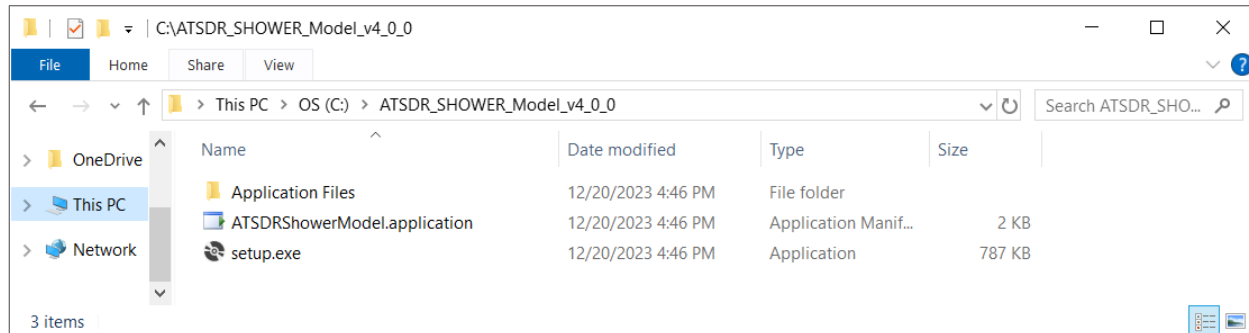
The SHOWER model executable and installation files are available for download at ATSDR's Public Health Assessment Guidance Manual (PHAGM) website (<https://www.atsdr.cdc.gov/pha-guidance/index.html>) (ATSDR 2023). From the PHAGM homepage, click on the Toolbox page and navigate to the Evaluating Exposure Pathways section. The SHOWER model installation package is available in this section under the ATSDR SHOWER Model link beneath the Modeling tools sub-bullet. Clicking the link will download the file **ATSDR_SHOWER_Model_v4_0_0.zip** to your computer. You can also download the SHOWER model installation package directly by clicking the following link: https://www.atsdr.cdc.gov/pha-guidance/toolbox/ATSDR_SHOWER_Model_v4_0_0.zip.

Evaluating Exposure Pathways

- [Chemical- and Site-Specific Factors That May Affect Contaminant Transport](#)
- [Exposure Pathways Checklist](#) [PDF – 100 KB]
- Examples of Exposure Assessment Tools
 - R package [openair](#) as a tool for evaluating air pathway data
 - Interpolation and data visualization (water levels / concentration plume to determine groundwater flow direction): [gstat R package](#)
 - Modeling tools:
 - [ATSDR SHOWER Model](#) [ZIP – 22 MB]
 - [Water Resources Groundwater Software](#)
 - [EPA Science Models and Research Tools \(SMaRT\)](#)
 - [EPANET](#)

2.3 Installation Procedure

The installation package described in Section 2.2 comes in the form of a zipped folder, the outer level of which contains three items: **setup.exe**, **ATSDRShowerModel.application**, and the **Application Files** folder. The image below shows these files after the installation package is unzipped. The file **setup.exe** is the primary installation file for the program. Double-clicking this file will begin the installation process for all the software components associated with the SHOWER model.

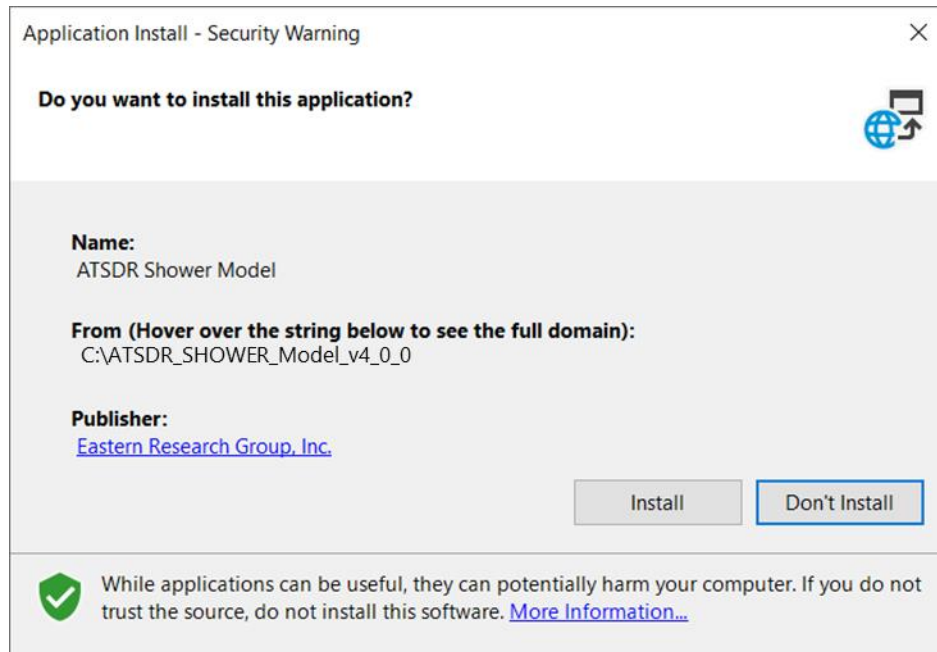


Before installing the current version of the program, you should uninstall any previous versions already on your computer (see Uninstall Procedure for further instructions). Because installation onto CDC/ATSDR computers requires the user to have administrative privileges, most CDC/ATSDR users will need to submit a request through ITSO's Software Request Tool to have the program installed. In addition, the SHOWER model is not currently approved for installation onto CITGO.

To install the SHOWER model onto your computer:

- 1) Download a copy of the SHOWER model zipped installation package and save the zipped folder somewhere on your computer.
- 2) Unzip the folder.

- 3) Double-click the file **setup.exe**. The file will check to see if the required components mentioned in Section 2.1 are installed. If they are not, accept any prompts provided by the program for their installation.
- 4) A security warning will appear showing basic information about the program, as shown below. Click **Install**.



- 5) Following a successful installation, the program will load and open to the Home screen (Section 3.1).
- 6) If you receive a message saying that the SHOWER Model is already installed, follow the steps in Section 2.4 to uninstall the program, then perform the steps listed below. These steps clear the cached Windows installation directories, which when done after a full uninstall should allow the program to install correctly.
 - a. Open a command prompt window (search for cmd.exe in the windows search bar).
 - b. Type in the command: `rundll32 dfshim CleanOnlineAppCache`
 - c. Install the program using the **setup.exe** file from the zip folder that you downloaded.

After the program has been installed, an "ATSDR Shower Model" folder will be added to your Programs menu under the Start menu. The icon to run the SHOWER model will be located within that folder. If desired, you can create a desktop shortcut by dragging the SHOWER model icon from the Start menu folder onto the desktop.

The actual executable for the program and all its associated references will be placed in a folder under the individual user's directory in Windows. To identify the location of the executable:

- 1) Run the program.
- 2) Open Task Manager. You can access Task Manager by holding Ctrl+Alt+Del, then selecting Task Manager from the screen that appears.
- 3) Right click the program's name in Task Manager.
- 4) Select **Open File Location**. A window will open to the folder containing the SHOWER model executable file, and the executable file will be highlighted.

2.4 Uninstall Procedure

To uninstall the SHOWER model from your computer:

- 1) Open the Control Panel.
- 2) Within the Control Panel window, click **Programs and Features**.
- 3) Within the Uninstall or Change a Program section, right-click the entry for the SHOWER model.
- 4) In the window that appears, select the option for "Remove the application from this computer" and click **Ok**.

3 Model Screens

SHOWER model v4.0 allows health assessors to rapidly evaluate inhalation and dermal exposures to volatile contaminants from indoor water sources, including showers, baths, and appliances. The SHOWER model can simulate two scenario types: residential scenarios and communal shower and bathroom scenarios. Users can assess inhalation and dermal exposures in houses (i.e., residential scenarios) or in buildings where people take showers or use the bathroom in a common facility (i.e., communal shower and bathroom scenarios).

For both scenario types, users can choose between two simulation pathways: default or custom. The default pathway uses standard values of model parameters and the custom pathway allows users to simulate site-specific conditions and to observe the sensitivity of model results to changes in model parameters.

In the SHOWER model, the user interacts with the program through a graphical user interface, which consists of the following:

- A home screen and resources page.
- A series of seven scenario-dependent screens in which the user can select and modify model input parameters.
- A screen that displays the model results.

This section describes how to navigate the program's user interface and highlights the various calculation and reporting options available within the program.

3.1 Home Screen

The first screen that you will see after opening the program is the Home screen. The Home screen contains introductory text that explains the overall purpose and use of the SHOWER model. This screen also provides the SHOWER model email address (showermodel@cdc.gov) where users can submit questions and comments.

Users have the choice to run a new scenario or open an existing scenario.

- **Run New Scenario** prompts you to choose a scenario type (residential scenario or communal shower or bathroom scenario) and then takes you to the Site Information screen where you can begin entering parameter values for the scenario you selected.
- **Open Existing Scenario** allows you to open a previously saved scenario. The program saves scenario data in SQLite database files with the extension “.showermodel”. After clicking on the blue button, navigate to where you previously saved a scenario file to open it.
- The **Resources** button opens a new screen that references documents that might be helpful in understanding and applying the model, such as the SHOWER model technical

document (ATSDR 2024b) and the guidance for evaluating inhalation and dermal exposure using the SHOWER model (ATSDR 2024a). The resources are located in PHAST via SAMS and can also be requested by email at showermodel@cdc.gov.


ATSDR Shower and Household Water-use Exposure Model

Health assessors can use this model to:

- assess inhalation and dermal exposure to VOCs and SVOCs from multiple indoor water sources, including showering, tub baths, and appliance use;
- assess exposures for a default residential scenario and for custom residential scenarios for households with up to eight persons; and
- assess exposures for buildings with communal shower and bathroom facilities.

For SHOWER model questions or support contact: showermodel@cdc.gov.

Run New Scenario Open Existing Scenario Resources

 **Version 4.0.0**

The **Agency for Toxic Substances and Disease Registry (ATSDR)**, based in Atlanta, Georgia, is a federal public health agency of the **U.S. Department of Health and Human Services**. ATSDR protects communities from harmful health effects related to exposure to natural and man-made hazardous substances. We do this by responding to environmental health emergencies; investigating emerging environmental health threats; conducting research on the health impacts of hazardous waste sites; and building capabilities of and providing actionable guidance to state and local health partners.

More information about ATSDR can be found at <https://www.atsdr.cdc.gov>.

The content and results of this model do not represent the official position of the Agency for Toxic Substances and Disease Registry.

Suggested citation: [ATSDR] Agency for Toxic Substances and Disease Registry. 2018. Shower and Household Water-use Exposure (SHOWER) Model, v4.0.0. Atlanta: Agency for Toxic Substances and Disease Registry. Accessed [insert month day, year]

The current model version is displayed in the lower-left corner of the Home screen. ATSDR will change this version number any time the model is updated and will notify staff from ATSDR and the agency's cooperative agreement states whenever a new version is available. For persons outside these two groups, send an email to showermodel@cdc.gov with your contact information, and ATSDR will notify you when an update is available.



Tip: Information icons are displayed in various locations throughout the program. Click the icon to generate a tooltip box that displays further information regarding the associated field. Clicking anywhere on the screen will make the tooltip disappear.

3.2 Navigation

After beginning or opening a scenario, the program loads seven scenario data entry screens specific to the scenario type selected. The progress bar across the top of these screens lets you

know which screen you are on, which screens you have opened, and which screens you have yet to visit. The progress bar colors have the following meanings:

- Light blue indicates the current screen.
- Dark blue indicates a visited screen.
- Gray indicates screens that have not yet been visited.

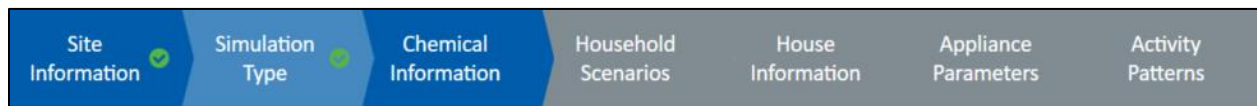
The progress bar will also display icons that indicate whether each screen is complete.

- A green check indicates a completed screen.
- No icon indicates that a field on the screen is incomplete.
- A red circle with an exclamation point indicates an error exists on the screen.

You can navigate back to any screen you have already visited by clicking on the dark blue area in the progress bar associated with the screen. When a screen contains an error, you can return to screens that you have previously visited, but you cannot navigate to the next screen, save your data, or run a simulation until the error is resolved.

Consider the example progress bars that follow. In the first example, from a residential scenario, the user is on the Simulation Type screen (light blue). The user has completed the Site Information and Simulation Type screens (green checks) and has visited the Chemical Information screen but has not completed it (dark blue but no green check). The user has not visited the remaining screens (gray).

Example 1 Progress Bar:



In the second example, from a communal shower and bathroom scenario, the user has completed the first three screens (dark blue with green checks) and is on the Usage Parameters screen (light blue). The Usage Parameters screen contains an error (red exclamation point). The user cannot proceed to the remaining three screens (gray) as long as an error is present on the Usage Parameters screen.

Example 2 Progress Bar:

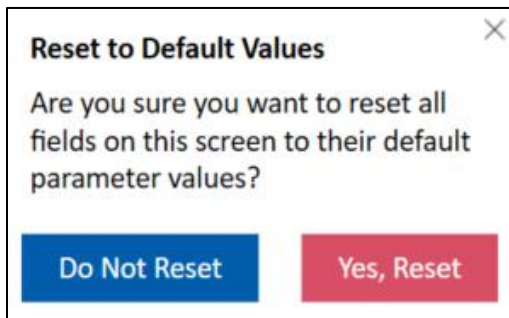


As shown below, each data entry screen contains two rows of navigation buttons at the bottom of the screen. The upper row contains the **Back** and **Next** buttons. These buttons will disappear

when you cannot proceed backward or forward to another data entry screen from the screen you are on. You must click the **Next** button to visit each new screen for the first time.



Depending on the program screen, the upper row will also contain either the **Clear All** button or the **Reset to Default Values** button. Clicking **Clear All** will clear all fields on the screen and clicking **Reset to Default Values** will restore all fields on the screen to their default values. Clicking either button can also reset values on other screens, as discussed in the sections that follow. Clicking either button will create a popup asking you to confirm whether you want to clear/reset the fields.



The bottom row contains the following buttons:

- 1) **Home:** Takes you back to the home screen. This action will reset parameters on all screens to their default values.
- 2) **Help:** Offers information on required fields and other guidance specific to the screen you are viewing.
- 3) **Notes:** Provides an opportunity to enter notes that are visible from all screens and are exported in the model report.
- 4) **Save:** Allows you to save your scenario. The save button will always prompt you for a file location before saving.
- 5) **Run Default/Custom Scenario:** Runs the scenario using default parameter values or site-specific parameter values entered by the user. This button remains inactive until all required parameters are entered for the scenario type you have selected on the Simulation Type screen. For more information, see Section 3.3.2 for residential scenarios and Section 3.4.2 for communal shower and bathroom scenarios.

Tip: A red error message will appear anytime you enter invalid data in a data field. The error message will pop up next to the field and will provide information about how to correct the data. Whenever an error message appears, you will be unable to navigate to the next screen, save your data, or run a simulation until the error is resolved.

3.3 Residential Scenario

Health assessors can use the SHOWER model's residential scenario to assess inhalation and dermal exposure to contaminants from household water sources including showers, bathtubs, clothes washers, sinks, and dishwashers. The default scenario requires only general information on the site name and address, contaminant name, and contaminant concentration in water as inputs. The custom scenario allows health assessors to input site-specific parameters of interest.

3.3.1 Site Information Screen

The Site Information screen is where you can enter data related to the name and location of the site under review. It contains the following fields:

- **Site Name:** Enter the name of the site under investigation.
- **Address:** Enter the site's address.
- **City/Town/County:** Enter the city, town, or county where the site is located.
- **State/Territory:** Select the state or territory where the site is located from the dropdown menu. If the site's state or territory is not included in the dropdown list, choose "Other" and enter the state or territory in the new field that appears.
- **Zip/Postal Code:** Enter the zip or postal code where the site is located.

Of the fields on this page, only the **Site Name** field is required. Once you have entered a site name, the **Next** button will appear at the lower right of the screen and you can proceed. Clicking the **Next** button will take you to the Simulation Type screen. After moving to the Simulation Type screen, the program will store and use the site information entered on the Site Information screen throughout the rest of the program, unless you return to the Site Information screen to enter new data. To delete existing data on this screen, you can either delete the data in each field, or you can press the **Clear All** button to clear the data from all fields simultaneously.

The screenshot shows the ATSDR SHOWER Model - Unsaved application window. The title bar is teal with the text "ATSDR SHOWER Model - Unsaved" and standard window controls. Below the title bar is a navigation menu with seven tabs: "Site Information" (selected, highlighted in blue), "Simulation Type", "Chemical Information", "Household Scenarios", "House Information", "Appliance Parameters", and "Activity Patterns". The main content area is titled "Site Information" and contains several input fields: "Site Name", "Address", "City / Town / County", "State / Territory" (a dropdown menu), and "Zip". Below these fields is a "Clear All" button. At the bottom of the window is a footer bar with five buttons: "Home", "Help", "Notes", "Save", and "Run Custom Scenario".

3.3.2 Simulation Type Screen

The Simulation Type screen allows you to choose whether to run the default scenario, which is recommended, or an optional custom scenario. The scenario options are:

- **Run Default Scenario (recommended):** Provides CTE and RME results for the most highly exposed person in a 4-person household, using default scenario parameter values. RME results for 1-, 2-, and 3-person households are also included for additional information, as are CTE results for 1-, 2-, 3-, and 4-person households. When the number of persons in a household or any other site-specific information is unknown, health assessors should use the default scenario RME results for the 4-person household to determine whether a health concern exists.
- **Run Custom Scenario (optional):** Allows users to build a custom scenario using one of the model's predefined scenarios as a starting point.

The **Run Default Scenario (recommended)** radio button is selected by default. To run the default scenario, you only need to click the **Next** button and select a chemical name and enter a water concentration on the Chemical Information screen. You cannot change chemical properties

or any parameter values on screens after the Chemical Information screen when the **Run Default Scenario (recommended)** option has been chosen.

To run a custom scenario, select the **Run Custom Scenario (optional)** radio button on the Simulation Type screen. As a reminder of your selection, the text in the **Run Default Scenario** button at the bottom right of the screen will change to "Run Custom Scenario" if you select this option. If you haven't already, you will need to input the chemical name and water concentration on the Chemical Information screen. After selecting the **Run Custom Scenario (optional)** radio button, you can change chemical properties and all other parameter values on subsequent screens, the titles of which are shown in the header on the screenshot that follows.

You can click the **Back** button to go back to the Site Information screen or the **Next** button to continue to the Chemical Information screen. Clicking **Reset to Default Values** will reselect the run default scenario option.

ATSDR SHOWER Model - Unsaved

Site Information Simulation Type Chemical Information Household Scenarios House Information Appliance Parameters Activity Patterns

Simulation Type

Run Default Scenario (recommended)

This option provides reasonable maximum exposure (RME) scenario results for the most highly exposed person in a 4-person household to be used in public health documents. RME results for 1-, 2-, and 3-person households are also included for additional information, as are central tendency exposure (CTE) results for households with 1-, 2-, 3- and 4- persons. The RME default scenario assumes three people take 10-minute showers and the fourth person takes a 15-minute shower, all followed by 5-minute bathroom stays. The CTE scenarios assume each person takes a 7-minute morning shower followed by a 5-minute bathroom stay. For each household, the person, either child or adult, taking the last shower is the most highly exposed person; results are given for this person only. The default scenario uses only default parameter values. Any custom parameter values entered on other model screens are ignored.

Run Custom Scenario (optional)

Select this option to run a custom scenario with parameter values specific to the site of interest. Users will build a custom scenario using one of the SHOWER model's standard scenarios as a starting point. Standard scenarios load with CTE model parameters.

◀ Back Reset to Default Values Next ▶

Home Help Notes Save Run Default Scenario

3.3.3 Chemical Information Screen

The Chemical Information screen is where you enter data related to the chemical under investigation, as well as the concentration of the chemical in household water and outdoor air.

Select a chemical by typing either its name or its Chemical Abstract Service Registry Number (CASRN) into the **Chemical Name** field at the top of the screen. The program will search for the chemical in the database that accompanies the program using one of three methods:

- Selecting the **Begins With** radio button will search the database for any chemical name or CASRN that begins with the characters entered in the field.
- Selecting the **Contains** radio button will search the database for any chemical name or CASRN that contains the characters entered in the field.
- Selecting the **Exact Match** radio button will search the database for any chemical name or CASRN that exactly matches the contents of the field.

ATSDR SHOWER Model - Unsavd

Site Information Simulation Type **Chemical Information** Household Scenarios House Information Appliance Parameters Activity Patterns

Chemical Information

Chemical Name i Edit Properties Add Chemical

Begins With Contains Exact Match

CASRN: None

Chemical Synonyms: None

Exposure Route(s) Available for This Chemical: **None**

Concentration In Water i µg/L ▼ Concentration In Outdoor Air i 0 µg/m3 ▼ Preview Default Scenario Results i

Report Units

µg/m³ ppb

← Back Clear All

Home Help Notes Save Run Default Scenario

As you type data into the text entry field, the program will show options from the database that match the search criteria in a dropdown menu below the text entry field. To select a chemical, single-click the entry for that contaminant in the dropdown menu.

If you selected the option to run the default scenario on the Simulation Type screen, both the **Edit Properties** and **Add Chemical** buttons will be inactive (grayed out). Users cannot modify

chemical properties for the default scenario, nor can they simulate a custom chemical. These options are available only if you run a custom scenario.

Within a custom scenario, the **Edit Properties** button will activate after you select a chemical. Clicking this button will open a popup that allows you to change chemical properties from their default values. In the popup that appears:

- Clicking **Cancel** will close the screen without saving any changes.
- Clicking **Reset** will restore the parameters to their default values included with the program.
- Clicking **Save** will save any changes you made for use within your scenario.

Note that clicking **Save** stores modified chemical properties for use in the current scenario only — it does not modify the default values included within the program.

The **Add Chemical** button allows you to add a new chemical for use in your scenario (see screenshot below). The **Chemical Name**, **Chemical CASRN**, **Molecular Weight**, and **Chemical Type** fields are required. To evaluate inhalation exposure, at least one **Chemical f Value** (fractional release value) and the chemical's **Henry's law constant** must be non-zero. To evaluate dermal exposure, all three **Chemical Dermal Parameters** must be non-zero. The **Save** button will activate only once you have completed the required fields. Click **Save** to save your new chemical or **Cancel** to exit without saving.

Add/Edit Chemical Data ⓘ

Chemical Name

Chemical CASRN

Molecular Weight g/mol

Chemical Type Organic Inorganic

Inhalation Parameters

Shower f value

Bathroom sink f value

Bathtub f value

Toilet f value

Clothes washer f value

Dishwasher f value

Kitchen sink f value

Henry's law constant (K_H) ⓘ

Dermal Parameters

Dermal permeability coefficient (K_p) cm/hr

Fraction absorbed through the skin (FA)

Fraction absorbed in GI tract (ABS_{GI})

Cancel **Save**

Tip: Adding a new chemical applies only to the current scenario. The chemical will not be added to the list of default chemicals included with the program's chemical database. However, if you save the scenario to a .showermodel scenario file, you can retrieve the added chemical information the next time you open the file.

Enter the concentration of the contaminant in household water and outdoor air in the **Concentration in Water** and **Concentration in Outdoor Air** fields, respectively. The program will accept concentrations entered in the following formats:

- Whole numbers
- Decimal numbers
- E notation (e.g., 1E-4)

The program uses a default value of 0 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) for the outdoor air concentration of each chemical. It does not have a default value for water concentration. You can select units for each concentration using the dropdown menus to the right of each concentration field. The program will automatically convert the selected units into the units needed for calculation and output. The **Report Units** option specifies whether the model report will use units of parts per billion (ppb) or $\mu\text{g}/\text{m}^3$ to display contaminant air concentrations.

You must select a chemical name and enter a chemical concentration in water to proceed. Changing the outdoor air concentration from the default value of 0 $\mu\text{g}/\text{m}^3$ is optional.

Outdoor air concentrations can be obtained from ATSDR's chemical-specific toxicological profiles or EPA's National Air Toxics Assessment (NATA). The NATA program includes emissions, ambient air concentrations, and exposure estimates for 180 of the 187 Clean Air Act air toxics. NATA takes information about emissions and models local ambient air concentrations and the risk of harmful effects. Modeled outdoor air estimates are available at the national, state, county, and census tract levels. The resources section in ATSDR's PHAGM has a link to EPA's NATA program (ATSDR 2023). If you have reliable, site-specific outdoor air measurements, you should use those values in the SHOWER model.

The **Preview Default Scenario Results** button will generate a popup that provides the average daily human exposure concentration for the most highly exposed person in the RME 4-person household default scenario. Results are provided in units of ppb and $\mu\text{g}/\text{m}^3$ to assist with selecting units for your output report. The **Preview Default Scenario Results** button will show you results for the default scenario regardless of whether you selected a default or custom scenario on the Simulation Type screen. Any custom changes to chemical or scenario parameter values will not be reflected in the preview results on the Chemical Information screen.

Depending on whether you selected a default or custom simulation on the Simulation Type screen, one of two things will happen once you complete all required fields on the Chemical Information screen:

- If you selected a default simulation, the **Run Default Scenario** button will activate at the bottom-right of the screen. Clicking the **Run Default Scenario** button will run the 1-person, 2-person, 3-person, and 4-person consecutive morning shower scenarios. See Section 4.2 for more details on the default results that are generated.
- If you selected a custom simulation, the **Next** button will appear and you can proceed to the Household Scenarios screen. Note that the Household Scenarios screen and all subsequent screens will only be available if you select a custom simulation from the Simulation Type screen.

The **Back** button will take you back to the Simulation Type screen. The **Clear All** button will delete the data from the **Chemical Name** and **Concentration in Water** fields and will reset all other fields on the screen to their defaults.

3.3.4 Household Scenarios Screen

The Household Scenarios screen is accessible only if you selected the **Run Custom Scenario (optional)** radio button on the Simulation Type screen. The Household Scenarios screen is where you select a standard scenario that will form the basis of your custom scenario. Changes made on this screen affect the parameter values on the subsequent three screens: the House Information screen, the Appliance Parameters screen, and the Activity Patterns screen.

The screenshot displays the ATSDR SHOWER Model software interface. The title bar reads "ATSDR SHOWER Model - Unsaved". The navigation bar at the top includes tabs for Site Information, Simulation Type, Chemical Information, Household Scenarios (the active tab), House Information, Appliance Parameters, and Activity Patterns. The main content area is titled "Household Scenarios" and features a dropdown menu labeled "Select number of persons in household" with an information icon. Below this, the "Other Scenario Options" section contains two rows of radio buttons: "Exhaust fan when bathrooms are occupied?" with "Off" and "On" options, and "Bathroom door when bathrooms are occupied?" with "Closed" and "Open" options. The "Exposure Groups" section includes a text block explaining that the model displays results for nine standard ATSDR exposure groups and allows for up to two additional groups, followed by a blue button labeled "Add Additional Exposure Group". At the bottom of the screen, there are navigation buttons: "Back", "Clear All", "Home", "Help", "Notes", "Save", and "Run Custom Scenario".

There are three settings that you need to select on this screen:

- 1) **The number of persons in the household.** Options include 1- to 8-person households. After selecting the number of persons in the household, you will see four different scenario options that can form the basis of your custom scenario. The scenario that you select from these four options will establish the initial parameter values used on the subsequent three screens. Click the **View Default Parameter Values** link to download a Word file that displays the default parameter settings for the selected scenario.

4-Person Household View Default Parameter Values

Four morning showers View Default Parameter Values
 Two morning showers and two evening showers
 Two morning showers and two evening baths (persons not helping with tub baths)
 Two morning showers and two evening baths (persons helping with tub baths)

- 2) **Whether the exhaust fans are on or off when the bathrooms are occupied.** This field activates after you select a scenario. The default setting for the exhaust fan is off but you have the option of selecting on.
- 3) **Whether the bathroom doors are open or closed when the bathrooms are occupied.** This field activates after you select a scenario. The default setting is the bathroom door is closed when the bathroom is occupied.

The SHOWER model includes ATSDR's nine standard exposure groups in each model report. You also have the option of adding up to two additional exposure groups by clicking the **Add Additional Exposure Group** button. In the popup, enter an exposure group name and the required physical/exposure parameters (all fields are required). Click **Save** to add the exposure group or click **Cancel** if you decide not to add the exposure group. After the group is added, you can **Edit Parameter Values** or **Delete** the exposure group by selecting the appropriate option after the exposure groups' name on the Household Scenarios screen.

Add/Edit Exposure Group Data ×

Exposure Group

Physical/Exposure Parameters

Total body surface area cm²

Hand surface area cm²

Body weight kg

Daily breathing rate L/min

Shower and bathroom breathing rate L/min

Cancel Save

The **Run Custom Scenario** button in the lower right corner of the screen will become active after the number of persons in the household is selected. You can click this button to generate your custom scenario results. If you would like to continue to customize the scenario's parameter values on the following screens, the **Next** button will appear after the number of persons in the household is selected. Clicking **Next** will take you to the House Information screen. Clicking **Back** will take you back to the Chemical Information screen and clicking **Clear All** will delete all data on this screen AND will reset all values on the subsequent screens.

Tip: Every time you select a new scenario on the Household Scenarios screen, all parameter values on the House Information, Appliance Parameters, and Activity Patterns screens will automatically update to the standard values associated with the new scenario you selected. Any user-defined custom values will be overwritten. This process may take a while on older computers. Be sure to save any custom settings to a new .showermodel database file before changing the scenario if you want to return to them in the future.

3.3.5 House Information Screen

The House Information screen allows you to modify the size and configuration of the house in your scenario. Default values are already selected based on information entered on the previous Household Scenarios screen.

ATSDR SHOWER Model - Unsaved

Site Information ✓ Simulation Type ✓ Chemical Information ✓ Household Scenarios ✓ House Information ✓ Appliance Parameters Activity Patterns

House Information [View House Layout](#)

Number of Bathrooms with Showers ⓘ

Shower/Bathtub Layout ⓘ

Shower/Bathtub #1 Bathtub with shower Shower stall and bathtub separate

Shower/Bathtub #2 Bathtub with shower Shower stall and bathtub separate













Clothes Washer Location ⓘ

Main House Bathroom #1 Bathroom #2

Exhaust Fan Location ⓘ

Exhaust Fan #1 Bathroom #1 Shower #1

Exhaust Fan #2 Bathroom #2 Shower #2

Area Volumes 		Air Exchange Rates 	
Total House	<input type="text" value="339.802"/> m ³ 	Main House	<input type="text" value="0.45"/> ACH 
Total Bathroom #1	<input type="text" value="9.061"/> m ³ 	Bathroom #1	<input type="text" value="0.45"/> ACH 
Shower #1	<input type="text" value="2.039"/> m ³ 	Shower #1	<input type="text" value="0.45"/> ACH 
Total Bathroom #2	<input type="text" value="9.061"/> m ³ 	Bathroom #2	<input type="text" value="0.45"/> ACH 
Shower #2	<input type="text" value="2.039"/> m ³ 	Shower #2	<input type="text" value="0.45"/> ACH 

Users can customize the scenario by changing any of the following parameters:

- Number of Bathrooms with Showers.** Options are 1 or 2 bathrooms. If only one bathroom is selected, then all parameters associated with bathroom #2 are inactive (gray) on this screen and subsequent screens.
- Shower/Bathtub Layout.** You can choose either “Bathtub with shower” or “Shower stall and bathtub separate”. Selecting “Bathtub with shower” means that people taking tub baths will be located in a shower compartment while they are taking a tub bath, whereas selecting “Shower stall and bathtub separate” means that they will be located in a bathroom compartment while they are taking a tub bath. Note that changing a bathroom’s **Shower/Bathtub Layout** will change its compartment volume as well. The default value for the total bathroom volume changes with the shower/bathtub layout:
 - Bathroom containing a bathtub with shower: 9.061 m³ (5 ft x 8 ft x 8 ft)
 - Bathroom with shower stall and bathtub separate: 11.326 m³ (5 ft x 10 ft x 8 ft)
- Clothes Washer Location.** The clothes washer location can be in the main house, bathroom 1, or bathroom 2 (if two bathrooms were selected). Note that changes to the **Clothes Washer Location** will change the bathroom volume as well. With a clothes washer included, the default values for the total bathroom volume are:
 - Bathroom containing a bathtub with shower plus clothes washer: 11.326 m³ (5 ft x 10 ft x 8 ft)
 - Bathroom with shower stall and bathtub separate plus clothes washer: 13.592 m³ (5 ft x 12 ft x 8 ft)
- Exhaust Fan Location.** Choices are bathroom or shower.

- **Area Volumes.** Values are needed for the total house, bathroom(s), and shower(s). If you choose to change the area volumes, open the information icon first and review the details of how compartment volumes are calculated. If you have information on house dimensions in English or metric units (e.g., square feet or meters), you can use the calculator to the right of each compartment to calculate volume in cubic meters. An example of the calculator icon is shown below.



- **Air Exchange Rates.** Air exchange rates determine the flow rates of air between model compartments, per equations described in the SHOWER model technical document (ATSDR 2024b). Values are needed for the main house, bathroom(s), and shower(s). If you have data on air residence times (the average amount of time that a parcel of air stays within a compartment), you can use the calculator to the right of each compartment to calculate the air exchange rate in units of air changes per hour (ACH). If you receive an error stating that the entered parameter values result in negative flow rates, refer to the SHOWER model technical document for further information on the equations affected by these terms (ATSDR 2024b).

You can use the **View House Layout** link to display a house layout image that reflects the options selected on the House Information screen. The layout image will show you the number of compartments in the house, their locations relative to each other, and the location of each appliance considered within the model. Note that the image is not to scale.

Changes to the **Number of Bathrooms with Showers** and the **Shower/Bathtub Layout** options will change the default values that appear on subsequent screens. Changes to the **Number of Bathrooms with Showers** will automatically update the values on the Appliance Parameters and Activity Patterns screens, and changes to the **Shower/Bathtub Layout** options will automatically update the parameter values on the Activity Patterns screen. Any user-defined custom values on these screens will be overwritten during the automatic updates. For example, if a user makes changes on the Appliance Parameters screen or the Activity Patterns screen and then returns to the House Information screen and changes the number of bathrooms, the model will replace the user-defined custom values entered on the Appliance Parameters and Activity Patterns screens with default values. Because user-defined custom values appear in red in the report, the user can always double-check that the intended custom values were used by the model.

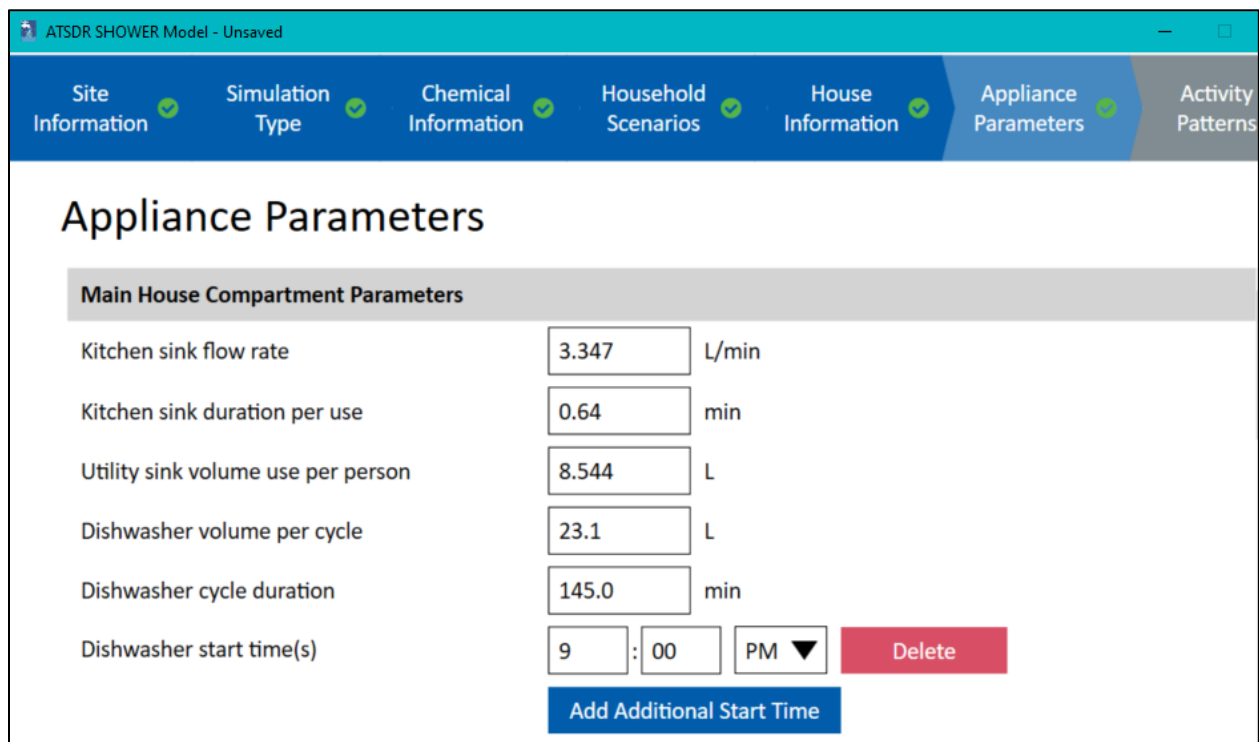
After making any desired changes to the default parameter settings on this screen, you can either click the **Run Custom Scenario** button to run the scenario or click the **Next** button to proceed to the Appliance Parameters screen. Clicking the **Back** button will take you back to the Household Scenarios screen. Clicking **Reset to Default Values** will reset all parameter values on this screen and on the subsequent two screens to the default values associated with the standard scenario you selected on the Household Scenarios screen.

3.3.6 Appliance Parameters Screen

The Appliance Parameters screen allows you to customize the appliance parameter values in your scenario. Default values are already selected based on the information entered on the Household Scenarios screen. For more information about the governing equations that use these parameters, see the SHOWER model technical document (ATSDR 2024b).

The location parameters on this screen (**Clothes Washer Location**, **Exhaust Fan Location**, and **Bathtub Location**) are permanently inactive. These location parameters can be changed on the House Information screen as explained in the information icon associated with each parameter. The parameter settings associated with Bathroom #2 will be active only for a scenario in which the **Number of Bathrooms with Showers** setting on the House Information screen is set to two.

Each standard scenario in the SHOWER model assumes one dishwasher use and one clothes washer use per day. Users can add additional dishwasher or clothes washer uses by clicking the **Add Additional Start Times** buttons. Up to five start times are allowed per appliance. The model will automatically check the start times and appliance durations for conflicts and will indicate an error if a conflict is detected. The model does not allow intermittent use of the clothes washer or dishwasher (for example, 3 times a week).



Clothes Washer Parameters

Clothes washer location ⓘ

Clothes washer volume per cycle L

Clothes washer cycle duration min

Clothes washer start time(s) : Delete

Add Additional Start Time

Bathroom Compartment Parameters

	Bathroom #1	Bathroom #2
Bathroom sink flow rate	<input type="text" value="3.347"/> L/min	<input type="text" value="3.347"/> L/min
Bathroom sink duration per use	<input type="text" value="0.64"/> min	<input type="text" value="0.64"/> min
Toilet volume per flush	<input type="text" value="8.7"/> L	<input type="text" value="8.7"/> L

Exhaust Fan Parameters

Exhaust fan location ⓘ	<input type="text" value="Bathroom #1"/>	<input type="text" value="Bathroom #2"/>
Exhaust fan flow rate	<input type="text" value="1416.0"/> L/min	<input type="text" value="1416.0"/> L/min

Bathtub Parameters

Bathtub location ⓘ	<input type="text" value="Shower #1"/>	<input type="text" value="Shower #2"/>
Bathtub volume	<input type="text" value="76.47"/> L	<input type="text" value="76.47"/> L

Shower Compartment Parameters

	Shower #1	Shower #2
Shower flow rate	<input type="text" value="7.6"/> L/min	<input type="text" value="7.6"/> L/min

From the Appliance Parameters screen, users can:

- 1) Proceed directly to the Activity Patterns screen by clicking the **Next** button.
- 2) Generate custom scenario results by clicking the **Run Custom Scenario** button in the lower right corner of the screen.
- 3) Go back to the Household Information screen by pressing the **Back** button.
- 4) Reset all fields on this screen to their default values by pressing the **Reset to Default Values** button. The **Reset to Default Values** button affects parameters on this screen only.

Tip: The SHOWER model does not include explicit options for removing appliances from scenarios. To simulate a house without a particular appliance, set the flowrate, volume, or volume per cycle parameters associated with that appliance to zero on the Appliance Parameters screen. For example, setting the kitchen sink flow rate to zero will eliminate any contaminant contribution from the kitchen sink, effectively removing it from consideration within the simulation. Contributions from the dishwasher and clothes washer can also be eliminated by deleting the start times associated with those appliances. In addition, you can simulate a house without contaminant air contributions from an appliance by setting the appliance's f value to zero in the **Add/Edit Chemical Data** menu on the **Chemical Information** screen.

3.3.7 Activity Patterns Screen

The Activity Patterns screen allows you to enter custom activity patterns for each person in the house. Default activity patterns and parameter values are already programmed in this screen based on the information entered on the Household Scenarios screen and on the House Information screen.

Person	Activity Time	Activity Type + Compartment	Activity Duration (min)	Time in Bathroom after Activity (min)	Person Helping with Tub Bath
1	Morning	Showering - Shower #1	7	5	
1	Evening				
2	Morning	Showering - Shower #1	7	5	
2	Evening				
3	Morning	Showering - Shower #2	7	5	
3	Evening				

The SHOWER model procedurally generates activity patterns for each person in the house using the parameters shown on this screen. You can customize activity patterns by modifying the morning or evening activities for each person in the house, their activity durations, and the time they spend in the bathroom after each activity. For each person that takes a tub bath, you can also specify a person that helps them with their bath. All residents of the house must have either a major morning or evening activity (shower or bath) scheduled for the simulation to proceed. The custom scenario report displays results for only one person in the house at a time. By

default, the program displays results for the most highly exposed person in the house. To view results for a different person, select their number in the **Target Person** dropdown menu.

The **Other Activity Information** section includes a few more parameters that help define activity patterns:

- **Time between bathroom stays and next shower/tub bath** defines the amount of time between one person exiting the bathroom after their shower or bath and the next person entering the same bathroom for their shower or bath. The standard value is 1 minute, meaning 1 minute elapses between consecutive showers or baths.
- **Bathroom visits separate from shower/tub bath** specifies how many additional bathroom visits each person makes throughout the day. You have the option of changing the number of additional visits per person (from zero to five), but you cannot specify the times that the visits occur — those times are fixed within the program. If a shower or tub bath activity setting or an away from home setting conflicts with a fixed time for an additional bathroom visit, the additional bathroom visit will not occur. For example, if you select a person to be away from home from 1 pm to 3 pm, their scheduled 2 pm bathroom visit will not take place.
- **Kitchen sink uses** specifies the number of times each person uses the kitchen sink during the day (from 0 to 30). The standard number of kitchen sink uses for each person in the household is 15, such that people who are home all day will use the kitchen sink 15 times when the standard value is used. If the person is away from home, the number of times they use the kitchen sink will be scaled in proportion to the number of hours they are away from home. Changes to this parameter do not affect the activity pattern generated for each person.

Target Person i Most Highly Exposed Person ▼

Other Activity Information

Time between bathroom stays and next shower/tub bath 1 min

Bathroom visits separate from shower/tub bath i 4 ▼ visits per person per day (max 5)

Kitchen sink uses i 15 uses per person per day (max 30)

The SHOWER model generates activity patterns for each person in the house by working backward from an established end time for morning and evening bathing activities. These end times are set using the **Activity End Time** parameters shown on this screen. Separate end times are assigned for activities in Bathroom #1 and Bathroom #2.

The model requires a morning and evening end time for each bathroom in which a major activity is scheduled. Each scenario in the model will have default end times. Note that staggering the

end times between bathrooms 1 and 2 allows Figure 1 in the model report to show distinct concentration profiles when the scenario includes two bathrooms. The example shown below is for a household where both bathrooms have morning and evening bathing activities. If a morning or evening bathing activity does not occur in a bathroom, end times are not shown.

Activity End Times i	Bathroom #1	Bathroom #2
Time when all morning showers/tub baths are complete	7 : 13 AM	7 : 23 AM
Time when all evening showers/tub baths are complete	7 : 43 PM	7 : 53 PM

To see how these parameters are used, consider the following two examples:

- Example 1:* A 1-person scenario in which the person spends seven minutes showering in Shower #1 and spends five minutes after the shower in Bathroom #1. If the **Time when all morning showers/tub baths are complete** in Bathroom #1 is 7:13 AM, the person will begin their shower at 7:01 AM (7:01 AM = 7:13 AM – five minutes in the bathroom – seven minutes in the shower). Thus, the start time calculated within the model is 7:13 AM – 12 minutes or 7:01 AM.
- Example 2:* A 2-person scenario in which both people take 7-minute morning showers in Shower #1 followed by 5-minute bathroom stays in Bathroom #1. Assume the **Time when all morning showers/tub baths are complete** in Bathroom #1 is still 7:13 AM as in the previous example. If the **Time between bathroom stays and next shower/tub bath** equals one minute, the first shower in the bathroom will occur at 6:48 AM (6:48 AM = 7:13 AM – five minutes in the bathroom for person 2 – seven minutes in the shower for person 2 – one minute between consecutive bathroom stays – five minutes in the bathroom for person 1 – seven minutes in the shower for person 1). Thus, the start time calculated within the model is 7:13 AM – 25 minutes or 6:48 AM.

The SHOWER model provides the **Activity Start Times** in each compartment for reference. Knowing the start time may be useful in resolving scheduling conflicts (see next section). You cannot directly enter activity start times, as they are calculated within the model based on activity end times, bathing duration, bathroom stay duration, and time between bathing activities.

Activity Start Times i	Bathroom #1	Bathroom #2
Time when all morning showers/tub baths begin	7 : 01 AM	7 : 11 AM
Time when all evening showers/tub baths begin	7 : 28 PM	7 : 38 PM

You can use the **Home All Day/Away From Home Options** to specify whether each person in the house is away from home during a portion of the day. All people that are away from home will be away during the time specified in the **Away from home start time** and **Away from**

home end time fields (shown below). When selected, the default time away from home is 10 hours. Because of the complexity in this parameter, the SHOWER model does not include a mechanism for setting different away from home times for different people in the house.

Home All Day/Away From Home Options		
Away from home start time	<input type="text"/> : <input type="text"/>	AM
Away from home end time	<input type="text"/> : <input type="text"/>	PM
Person 1	<input checked="" type="radio"/> Home All Day	<input type="radio"/> Away From Home
Person 2	<input checked="" type="radio"/> Home All Day	<input type="radio"/> Away From Home
Person 3	<input checked="" type="radio"/> Home All Day	<input type="radio"/> Away From Home
Person 4	<input checked="" type="radio"/> Home All Day	<input type="radio"/> Away From Home

The SHOWER model will automatically check the settings entered on the Activity Pattern screen to ensure that all entered time settings are valid and that no conflicts exist. The program will ensure that all morning activities begin after midnight and that all evening activities begin after noon. For example, an error will appear if afternoon activities are back-calculated to start before 12:00 noon.

In addition, the program requires that persons cannot leave the house before the last bathing activity takes place. Thus, the away from home start time must occur *after* the end time of all morning bathing activities. Similarly, persons must return home in the evening before evening bathing activities start. Thus, the away from home end time must occur *before* the start time of all evening bathing activities. Any violations to these validity checks will result in an error which must be resolved. To fix the error, follow the prompts that appear in the error message popups.

Consider the following two examples of how to resolve errors for the away from home start and end times:

- *Example 1:* A standard 4-person, four morning showers scenario in which someone is away from home (see screenshot below). When a person is selected for being away from home, the model will automatically enter a 10-hour window using 8:00 AM as the start time and 6:00 PM as the end time.
 - If you change the **Away from home start time** from the default of 8:00 AM to 7:00 AM, you will see an error informing you that the away from home start time must occur after the time when all morning bathing activities are complete.
 - In this example, the error occurred because the **Away from home start time** of 7:00 AM is before the **Time when all morning showers/tub baths are complete** in Bathroom #1 (7:13 AM). The error occurs because household members cannot be out of the house before their shower or bath is finished.

- To fix the error, do either of the following:
 - Change the time when all morning showers/tub baths are complete in Bathroom #1 to an earlier time. For example, change 7:13 AM to 6:55 AM. With this change, the time when all morning showers/tub baths are complete (6:55 AM) is earlier than the start time when people are away from home (7:00 AM), and the error is resolved.
 - Change the away from home start time to a later time. For example, change 7:00 AM to 7:20 AM. With this change, the away from home start time (7:20 AM) is later than the time when all morning showers/tub baths are complete in Bathroom #1 (7:13 AM), and the error is resolved.
- Once corrected, the error message will disappear.

Activity End Times i	Bathroom #1	Bathroom #2
Time when all morning showers/tub baths are complete	<input type="text" value="7"/> : <input type="text" value="13"/> AM	<input type="text"/> : <input type="text"/> AM
Time when all evening showers/tub baths are complete	<input type="text"/> : <input type="text"/> PM	<input type="text"/> : <input type="text"/> PM
Activity Start Times i	Bathroom #1	Bathroom #2
Time when all morning showers/tub baths begin	<input type="text" value="6"/> : <input type="text" value="22"/> AM	<input type="text"/> : <input type="text"/> AM
Time when all evening showers/tub baths begin	<input type="text"/> : <input type="text"/> PM	<input type="text"/> : <input type="text"/> PM
Home All Day/Away From Home Options		
Away from home start time	<input style="border: 2px solid red;" type="text" value="7"/> : <input type="text" value="00"/> AM	Compare the away from home start time here with the activity start and end times above. The away from home start time must occur after the time when all morning showers/baths are complete.
Away from home end time	<input type="text" value="6"/> : <input type="text" value="00"/> PM	
Person 1	<input type="radio"/> Home All Day	<input checked="" type="radio"/> Away From Home
Person 2	<input checked="" type="radio"/> Home All Day	<input type="radio"/> Away From Home
Person 3	<input checked="" type="radio"/> Home All Day	<input type="radio"/> Away From Home
Person 4	<input checked="" type="radio"/> Home All Day	<input type="radio"/> Away From Home

- *Example 2:* A standard 2-person, one morning shower and one evening shower scenario in which someone is away from home.
 - If you change the **Away from home end time** from the default of 6:00 PM to 7:35 PM, you will see an error informing you that the away from home end time must occur before the time when all evening showers/baths begin (see screenshot below).

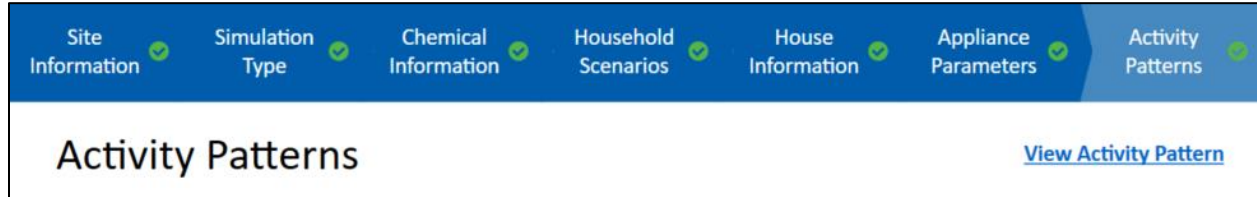
That is, everyone who is out of the house must return home before evening bathing activities start.

- The only evening activity in this scenario is a 7-minute shower followed by a 5-minute bathroom stay in Bathroom #1. Based on the evening activity end time of 7:43 PM in bathroom #1, the shower begins at 7:31 PM (7:31 PM = 7:43 PM – five minutes in the bathroom – seven minutes in the shower).
- The error occurs because household members cannot be out of the house when their evening bathing activity begins.
- To fix the error, do either of the following:
 - Change the **Time when all evening showers/tub baths are complete** in Bathroom #1 to a later time. For example, change 7:43 PM to 7:50 PM. With this change, the time when activities begin in Bathroom #1 changes to 7:38 PM (7:38 PM = 7:50 PM – five minutes in the bathroom – seven minutes in the shower), which is later than the away from home end time (7:35 PM). Thus, the error is resolved.
 - Change the **Away from home end time** to an earlier time. For example, change 7:35 PM to 7:25 PM. With this change, the away from home end time (7:25 PM) is earlier than the time when evening bathing activities begin in Bathroom #1 (7:31 PM), and the error is resolved.
- Once corrected, the error message will disappear.

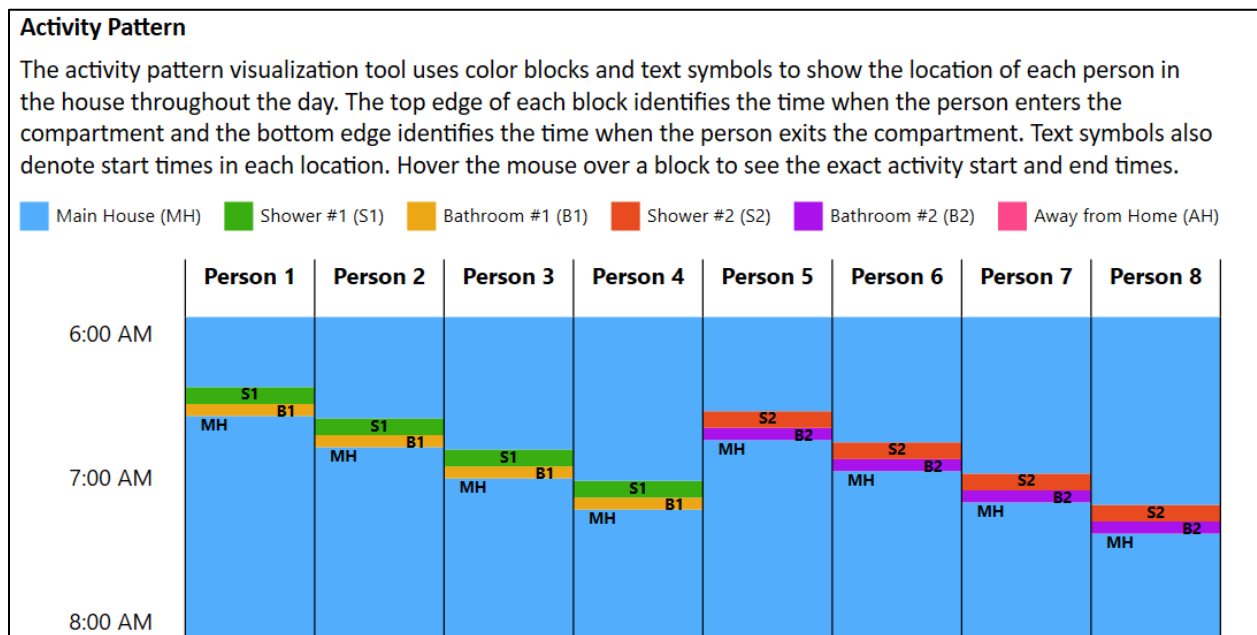
Activity End Times i	Bathroom #1	Bathroom #2
Time when all morning showers/tub baths are complete	7 : 13 AM	<input type="text"/> : <input type="text"/> AM
Time when all evening showers/tub baths are complete	7 : 43 PM	<input type="text"/> : <input type="text"/> PM
Activity Start Times i	Bathroom #1	Bathroom #2
Time when all morning showers/tub baths begin	7 : 01 AM	<input type="text"/> : <input type="text"/> AM
Time when all evening showers/tub baths begin	7 : 31 PM	<input type="text"/> : <input type="text"/> PM
Home All Day/Away From Home Options		
Away from home start time	8 : 00 AM	
Away from home	7 : 35 PM	
Person 1	<input type="radio"/> Home All Day	<input checked="" type="radio"/> Away From Home
Person 2	<input checked="" type="radio"/> Home All Day	<input type="radio"/> Away From Home

Compare the away from home end time here with the activity start and end times and durations above. The away from home end time must occur before the time when all evening showers/baths begin.

You can use the **Activity Pattern Visualization Tool** to view a diagram that shows each person’s activity pattern based on the current parameter settings selected on the Activity Patterns screen. To open the tool, click the **View Activity Pattern** link in the upper right corner of the screen.



The **Activity Pattern Visualization Tool** uses color blocks to identify the location of each person throughout the day. Hover the mouse over a color block in the tool to open a popup window with the specific start and end times of each activity. Click the “x” in the upper right corner of the tool to close the window. Below is a screenshot showing part of the activity pattern for an 8-person household with each person taking a morning shower or bath in either Bathroom #1 or Bathroom #2, followed by a short bathroom stay before entering the main house.



From the Activity Patterns screen, users can:

- 1) Generate custom scenario results by clicking the **Run Custom Scenario** button in the lower right corner of the screen.
- 2) Go back to the Appliance Parameters screen by pressing the **Back** button.
- 3) Reset the parameters on this screen to their default values by pressing the **Reset to Default Values** button.

Tip: If you cannot determine how to resolve an error message while implementing a custom activity pattern, click the **Reset to Default Values** button on the Activity Patterns screen to restore the original values and try rebuilding the scenario step by step, checking the View Activity Pattern tool after each modification. If you still cannot determine why an error is triggered in your scenario, contact showermodel@cdc.gov for assistance.

3.4 Communal Shower and Bathroom Scenario

Health assessors can use the SHOWER model to assess inhalation and dermal exposure from indoor water sources in communal showers and locker rooms or communal bathrooms. Default communal shower and bathroom scenarios require information on the site name and address, building type, facility type, number of people using the facility, contaminant name, and contaminant concentration in water as inputs.

3.4.1 Site Information Screen

The Site Information screen is where you can enter data related to the name and location of the site under review. It contains the following fields:

- **Site Name:** Enter the name of the site under investigation.
- **Address:** Enter the site's address.
- **City/Town/County:** Enter the city, town, or county where the site is located.
- **State/Territory:** Select the state or territory where the site is located from the dropdown menu. If the site's state or territory is not included in the dropdown list, choose "Other" and enter the state or territory in the new field that appears.
- **Zip/Postal Code:** Enter the zip or postal code where the site is located.

Of the fields on this page, only the **Site Name** field is required. Once you have entered a site name, the **Next** button will appear at the lower right of the screen and you can proceed. Clicking the **Next** button will take you to the Simulation Type screen. After moving to the Simulation Type screen, the program will store and use the site information entered on the Site Information screen throughout the rest of the program, unless you return to the Site Information screen to enter new data. To delete existing data on the Site Information screen, you can either delete the data in each field, or you can press the **Clear All** button to clear the data from all fields simultaneously.

The screenshot shows the ATSDR SHOWER Model - Unsaved application window. The top navigation bar includes tabs for Site Information, Simulation Type, Chemical Information, Usage Parameters, Facility Information, Appliance Parameters, and Activity Durations. The Site Information tab is active, displaying a form with the following fields:

- Site Name:
- Address:
- City / Town / County:
- State / Territory: ▼
- Zip:

Below the form is a "Clear All" button. At the bottom of the window, there are buttons for "Home", "Help", "Notes", "Save", and "Run Default Scenario".

3.4.2 Simulation Type Screen

The Simulation Type screen allows you to identify the building type, facility type, scenario type, and number of people using the facility. The SHOWER model defines a facility as either a single communal shower area with adjoining locker room and bathroom area or a single communal bathroom area consisting of toilets and sinks. The **Building Type** field allows you to identify the type of building where the facility is located. Options include a commercial gym, commercial daycare, dorm or barracks, office, or school. If the facility is not located in one of those buildings, select the option for the “Other” building type and enter the name of the building type in the **Other Building Type** field.

Select the type of facility you are simulating using the **Facility Type** field. The options are:

- **Shower and locker room:** Simulates a communal shower and locker room facility.
- **Bathroom:** Simulates a communal bathroom facility without showers.

Bathroom facilities can be simulated for all building types, whereas shower and locker room facilities can be simulated for all building types except commercial daycares. Click the **View Example Facility Diagram** link to display a popup showing a sample conceptual model for a

bathroom facility or a shower and locker room facility. The popup will show the conceptual model that matches the facility type selected on the Simulation Type screen.

Tip: The facility type you select will depend on the layout of showers, toilets, and locker rooms in your building. Facilities that have a locker room with toilets and sinks and an adjacent shower area are referred to as communal shower and locker room facilities in the SHOWER model. Facilities with just toilets and sinks, and no showers, are referred to as communal bathroom facilities.

Buildings can have more than one facility, but the SHOWER model can simulate only one facility at a time. If a building has separate men's and women's facilities, you will need to run a separate simulation for each facility. Similarly, facilities on different floors of a building must be simulated separately.

Each building and facility type supports the following **Scenario Type** options:

- **Run Default Scenario (recommended):** Default scenarios use standard parameter values for the selected building and facility type. For more information on how the standard parameter values in the default scenario were derived, see ATSDR's guidance for evaluating exposure using the SHOWER model (ATSDR 2024a).
- **Run Custom Scenario (optional):** Allows users to customize model parameters. Custom scenarios start with the same standard parameter values applied in default scenarios, but users can change the parameter values on the screens labelled Usage Parameters, Facility Information, Appliance Parameters, and Activity Durations.

Both default and custom scenarios use Monte Carlo simulations to generate CTE and RME results for persons using each facility. For scenarios involving showers in which some facility users do not shower, CTE and RME results are provided both for people who shower and for people who do not shower.

ATSDR SHOWER Model - Unsaved

Site Information Simulation Type Chemical Information Usage Parameters Facility Information Appliance Parameters Activity Durations

Simulation Type

Building Type i

Commercial gym (non-school) Office

Commercial daycare (non-residential) School

Dorm or barracks Other

Facility* Type i

Shower and locker room Bathroom

Scenario Type i

Run default scenario (recommended) Run custom scenario (optional)

Number of People Using the Facility* i people

* "Facility" refers to either a single communal shower area with adjoining bathroom area or a single communal bathroom area. If a building has separate facilities by gender, family status, accessibility, or other trait, you should run the model for each facility individually.

[View Example Facility Diagram](#)

The **Number of People Using the Facility** specifies the number of people that use the facility on a typical day. For buildings with only one facility (e.g., an office with one bathroom), the number would likely be the total number of people in the building. For buildings with multiple facilities by gender, the number should represent the approximate number of people using the specific facility (e.g., women's locker room) being evaluated. Up to 1,000 people may be simulated for a single facility. The model can only simulate one facility at a time, but different numbers of people may be simulated for each facility within the same building. For example, a building with one women's and one men's restroom would require two simulations, and the number of people using each facility would likely be different. Note that simulations of 100 people or more may take several minutes to complete depending on the speed of your computer.

To run a default scenario, select the applicable building and facility type, click the **Run Default Scenario (recommended)** radio button, and then input the number of people using the facility. After making these selections, the **Next** button will appear on the bottom right of the screen above allowing you to proceed to the Chemical Information screen. The **Next** button will not appear until all the information on the screen is entered. In the screenshot above, it does not appear because the **Number of People Using the Facility** has not been entered.

When the **Run Default Scenario (recommended)** option has been chosen, you cannot change chemical properties or any parameter values on screens after the Chemical Information screen.

To change these parameters, you must run a custom scenario. To run a custom scenario, select the applicable building and facility type, click the **Run Custom Scenario (optional)** radio button, and then input the number of people using the facility. As a reminder of your selection, the text in the **Run Default Scenario** button at the bottom right of the screen will change to "Run Custom Scenario". After selecting the **Run Custom Scenario (optional)** radio button, you can change chemical properties and all other parameter values on subsequent screens.

You can click the **Back** button to go back to the Site Information screen or the **Next** button to continue to the Chemical Information screen. Clicking **Reset to Default Values** will reset all fields on the current screen to their initial values.

Tip: The initial parameter values on the screens for Usage Parameters, Facility Information, Appliance Parameters, and Activity Durations depend on the selected building type, facility type, and number of people using the facility. In a custom scenario, if you change parameter values on those screens, coming back to the Simulation Type screen and modifying the building type, facility type, or number of people using the facility will reset any user-defined custom values on the screens for Usage Parameters, Facility Information, Appliance Parameters, and Activity Durations to their standard values. If you want to store custom parameter values entered on those screens for future use, be sure to save your scenario to a new .showermodel database file before changing the building type, facility type, or number of people using the facility. See Section 3.2 and Section 4.1 for more information on saving scenarios.

3.4.3 Chemical Information Screen

The Chemical Information screen is where you enter data related to the chemical being simulated, as well as the concentration of the chemical in water, in outdoor air, and in air in the main building.

Select a chemical by typing either its name or its Chemical Abstract Service Registry Number (CASRN) into the **Chemical Name** field at the top of the screen. The program will search for the chemical in the database that accompanies the program using one of three methods:

- Selecting the **Begins With** radio button will search the database for any chemical name or CASRN that begins with the characters entered in the field. The **Begins With** radio button is selected by default.
- Selecting the **Contains** radio button will search the database for any chemical name or CASRN that contains the characters entered in the field.
- Selecting the **Exact Match** radio button will search the database for any chemical name or CASRN that exactly matches the contents of the field.

As you type data into the text entry field, the program will show options from the database that match the search criteria in a dropdown menu below the text entry field. To select a chemical, single-click the entry for that contaminant in the dropdown menu.

If you selected the option to run the default scenario on the Simulation Type screen, both the **Edit Properties** and **Add Chemical** buttons will be inactive (grayed out). Users cannot modify chemical properties for the default scenario, nor can they simulate a custom chemical. These options are available only if you run a custom scenario.

Within a custom scenario, the **Edit Properties** button will activate after you select a chemical. Clicking this button will open a popup that allows you to change chemical properties from their default values. In the popup that appears:

- Clicking **Cancel** will close the screen without saving any changes.
- Clicking **Reset** will restore the parameters to their default values included with the program.
- Clicking **Save** will save any changes you made for use within your scenario.

Note that clicking **Save** stores modified chemical properties for use in the current scenario only — it does not modify the default values included within the program.

The **Add Chemical** button allows you to add a new chemical for use in your scenario (see screenshot below). The **Chemical Name**, **Chemical CASRN**, **Molecular Weight**, and **Chemical Type** fields are required. To evaluate inhalation exposure, at least one **Chemical f Value** (fractional release value) and the chemical's **Henry's law constant** must be non-zero. The grayed-out f value fields are for appliances considered in residential scenarios only and cannot be entered in communal shower and bathroom scenarios. To evaluate dermal exposure, all three **Chemical Dermal Parameters** must be non-zero. The **Save** button will activate only once you have completed the required fields. Click **Save** to save your new chemical or **Cancel** to exit without saving.

The Chemical Information screen contains the following concentration fields:

- **Concentration In Water:** Enter the water concentration you are evaluating at your site. There is no default value for water concentration.
- **Concentration In Outdoor Air:** Enter the outdoor concentration, if known. Otherwise, the default is 0 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$).
- **Concentration in Main Building:** Enter the indoor air concentration in the main building, if known. Otherwise, the default is 0 $\mu\text{g}/\text{m}^3$.

You must select a chemical name and enter a chemical concentration in water to proceed. The program will accept concentrations entered in the following formats:

- Whole numbers

- Decimal numbers
- E notation (e.g., 1E-4)

You can select units for each concentration using the dropdown menus to the right of each concentration field. The program will automatically convert the selected units into the units needed for model calculation and output. The **Report Units** option specifies whether the model report will use units of parts per billion (ppb) or $\mu\text{g}/\text{m}^3$ to display contaminant air concentrations.

Outdoor air concentrations can be obtained from ATSDR's chemical-specific toxicological profiles or EPA's National Air Toxics Assessment (NATA). The NATA program includes emissions, ambient air concentrations, and exposure estimates for 180 of the 187 Clean Air Act air toxics. NATA takes information about emissions and models local ambient air concentrations and the risk of harmful effects. Modeled outdoor air estimates are available at the national, state, county, and census tract levels. The resources section in ATSDR's PHAGM has a link to EPA's NATA program (ATSDR 2023). If you have reliable, site-specific outdoor air measurements, you should use those values in the SHOWER model.

The contaminant concentration in the main building can be obtained from site-specific indoor air measurements. If site-specific measurements are not available, representative indoor air background levels may be available in the literature depending on the type of building simulated—see the guidance for evaluating inhalation and dermal exposure using the SHOWER model (ATSDR 2024a) for more details.

Depending on whether you selected a default or custom simulation on the Simulation Type screen, one of two things will happen once you complete all required fields on the Chemical Information screen:

- If you selected a default simulation, the **Run Default Scenario** button will activate at the bottom-right of the screen. Clicking the **Run Default Scenario** button will run the default Monte Carlo simulation for the selected facility type and number of people using the facility. See Section 4.2 for more details on the default results that are generated.
- If you selected a custom simulation, the **Next** button will appear and you can proceed to the Usage Parameters screen. Note that the Usage Parameters screen and all subsequent screens will only be available if you select a custom simulation from the Simulation Type screen.

The **Back** button will take you back to the Simulation Type screen. The **Clear All** button will delete the data from the **Chemical Name** and **Concentration In Water** fields and will reset all other fields on the screen to their defaults.

3.4.4 Usage Parameters Screen

The Usage Parameters screen allows you to establish the facility's operating hours and usage patterns, set facility user activity pattern parameters, and add custom exposure groups to your scenario. The Usage Parameters screen is accessible only if you selected the **Run Custom Scenario (optional)** radio button on the Simulation Type screen. Initial values for scenario

parameters on this screen are based on the building and facility type selected on the Simulation Type screen. This screen includes five settings that can be modified:

- 1) **Exposure Groups:** The SHOWER model automatically returns results for standard exposure groups associated with your selected building type. Commercial gyms, dorms or barracks, and “other” building types use ATSDR’s standard exposure groups. Offices, schools, and commercial daycares use ATSDR’s exposure groups for full- and part-time workers. Schools and commercial daycares include additional groups for children, and schools also include groups for full- and part-time workers. Click the **View list of standard exposure groups** link to see the standard exposure groups associated with the building type you have selected.

Exposure Groups [View list of standard exposure groups](#)

The SHOWER model automatically displays results for standard exposure groups associated with your selected building type. To consider an additional group (optional), use the buttons below. Up to two additional groups are allowed.

[Add Additional Exposure Group](#)

To consider an additional exposure group (optional), click the **Add Additional Exposure Group** button to add up to two exposure groups. In the popup, enter an exposure group name and the required physical/exposure parameters. All fields are required for added exposure groups. You may be able to find exposure parameters in ATSDR’s exposure dose guidance documents located on the PHAGM resource page (ATSDR 2023) or generate your own using USEPA’s Exposure Factors Handbook (USEPA 2011). Click **Save** to add the exposure group and use it in your simulation or click **Cancel** if you decide not to add the exposure group. After the group is added, you can **Edit Parameter Values** or **Delete** the exposure group by selecting the appropriate option next to the exposure group’s name on the Usage Parameters screen.

- 2) **Activity Parameters:** Activity parameters that can be customized on this screen include the time each person spends in the building, the average number of bathroom visits per person, and the percent of people taking showers.
 - **Time each person spends in building:** Use the dropdown to choose how the model will simulate the time that people spend in the main building. The standard

distribution option will randomly sample the time each person spends in the building from a standard distribution based on the building type. Selecting the custom value option will simulate the time each person spends in the building as a constant value for each person. “Other” buildings do not have a standard distribution so the user must enter a custom value.

- **Average bathroom visits per person:** Enter the average number of times that people in the group tried to visit the facility to use the bathroom during the day. For example, if two people use the facility and one tries to use it twice and the other tries to use it four times, enter the average of three times in this field. For shower scenarios, this number includes each person’s bathroom visit immediately after showering.
- **Percent of people taking showers:** Enter the percent of people taking showers as a number from 0% to 100%. People who do not take showers may still use the facility for bathroom-only visits. For example, for people using commercial gyms, the default percent of people taking showers is 25%.

Activity Parameters

Time each person spends in building ⓘ Standard distribution ▼ [] hr

Average bathroom visits per person ⓘ [1]

Percent of people taking showers ⓘ [25.0] %

3) **Operating Hours:** Select whether the facility is open all day or whether it is closed for part of the day. If the facility is open all day, facility visits can occur at any time during the day or night. If the facility is closed for part of the day, facility visits can occur only between the facility’s **Opening Time** and **Closing Time**.

Operating Hours ⓘ Open all day Closed for part of the day

Opening Time [6] : [00] AM ▼ Closing Time [10] : [00] PM ▼

4) **Usage Pattern:** Select either a constant or a peak hours usage pattern. In a constant usage pattern, people arrive at the facility at a constant rate while the facility is open. In a peak hours usage pattern, people arrive more frequently during peak periods than during non-peak periods. Click the **View example usage patterns** link to view four examples of usage patterns that can be simulated using the model.

Usage Pattern ⓘ Constant Peak hours [View example usage patterns](#)

5) **Peak Hours:** The peak hours will be inactive (grayed out) unless you select the peak hours usage pattern. Enter times for up to three peak periods for the facility. People arrive at the facility more frequently during peak periods than during non-peak periods. The

peak periods cannot overlap. If all three peak periods are used, **Peak Period 1** must finish before **Peak Period 2** begins, and **Peak Period 2** must finish before **Peak Period 3** begins. The arrival rate during each peak period is the same.

Peak Hours i	Start Time			End Time		
Peak Period 1	<input type="text"/>	:	<input type="text"/> ▼	<input type="text"/>	:	<input type="text"/> ▼
Peak Period 2	<input type="text"/>	:	<input type="text"/> ▼	<input type="text"/>	:	<input type="text"/> ▼
Peak Period 3	<input type="text"/>	:	<input type="text"/> ▼	<input type="text"/>	:	<input type="text"/> ▼

As mentioned, clicking the **View example usage patterns** link will show four examples of usage patterns that can be entered using settings on this screen. One is for a constant usage pattern, and the other three are for patterns with one, two, or three peak periods. The image below shows how the **Peak Hours** fields would be filled out to match the “Three peak periods usage pattern” described in the link. In this example, the facility is open from 6 AM to 10 PM and has three peak periods—one from 7 AM to 9 AM, one from 11 AM to 1 PM, and one from 5 PM to 8 PM.

Operating Hours i	<input type="radio"/> Open all day	<input checked="" type="radio"/> Closed for part of the day		
Opening Time	<input type="text"/> 6 : <input type="text"/> 00 AM ▼	Closing Time	<input type="text"/> 10 : <input type="text"/> 00 PM ▼	
Usage Pattern i	<input type="radio"/> Constant	<input checked="" type="radio"/> Peak hours	View example usage patterns	
Peak Hours i	Start Time		End Time	
Peak Period 1	<input type="text"/> 7 : <input type="text"/> 00 AM ▼	<input type="text"/> 9 : <input type="text"/> 00 AM ▼		
Peak Period 2	<input type="text"/> 11 : <input type="text"/> 00 AM ▼	<input type="text"/> 1 : <input type="text"/> 00 PM ▼		
Peak Period 3	<input type="text"/> 5 : <input type="text"/> 00 PM ▼	<input type="text"/> 8 : <input type="text"/> 00 PM ▼		

The **Run Custom Scenario** and **Next** button in the lower right corner of the screen will become active after the building type is selected. You can click the **Run Custom Scenario** button to generate your custom scenario results, or you can click the **Next** button to continue customizing the scenario’s parameter values on the following screens. Clicking the **Next** button will take you to the Facility Information screen and clicking the **Back** button will take you back to the Chemical Information screen. Clicking the **Clear All** button will delete all data on the Usage Parameters screen.

3.4.5 Facility Information Screen

The Facility Information screen allows you to modify the facility’s number of appliances, area volumes, and air exchange rates. Default values for the parameters on this screen are based on the building type and the number of facility users entered on the Simulation Type screen. The default numbers of each appliance and the default area volumes are determined by the number of facility users. The program assumes an initial number of showers, toilets, and bathroom sinks

based on workplace standards and building codes, and the area volumes reflect the space required to accommodate those showers, toilets, and bathroom sinks. The default air exchange rates are determined by the building type and come from USEPA's Exposure Factors Handbook (USEPA 2011). More information about the default values is available in ATSDR's guidance document on evaluating exposures using the SHOWER model (ATSDR 2024a).

ATSDR SHOWER Model - Unsaved

Site Information ✓ Simulation Type ✓ Chemical Information ✓ Usage Parameters ✓ Facility Information ✓ Appliance Parameters Activity Durations

Facility Information [View Example Facility Diagram](#)

Number of Appliances ⓘ

Showers

Toilets

Bathroom sinks

Area Volumes ⓘ

Total shower m³

Total bathroom m³

Air Exchange Rates ⓘ

	Facility Open		Facility Closed	
Total shower	<input type="text" value="1.4"/>	ACH	<input type="text" value="0.4"/>	ACH
Total bathroom	<input type="text" value="1.4"/>	ACH	<input type="text" value="0.4"/>	ACH

Users can customize the following parameters on this screen:

- 1) **Number of Appliances:** Enter the number of each appliance type in the facility (i.e., showers, toilets, and bathroom sinks).
- 2) **Area Volumes:** Enter the volume of each area in the facility (i.e., shower area and bathroom area). For shower and locker room facilities, the locker room is part of the bathroom area. The standard values for these parameters are based on the number of showers, toilets, and bathroom sinks in the facility, which depend on the number of daily facility users entered on the Simulation Type screen. If you choose to change the area volumes, open the information icon first and review the details of how compartment volumes are calculated. If you have information on area dimensions in English or metric units (e.g., square feet or meters), you can use the calculator to the right of each compartment to calculate volume in cubic meters. An example of the calculator icon is shown below.



- 3) **Air Exchange Rates:** Air exchange rates determine the flow rates of air between model compartments, per equations described in the SHOWER model technical document (ATSDR 2024b). Values are needed for the shower area and bathroom area when the facility is open and closed. The **Facility Open** values correspond with the facility's air exchange rates when the building's heating, ventilation, and air conditioning (HVAC) system is on, and the **Facility Closed** values correspond with air exchange rates when the HVAC system is off. If you have data on air residence times (the average amount of time that a parcel of air stays within a compartment), you can use the calculator to the right of each compartment to calculate the air exchange rate in units of air changes per hour (ACH). If you receive an error stating that the entered parameter values result in negative flow rates, refer to the SHOWER model technical document for further information on the equations affected by these terms (ATSDR 2024b).

Click the **View Example Facility Diagram** link to display a popup showing an example conceptual model for either a one-compartment bathroom facility or a two-compartment shower and locker room facility. The popup will show the conceptual model that matches the facility type selected on the Simulation Type screen. Use the image as a guide in determining how to apportion space between the shower area, bathroom area (toilets, sinks), and main building when site-specific facility layout information is available. Note that the conceptual model images are not to scale.

After making any desired changes to the default parameter settings on the Facility Information screen, you can either click the **Run Custom Scenario** button to run the scenario or click the **Next** button to proceed to the Appliance Parameters screen. Clicking the **Back** button will take you back to the Usage Parameters screen. Clicking **Reset to Default Values** will reset all parameter values on this screen to their defaults.

Tip: In communal bathroom scenarios, the facility does not have a communal shower area. As a result, any fields related to showers or showering will be grayed-out on the screens for Usage Parameters, Facility Information, Appliance Parameters, and Activity Durations. Throughout the SHOWER model, if a field is grayed-out, it is not required to run the scenario you have selected.

3.4.6 Appliance Parameters Screen

The Appliance Parameters screen allows you to customize the appliance parameter values in your scenario. Default values are already selected based on the number of daily facility users entered on the Simulation Type screen. For more information about how the default values for these parameters were derived and about the governing equations that use these parameters, see the guidance for evaluating inhalation and dermal exposure using the SHOWER model (ATSDR 2024a) and the SHOWER model technical document (ATSDR 2024b).

ATSDR SHOWER Model - Unsaved

Site Information ✓ Simulation Type ✓ Chemical Information ✓ Usage Parameters ✓ Facility Information ✓ Appliance Parameters ✓ Activity Durations

Appliance Parameters

Bathroom Compartment Parameters

Toilet volume per flush L

Bathroom sink flow rate L/min

Shower Compartment Parameters

Shower flow rate L/min

Airflow Parameters ⓘ [View Airflow Diagram](#)

Outdoor air supply flow rate L/min

Bathroom exhaust fan flow rate L/min

Shower exhaust fan flow rate L/min

On the Appliance Parameters screen, users can:

- 1) Enter custom appliance parameters (optional) for the following categories:
 - **Bathroom Compartment Parameters:** Enter the toilet volume per flush and bathroom sink flow rate for all toilets and bathroom sinks in the facility.
 - **Shower Compartment Parameters:** Enter the shower flow rate for all showers in the facility.
 - **Airflow Parameters:** Enter the parameters identifying total airflow into and out of the facility (i.e., outdoor air supply flow rate, bathroom exhaust fan flow rate, and shower exhaust fan flow rate). The standard values of these parameters depend on the number of showers and toilets in the facility.
- 2) Generate custom scenario results by clicking the **Run Custom Scenario** button in the lower right corner of the screen.
- 3) Proceed directly to the Activity Durations screen by clicking the **Next** button.
- 4) Go back to the Facility Information screen by pressing the **Back** button.

- 5) Reset all fields on this screen to their default values by pressing the **Reset to Default Values** button.

You can use the **View Airflow Diagram** link to display the direction of positive airflow in the SHOWER model governing equations when the facility is open and closed. The numeric values of the airflow rates reported beneath the figures are calculated using the airflow, volume, and air exchange rate data entered on the Appliance Parameters and Facility Information screens. Positive values mean that air is flowing in the direction shown in the figure, and negative values mean that air is flowing in the opposite direction.

In default scenarios, when a facility is open, air flows from the main building into the facility (i.e., into the locker room or communal bathroom) but not from the facility back into the main building. In communal shower and locker room facilities, air flows from the locker room, which includes the sink and toilet areas, to the shower area, but not in the other direction. Air is also vented from both the locker room and the shower area to the outdoors, and fresh air is brought into the locker room from the outdoors. For more information, see the guidance document for evaluating exposures using the SHOWER model (ATSDR 2024a) and the SHOWER model technical document (ATSDR 2024b).

3.4.7 Activity Durations Screen

The Activity Durations screen allows you to specify the distribution parameters used in the Monte Carlo simulation to generate random activity patterns for the facility users. You can customize distribution parameters for the following settings:

- 1) **Shower Duration** estimates the time that each person spends in the shower using a lognormal distribution. The default mean and standard deviation are 8.0 minutes and 5.3 minutes, respectively.
- 2) **Average Time in Locker Room Before Shower** estimates the time that each person spends in the locker room before taking a shower using a normal distribution. The default mean is 5 minutes. The standard deviation cannot be assigned manually, but is calculated internally as one-fifth of the mean.
- 3) **Average Time in Locker Room After Shower** estimates the time that each person spends in the locker room after taking a shower. The default mean is 10 minutes. The standard deviation cannot be assigned manually, but is calculated internally as one-fifth of the mean.
- 4) **Average Time in Bathroom for Bathroom-only Visits** estimates the time that each person spends in the bathroom for a bathroom-only visit. A bathroom-only visit is a visit in which the person uses the facility toilet and bathroom sink but not the shower. The default mean is 5 minutes. The standard deviation cannot be assigned manually, but is calculated internally as one-fifth of the mean.

- 5) **Bathroom Sink Use Duration** estimates the time that each person spends washing their hands in the bathroom sink using a lognormal distribution. The default mean and standard deviation are 0.628 minutes and 0.27 minutes, respectively.

Site Information ✓
Simulation Type ✓
Chemical Information ✓
Usage Parameters ✓
Facility Information ✓
Appliance Parameters ✓
Activity Durations ✓

Activity Durations

Shower Duration ⓘ

Mean min

Standard deviation min

Average Time in Locker Room Before Shower ⓘ min

Average Time in Locker Room After Shower ⓘ min

Average Time in Bathroom for Bathroom-only Visits ⓘ min

Bathroom Sink Use Duration ⓘ

Mean min

Standard deviation min

After making any desired changes to the default parameter settings on the Activity Durations screen, you can click the **Run Custom Scenario** button to run the scenario. Clicking the **Back** button will take you back to the Appliance Parameters screen and clicking the **Reset to Default Values** button will reset all parameter values on this screen.

4 Model Reports

This section discusses the SHOWER model results screen and provides brief examples of the main results generated by the SHOWER model. It does not provide information on interpreting these results. For further information on interpreting and applying the model results, see the guidance for evaluating inhalation and dermal exposure using the SHOWER model (ATSDR 2024a). For details regarding the equations underlying the data in the report tables and figures, refer to the SHOWER model technical document (ATSDR 2024b).

4.1 Report Screen

The reports generated by the SHOWER model appear as a scrollable screen in the program. Use the scroll bar located at the right of the program window to scroll through the report.

Information	Report Setting
Site Information	
Site name:	Example
Address:	---
Application:	Version 4.0.0
CASRN:	127-18-4
Contaminant:	Tetrachloroethylene
	1,1,2,2-perchloroethylene
	1,1,2,2-tetrachloroethylene
Synonym:	PCE
	PERC
	Perchloroethylene
	Tetrachloroethene
Model Input Information	
Chemical name:	Tetrachloroethylene
Chemical properties:	Default
Exposure routes available:	Inhalation and Dermal
Water concentration:	100 µg/L
Outdoor air concentration:	0 µg/m ³
Number of persons in household:	4

There are five blue action buttons located at the bottom of the Report screen window:

- **Back:** Takes users back to the program screen from which they ran the simulation.
- **Export Raw Data:** Generates Excel files with raw data for the simulation.

- For residential scenarios, pressing this button will generate eight Excel files for a default simulation run (one for each household scenario) and one Excel file for a custom simulation.
- For communal shower and bathroom scenarios, pressing this button will generate one Excel file with inhalation concentration and highest administered dermal dose results for each person simulated in each Monte Carlo iteration. If you want to see the highest daily exposure concentration and highest dermal dose generated by the model for any person, export the raw data and sort the columns by concentration or dose. You could also estimate these values by looking at Figures 1 and 2 in the report.
- **Export Word:** Generates a Word file with details about the simulation and the simulation results. The Word file will contain the same content as that shown on the Report screen.
- **Export to PHAST:** Generates a file with simulation information and results that can be imported to PHAST. This file has a “.showermodelphastexport” extension. The extension should not be changed when importing the results into PHAST.
- **Save:** Allows you to choose a location on your computer to save your simulation as a file with a “.showermodel” extension. Saving a simulation will allow you to load the same parameter values into the model for future work. The extension should not be changed when importing the simulation back into the SHOWER model.

The residential scenario Excel files include the following tabs:

- **ReadMe:** This tab provides a definition for each field in the workbook.
- **ConcentrationArrays:** This tab lists the air concentration of the contaminant in each compartment at each minute of the day. These data are used to generate Figure 1 in the model report. This tab also shows the target person's location throughout the day, and the air concentration in the compartment where the target person is located at each minute. These data are used to generate Figure 2 in the model report, as well as the average exposure concentration data reported in various report tables. The results are in $\mu\text{g}/\text{m}^3$ or ppb depending on the units chosen for the model report on the Chemical Information screen.
- **InhalationIntake:** This tab lists the cumulative inhaled mass intake of the contaminant at each minute of the day. The results are in μg and can be used to confirm the average daily dose for the target person presented in the model report.
- **ApplianceInfo:** This tab provides summary data on the total amount of water used by each appliance in the household.
- **Scenario:** This tab provides summary information about the scenario represented in the Excel file. Use the information in this tab to differentiate between the eight scenario Excel files generated for the default simulation.

The communal shower and bathroom scenarios include the following tabs:

- **ReadMe:** This tab provides a definition for each field in the workbook.
- **InhalationConcentrations:** This tab provides the calculated inhalation daily exposure concentration for each person simulated in each Monte Carlo iteration.
- **DermalDoses:** This tab provides the highest administered dermal dose for any exposure group for each person simulated in each Monte Carlo iteration.
- **Scenario:** This tab provides summary information about the scenario represented in the Excel file.

Tip: The Excel and Word files are both created in the temp folder under your user account in Windows. Once the file opens on your computer, you should rename it and save it in a desired location. For reference, the initial file name includes the following information:

Residential Scenario Files

- Word: [Site name]_[D (default) or C (custom)]_[Contaminant name] [Date].docx
- Excel: [Site name]_[D (default) or C (custom)]_[Contaminant name] [Date].xlsx

Communal Shower and Bathroom Scenario Files

- Word: [Site name]_[S (shower) or B (bathroom)]_[Contaminant name] [Date].docx
- Excel: [Site name]_[S (shower) or B (bathroom)]_[Contaminant name] [Date].xlsx

4.2 Residential Scenarios

Residential scenario reports include information on the average daily exposure concentration, dermal doses, and inhalation doses calculated for the target person in the simulated scenario. They also include figures showing air concentrations in the simulated compartments, and tables showing the scenario input parameters. The custom scenario report includes information for just one scenario, but the default scenario report includes supplementary information for other scenarios in addition to the default 4-person household RME scenario results.

4.2.1 Default Scenarios

To obtain default residential scenario results, you must first select **Run Default Scenario (recommended)** on the Simulation Type screen and enter a contaminant and a water concentration on the Chemical Information screen. After entering these data, clicking the **Run Default Scenario** button will run the simulation and bring up the default scenario results in an onscreen report. The example text and screenshots in this section show data for tetrachloroethylene at 100 µg/L in household water.

The title of the onscreen report is “ATSDR SHOWER Model Report, Default 4-Person Household (With Additional Results for 1-, 2-, and 3-Person Households). The report starts by

displaying the user-entered **Site and Model Input Information**, followed by the **Default Scenario Report** section which provides a description of the report contents. The default scenario report provides both CTE and RME results for households with 1, 2, 3, and 4 persons. The CTE and RME results approximate the 50th and 95th percentile exposures, respectively, for each household scenario.

Although a default simulation includes CTE and RME results for 1-, 2-, 3-, and 4-person households, only one of these (the 4-person household RME scenario) is the default scenario that should be used to make public health decisions. All other scenarios are provided for additional information only. Results for each scenario are given for the last person (child and adult) who showers in a household because they are the most highly exposed. This person is referred to as the target person.

The screenshot displays the ATSDR SHOWER Model Report interface. The title bar reads "ATSDR SHOWER Model - Unsaved". The main header is "ATSDR SHOWER Model Report" with a subtitle "Default 4-Person Household (With additional results for 1-, 2-, and 3-person households)". The section "Site and Model Input Information" is expanded, showing two tables:

Information	Report Setting
Site Information	
Site name:	Example
Address:	---
Application:	Version 4.0.0
CASRN:	127-18-4
Contaminant:	Tetrachloroethylene
Synonym:	1,1,2,2-perchloroethylene
	1,1,2,2-tetrachloroethylene
	PCE
	PERC
	Perchloroethylene
Model Input Information	
Chemical name:	Tetrachloroethylene
Chemical properties:	Default
Exposure routes available:	Inhalation and Dermal
Water concentration:	100 µg/L
Outdoor air concentration:	0 µg/m ³
Number of persons in household:	4

At the bottom of the interface, there are five buttons: "Back", "Export Raw Data", "Export Word", "Export to PHAST", and "Save".

In the **Primary Results: Used to Make Health Determinations** section, the model report presents tabular result data for the default scenario. This section contains two data tables:

- **Table S1** provides the RME daily exposure concentration for the target person in the default scenario. The default scenario assumes three people take 10-minute consecutive morning showers and the fourth person takes a 15-minute shower, each followed by 5-

minute bathroom stays. The fourth person is the target person in the default scenario. The concentration shown in **Table S1** applies to all age groups including infants (birth to < 1 year) who are exposed from taking baths. Although infants do not shower, their inhalation and dermal exposures from a 20-minute bath scenario are comparable to the RME inhalation and dermal exposures from the default shower scenario.




Table S1. RME daily exposure concentration in $\mu\text{g}/\text{m}^3$ for the target person (person 4) in the 4-person household

RME Daily Exposure Concentration
74

Abbreviations: $\mu\text{g}/\text{m}^3$ = micrograms chemical per cubic meter air; RME = reasonable maximum exposure

- **Table S2** provides the average RME daily administered dermal dose from contact with water for the target person in the default scenario. These doses are based on age-specific factors, such as skin surface area and body weight, and thus vary with age group.




Table S2. RME daily administered dermal dose in $\mu\text{g}/\text{kg}/\text{day}$ for the target person (person 4) in the 4-person household

Exposure Group	RME Administered Dermal Dose
Birth to < 1 year	2.5
1 to < 2 years	2.3
2 to < 6 years	1.9
6 to < 11 years	1.6
11 to < 16 years	1.3
16 to < 21 years	1.2
Adult	1.2
Pregnant & breastfeeding women	1.2

Abbreviations: $\mu\text{g}/\text{kg}/\text{day}$ = micrograms chemical per kilograms body weight per day

In the **Secondary Results: Optional Supporting Information** section, the model report presents supporting tabular result data for the additional household scenarios along with the results for the default scenario. These additional scenarios include a CTE scenario for the 4-person household and CTE and RME scenarios for households with 1, 2, and 3 persons. This section contains two data tables of results.

- **Table S3** shows the CTE and RME daily air concentrations for the 1-, 2-, 3-, and 4-person households in the default simulation. The highlighted cell in Table S3 is the concentration for the target person in the default 4-person household RME scenario and is the same as the concentration shown in Table S1.




Table S3. Daily exposure concentration in $\mu\text{g}/\text{m}^3$ in each scenario

Scenario Type	1-Person Household	2-Person Household	3-Person Household	4-Person Household
RME	20	40	57	74
CTE	8.5	17	25	33

Abbreviations: CTE = central tendency exposure; $\mu\text{g}/\text{m}^3$ = micrograms chemical per cubic meter air; RME = reasonable maximum exposure

- **Table S4** shows the daily administered dermal doses for the CTE and RME 1-, 2-, 3-, and 4-person household scenarios in the default simulation. The highlighted cells in Table S4 are the default scenario doses and are the same as those shown in Table S2.




Table S4. Daily administered dermal dose in $\mu\text{g}/\text{kg}/\text{day}$ in each scenario

Exposure Group	RME 1-P	RME 2-P	RME 3-P	RME 4-P	CTE 1-P	CTE 2-P	CTE 3-P	CTE 4-P
Birth to < 1 year	NC	2.4	2.4	2.5	NC	1.6	1.6	1.6
1 to < 2 years	NC	2.3	2.3	2.3	NC	1.5	1.5	1.5
2 to < 6 years	NC	1.9	1.9	1.9	NC	1.3	1.3	1.3
6 to < 11 years	NC	1.6	1.6	1.6	NC	1.1	1.1	1.1
11 to < 16 years	NC	1.3	1.3	1.3	NC	0.86	0.86	0.86
16 to < 21 years	NC	1.2	1.2	1.2	NC	0.79	0.79	0.79
Adult	1.1	1.2	1.2	1.2	0.77	0.77	0.77	0.78
Pregnant & breastfeeding women	1.2	1.2	1.2	1.2	0.78	0.78	0.78	0.78

Abbreviations: -P = person; CTE = central tendency exposure; $\mu\text{g}/\text{kg}/\text{day}$ = micrograms chemical per kilograms body weight per day; NC = not calculated; RME = reasonable maximum exposure

After this table, the default SHOWER model report includes a brief reminder to users about the model’s ability to run custom scenarios, information about importing results into PHAST, and guidance on where to look for additional SHOWER model resources and supporting documents.

The **Detailed Results for the 4-Person Household** section provides more information about the default RME 4-person scenario beyond what is provided in Tables S1 and S2. This section provides information about all four members in a 4-person household (Table 1), inhalation and dermal doses for the target person (Table 2), exposure concentration by location in the house (Table 3), and percent exposure by location in the house (Table 4). In addition, two figures are provided that show air concentrations in each compartment throughout the day.

- **Table 1** shows the RME daily exposure concentration for each person in the 4-person household, including the most highly exposed person (person 4 in the default scenario).

The air concentration estimated by the model is independent of who is showering and thus applies to both children and adults.




Table 1. RME daily exposure concentration in $\mu\text{g}/\text{m}^3$ for each person in the house

Person	Target Person	Main Activities	RME Daily Exposure Concentration
1	—	Showering in Shower #1 at 6:05 a.m.	25
2	—	Showering in Shower #1 at 6:21 a.m.	36
3	—	Showering in Shower #1 at 6:37 a.m.	45
4	X	Showering in Shower #1 at 6:53 a.m.	74

Abbreviations: $\mu\text{g}/\text{m}^3$ = micrograms chemical per cubic meter air

- **Table 2** presents the dermal doses from contact with water only for the most highly exposed person in this scenario (person 4). **Table 2** also shows the inhaled dose in $\mu\text{g}/\text{kg}/\text{day}$, which is derived from the RME daily exposure concentration for the most highly exposed person in Table 1.




Table 2. RME daily inhalation dose and administered dermal dose in $\mu\text{g}/\text{kg}/\text{day}$ for the target person

Exposure Group	Inhalation	Dermal
Birth to < 1 year	97	2.5
1 to < 2 years	104	2.3
2 to < 6 years	65	1.9
6 to < 11 years	36	1.6
11 to < 16 years	24	1.3
16 to < 21 years	18	1.2
Adult	16	1.2
Pregnant & breastfeeding women	23	1.2

Abbreviations: $\mu\text{g}/\text{kg}/\text{day}$ = micrograms chemical per kilograms body weight per day; NC = not calculated

The SHOWER model’s default scenario simulates a house that consists of three compartments: a shower stall, the bathroom, and the main house. The next two tables (**Table 3** and **Table 4**) provide exposure information for the time that the target person spends taking a shower, the time they spend in the bathroom afterward, and the time that they spend in the main house throughout the rest of the day. When the target person visits the bathroom during other parts of the day, those bathroom times are included in the main house exposure time.

- **Table 3** shows the average human exposure concentration that the target person experiences in each location.




Table 3. Exposure time and average human exposure concentration by location for the target person

Location	Exposure Time (min)	Average Human Exposure Concentration ($\mu\text{g}/\text{m}^3$)
Shower	15	4,921
Bathroom after shower	5	601
Main house with additional bathroom visits	1,420	21
Away from house	0	0
Average daily exposure	1,440	74
Main house (all day)	1,440	9.7

Abbreviations: $\mu\text{g}/\text{m}^3$ = micrograms chemical per cubic meter air; min = minute

- **Table 4** shows the percent of exposure that the target person experiences in each location.


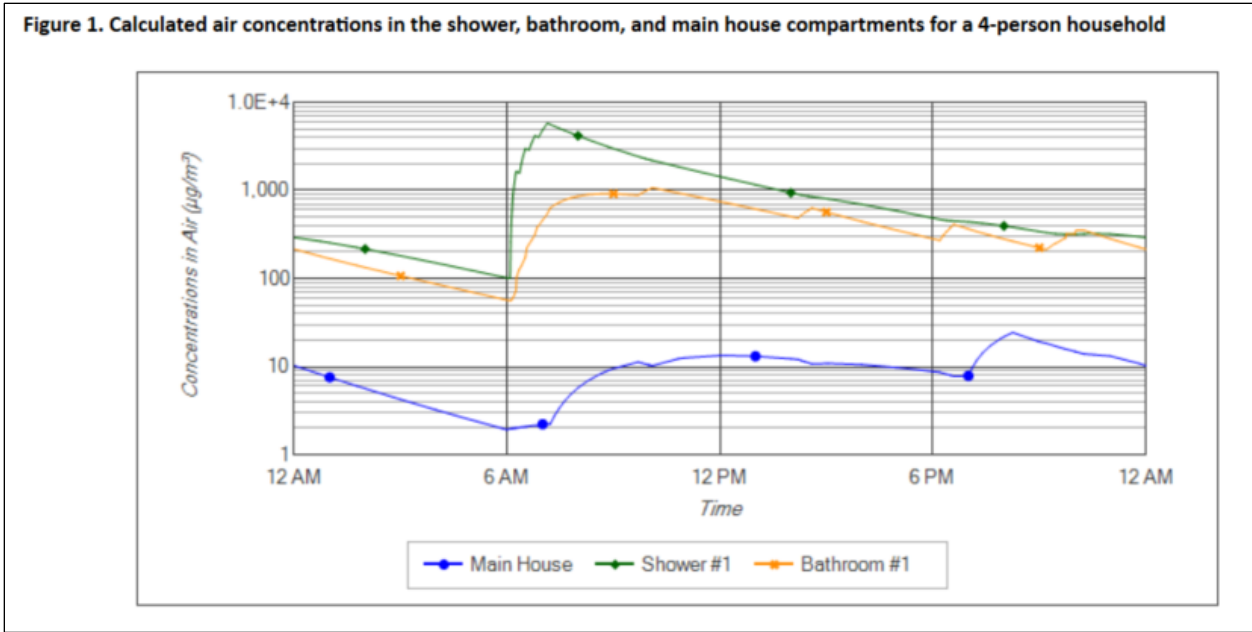


Table 4. Exposure time and percent of total exposure by location for the target person

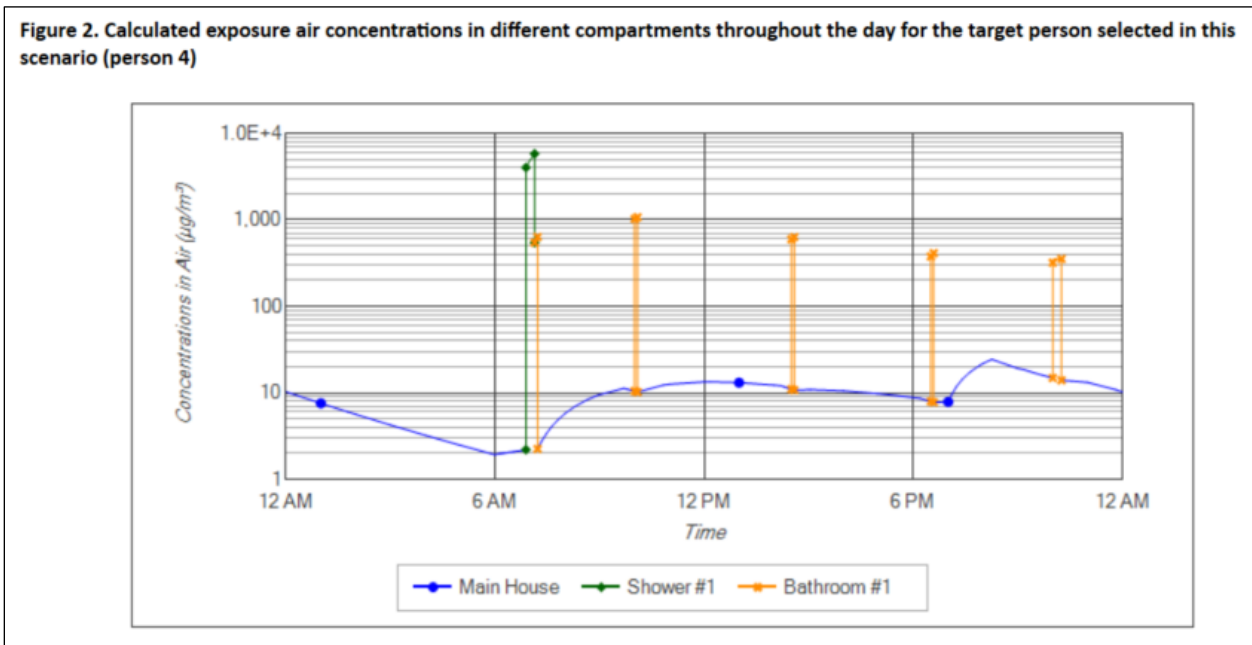
Location	Exposure Time (min)	Percent Exposure (%)
Shower	15	70
Bathroom after shower	5	2.8
Main house with additional bathroom visits	1,420	28
Away from house	0	0
Average daily exposure	1,440	100
Main house (all day)	1,440	100

Abbreviations: min = minute; % = percent

The **4-Person Household Results—Figures** section provides two figures showing chemical air concentrations within the house. Using a log scale for concentration, **Figure 1** shows the chemical air concentrations in the shower, bathroom, and main house compartments throughout the day for the default scenario.



Also using a log scale, **Figure 2** shows the contaminant air concentrations for the target person (person 4) as they move between compartments throughout the day. The contaminant air concentrations shown in **Figure 2** are used to calculate the RME daily exposure concentration and dermal doses for the target person (person 4) shown in **Tables S1** and **S2**. The contaminant air concentrations are also used to calculate the doses and location statistics for the target person shown in **Tables 2, 3, and 4**.



The **Model Parameters** section of the report identifies the parameter values that were used to run the default RME 4-person household scenario. It includes the following:

- **Table 5** presents the chemical properties.
- **Table 6** presents the mean parameters used to calculate inhalation and dermal doses for ATSDR's standard exposure groups.
- **Table 7** presents parameters related to the house layout, size, and air exchange rates.
- **Table 8** presents the appliance parameters.
- **Table 9** presents the clothes washer and dishwasher use schedule.
- **Table 10** presents the timing and duration of showers and bathroom stays for each person in the household.
- **Table 11** presents several activity parameters not covered in other tables.

4.2.2 Custom Scenarios

You can perform a custom simulation by clicking on the **Run Custom Scenario** button on the bottom navigation row of the data entry screens. Most of the tables and figures provided in the custom scenario reports are the same as those provided in the **Detailed Results for the 4-Person Household** section of the default report. However, the custom report results reflect the specific scenario you selected on the Household Scenarios screen and any custom information you entered for your scenario on other screens.

The onscreen report starts by displaying the user-entered **Site and Model Input Information**, followed by the **Scenario Description**. Parameter values in the custom scenario that differ from the default values are highlighted in red. If you select a target person that is not the most highly exposed person, you will also see a message box which provides information on the most highly exposed person in your scenario.

The **Household Results – Tables** section of the model report presents tabular result data for the custom scenario. The report contains four data tables of results. The example screenshots in this section show data for a standard 8-person, eight morning showers scenario with tetrachloroethylene at 100 µg/L in household water. The scenario also includes an additional exposure group with the parameters that follow; all other parameters were left at the standard values for the 8-person, eight morning showers scenario.

- Exposure group name: Seniors
- Total body surface area: 19,000 cm²
- Hand surface area: 980 cm²
- Body weight: 75.8 kg
- Daily breathing rate: 9.1 L/min

- Shower and bathroom breathing rate: 12 L/min

The **Household Results – Tables** data tables are as follows:

- **Table 1** provides the average daily exposure concentration for each person in the household. It also lists each person’s main activities and indicates the target person in the scenario.




Table 1. Average daily exposure concentration in $\mu\text{g}/\text{m}^3$ for each person in the house

Person	Target Person	Main Activities	Average Daily Exposure Concentration
1	—	Showering in Shower #1 at 6:22 a.m.	22
2	—	Showering in Shower #1 at 6:35 a.m.	28
3	—	Showering in Shower #1 at 6:48 a.m.	33
4	—	Showering in Shower #1 at 7:01 a.m.	38
5	—	Showering in Shower #2 at 6:32 a.m.	22
6	—	Showering in Shower #2 at 6:45 a.m.	28
7	—	Showering in Shower #2 at 6:58 a.m.	33
8	X	Showering in Shower #2 at 7:11 a.m.	38

Abbreviations: $\mu\text{g}/\text{m}^3$ = micrograms chemical per cubic meter air

- **Table 2** provides the average daily inhalation and dermal doses for the target person. The table lists a value of “NC” for any age group where a dose is not calculated. For example, when the target person takes a shower in a custom scenario, dermal doses are not calculated for the “birth to < 1 year” group because infants do not shower regularly. The inhalation dose reported for the “birth to < 1 year” group is calculated using the main house (all day) average air concentration when the target person takes a shower.




Table 2. Average daily inhalation dose in $\mu\text{g}/\text{kg}/\text{day}$ and administered dermal dose for the target person

Exposure Group	Inhalation	Dermal
Birth to < 1 year	8.7	NC
1 to < 2 years	48	1.5
2 to < 6 years	31	1.3
6 to < 11 years	18	1.1
11 to < 16 years	12	0.86
16 to < 21 years	9.1	0.79
Adult	8.1	0.78
Pregnant & breastfeeding women	12	0.78
Seniors	8.1	0.80

Abbreviations: $\mu\text{g}/\text{kg}/\text{day}$ = micrograms chemical per kilograms body weight per day; NC = not calculated

- Table 3** shows the exposure time for the target person's primary bathing activity, the time they spend in the bathroom immediately afterwards, and the time they spend in the house the rest of the day. The table also shows the average exposure concentration associated with their time in these areas. The exposure from bathing and being in the bathroom immediately afterwards can be much higher (but for shorter periods) than the exposure from being in the main house throughout the day.




Table 3. Exposure time and average human exposure concentration by location for the target person

Location	Exposure Time (min)	Average Human Exposure Concentration ($\mu\text{g}/\text{m}^3$)
Shower	7	3,394
Bathroom after shower	5	374
Main house with additional bathroom visits	1,428	21
Away from house	0	0
Average daily exposure	1,440	38
Main house (all day)	1,440	13

Abbreviations: $\mu\text{g}/\text{m}^3$ = micrograms chemical per cubic meter air; min = minute

- **Table 4** shows the percent of exposure that the target person experiences in each location.




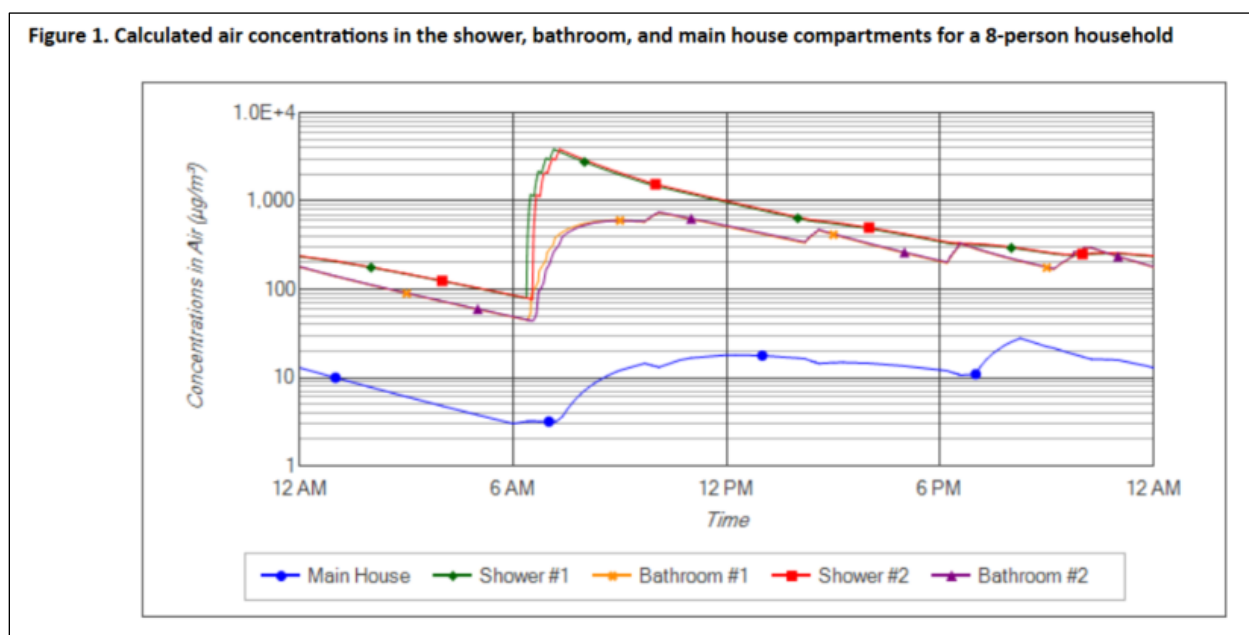
Table 4. Exposure time and percent of total exposure by location for the target person

Location	Exposure Time (min)	Percent Exposure (%)
Shower	7	43
Bathroom after shower	5	3.4
Main house with additional bathroom visits	1,428	54
Away from house	0	0
Average daily exposure	1,440	100
Main house (all day)	1,440	100

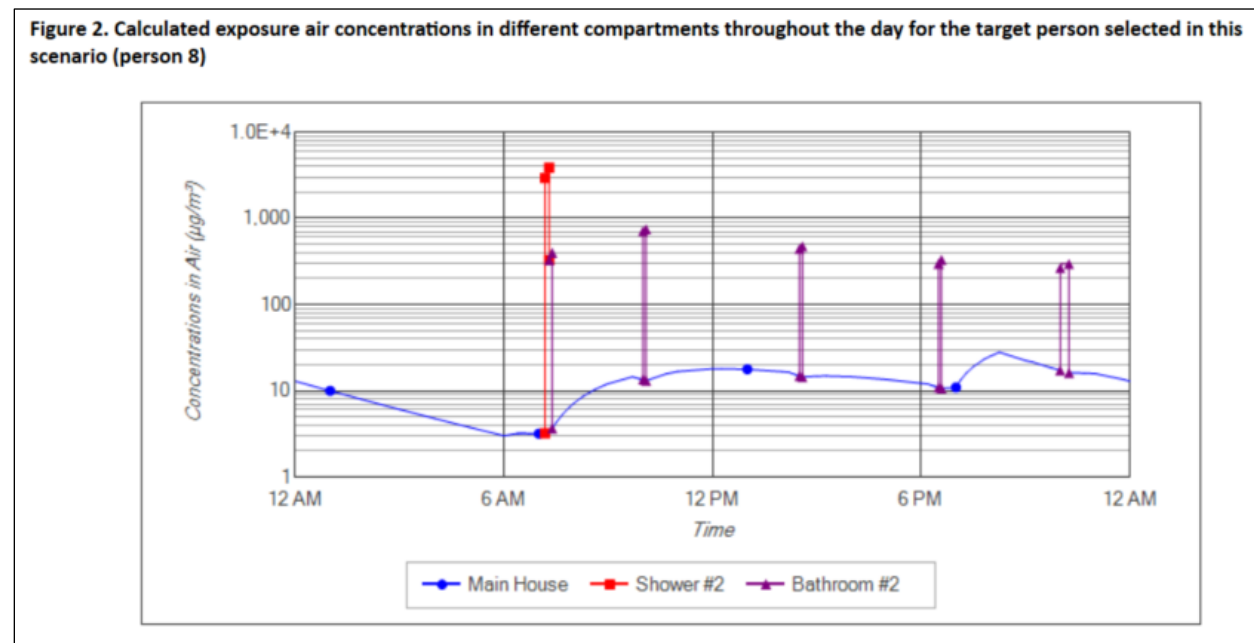
Abbreviations: min = minute; % = percent

The **Results – Figures** section contains figures showing minute-by-minute concentration data from the scenario. This section contains two figures in the custom report.

- **Figure 1** shows the chemical air concentrations in the shower, bathroom, and main house compartments throughout the day. The image below shows results for the example 8-person household scenario, which has two bathrooms and two shower compartments.



- **Figure 2** shows the chemical air concentrations that the target person is exposed to as they move between compartments throughout the day.



The **Model Parameters** section of the report identifies the parameter values that were used to run the custom scenario. It includes the following:

- **Table 5** presents the chemical properties.
- **Table 6** presents the mean parameters used to calculate inhalation and dermal doses for ATSDR's standard exposure groups and any custom exposure groups.
- **Table 7** presents parameters related to the house layout, size, and air exchange rates.
- **Table 8** presents the appliance parameters.
- **Table 9** presents the clothes washer and dishwasher use schedule.
- **Table 10** presents the timing and duration of showers and bathroom stays for each person in the household.
- **Table 11** presents several activity parameters not covered in the other tables.
- **Table 12** presents the human activity pattern for each person in the scenario. The report will include a separate sub-table (labeled a through h) for each person in the scenario if your custom scenario has more than one person.
- **Figure 3** presents a chart showing the compartment location of each person in the house throughout the day.

4.3 Communal Shower and Bathroom Scenarios

Communal shower and bathroom scenario reports include information on the distribution of average daily exposure concentrations, dermal doses, and inhalation doses calculated for all users of the facility in the Monte Carlo simulation. They also include histograms of the calculated inhalation concentrations and dermal doses, and summary statistics on facility usage parameters. For shower and locker room facilities where not all persons take a shower, the report presents results separately for those who shower and for those who do not shower. Persons who do not shower still use the facility toilets and bathroom sinks.

4.3.1 Default Scenarios

To obtain default communal shower and bathroom scenario results, on the Simulation Type screen, first select the Building Type and Facility Type. Next, under the Scenario Type heading, select the **Run Default Scenario (recommended)** option. Enter the remaining information needed on the Simulation Type and Chemical Information screens, and then click the **Run Default Scenario** button to run the simulation and bring up the default scenario results in an onscreen report.

The screenshot displays the ATSDR SHOWER Model Report interface. The title bar indicates the window is titled "ATSDR SHOWER Model - Unsaved". The main header area is blue and contains the text "ATSDR SHOWER Model Report", "Default Commercial Gym Scenario", and "200-Person Shower and Locker Room Facility". Below the header, the section "Site and Model Input Information" is displayed. This section contains a table with two columns: "Information" and "Report Setting".

Information	Report Setting
Site Information	
Site name:	Example
Address:	—
Application:	Version 4.0.0
CASRN:	56-23-5
Contaminant:	Carbon tetrachloride
Synonym:	Benzinoform Methane tetra chloride Perchloromethane, tetrachloromethane Tetrachloromethane
Model Input Information	
Chemical name:	Carbon tetrachloride
Chemical properties:	Default
Exposure routes available:	Inhalation and Dermal
Water concentration:	10 µg/L
Outdoor air concentration:	0 µg/m ³
Main building air concentration:	0 µg/m ³
Scenario type:	Default Shower and Locker Room Scenario
Building type:	Commercial Gym

At the bottom of the interface, there are five buttons: "Back", "Export Raw Data", "Export Word", "Export to PHAST", and "Save".

The example text and screenshots in this section show results for a shower and locker room in a commercial gym that has water contaminated with 10 µg/L of carbon tetrachloride. The locker room is a women's locker room and is used by about 200 women that come to the gym each day. To simulate the men's locker room, an additional simulation would be required based on the number of men that come to the gym and use the locker room each day.

In this example, the title of the onscreen report is "ATSDR SHOWER Model Report, Default Commercial Gym Scenario, 200-Person Shower and Locker Room Facility." The report starts by displaying the user-entered **Site and Model Input Information**, followed by the **Generating Hazard Quotients and Cancer Risk Estimates** section, which provides brief instructions on exporting results from the SHOWER model for analysis in PHAST. To export results, click the **Export to PHAST** button at the bottom of the Results screen.

The **Scenario Description** section provides a description of the scenario you ran and the report contents, followed by the **Quick Summary** section of the model report, which presents tabular result data for the default scenario. For shower and locker room facilities where not all facility users take showers, it contains four tables:

- **Table S1** and **Table S3** provide the CTE and RME daily exposure concentrations for persons who do and do not shower in the facility, respectively.




Table S1. CTE and RME daily exposure concentrations for persons who shower in the facility

Exposure Type	Percentile Exposure	Daily Exposure Concentration (µg/m ³)
CTE	50 th	0.027
RME	95 th	0.088

Abbreviations: CTE = central tendency exposure; µg/m³ = micrograms chemical per cubic meter air; RME = reasonable maximum exposure




Table S3. CTE and RME daily exposure concentrations for persons who do not shower in the facility

Exposure Type	Percentile Exposure	Daily Exposure Concentration (µg/m ³)
CTE	50 th	9.6E-4
RME	95 th	0.0022

Abbreviations: CTE = central tendency exposure; µg/m³ = micrograms chemical per cubic meter air; RME = reasonable maximum exposure

- **Table S2** and **Table S4** provide the CTE and RME daily administered dermal doses from contact with water for persons using the facility. The standard exposure groups included in the table depend on the selected building type. Table S2 provides results for persons who shower, and Table S4 provides results for persons who do not shower.




Table S2. CTE and RME daily administered dermal dose for persons who shower in the facility

Exposure Group	CTE Dermal Dose (µg/kg/day)	RME Dermal Dose (µg/kg/day)
Birth to < 1 year	0.052	0.085
1 to < 2 years	0.048	0.077
2 to < 6 years	0.042	0.069
6 to < 11 years	0.035	0.056
11 to < 16 years	0.029	0.046
16 to < 21 years	0.026	0.043
Adult	0.025	0.041
Pregnant & breastfeeding women	0.025	0.041

Abbreviations: CTE = central tendency exposure; µg/kg/day = micrograms chemical per kilograms body weight per day; RME = reasonable maximum exposure




Table S4. CTE and RME daily administered dermal dose for persons who do not shower in the facility

Exposure Group	CTE Dermal Dose (µg/kg/day)	RME Dermal Dose (µg/kg/day)
Birth to < 1 year	8.2E-4	0.0016
1 to < 2 years	8.0E-4	0.0015
2 to < 6 years	6.1E-4	0.0012
6 to < 11 years	4.9E-4	9.4E-4
11 to < 16 years	3.8E-4	7.4E-4
16 to < 21 years	3.5E-4	6.8E-4
Adult	3.7E-4	7.2E-4
Pregnant & breastfeeding women	3.7E-4	7.2E-4

Abbreviations: CTE = central tendency exposure; µg/kg/day = micrograms chemical per kilograms body weight per day; RME = reasonable maximum exposure

In bathroom facilities without showers and in facilities where 100% of facility users take showers, the **Quick Summary** section only includes two tables. **Table S1** provides CTE and RME inhalation exposure concentrations for all facility users, and **Table S2** provides CTE and RME daily administered dermal doses for all facility users.

The **Supplemental Information** section of the model report presents additional supporting information for the scenario. This includes additional summary statistics for the Monte Carlo simulation, histograms of the simulation results, and multiple tables showing the input parameters used in the scenario.

Tip: In the example screenshots below, Tables 1, 2, and 3 from the model reports are subdivided into “a” and “b” tables. The “a” tables present results for persons who take showers in the facility, and the “b” tables present results for persons who do not take showers in the facility. For example, Table 1a gives simulation summary statistics for persons who shower, and Table 1b gives summary statistics for persons who do not shower. Figures 1 and 2 in the reports are similarly subdivided into “a” and “b” figures that present results separately for persons who do and do not shower. For shower and locker room facilities where not all facility users take showers, report Tables 1–3 and Figures 1–2 will always be subdivided into “a” and “b” tables that present results separately for persons who do and do not shower in the facility.

- **Table 1** in the **Monte Carlo Simulation Summary Statistics** section shows summary statistics about the randomly generated facility usage patterns for the scenario. The statistics summarize the data for each parameter for all users of the facility across all Monte Carlo iterations.




Table 1a. Facility usage summary statistics for persons who shower in the facility

Parameter	Mean	50 th percentile	95 th percentile
Shower duration	7.9 min	6.6 min	18 min
Time in shower and locker room	24 min	23 min	34 min
Time using bathroom sink	0.62 min	0.46 min	1.7 min
Time in building	2.3 hr	1.9 hr	5.6 hr

Abbreviations: hr = hours; min = minute


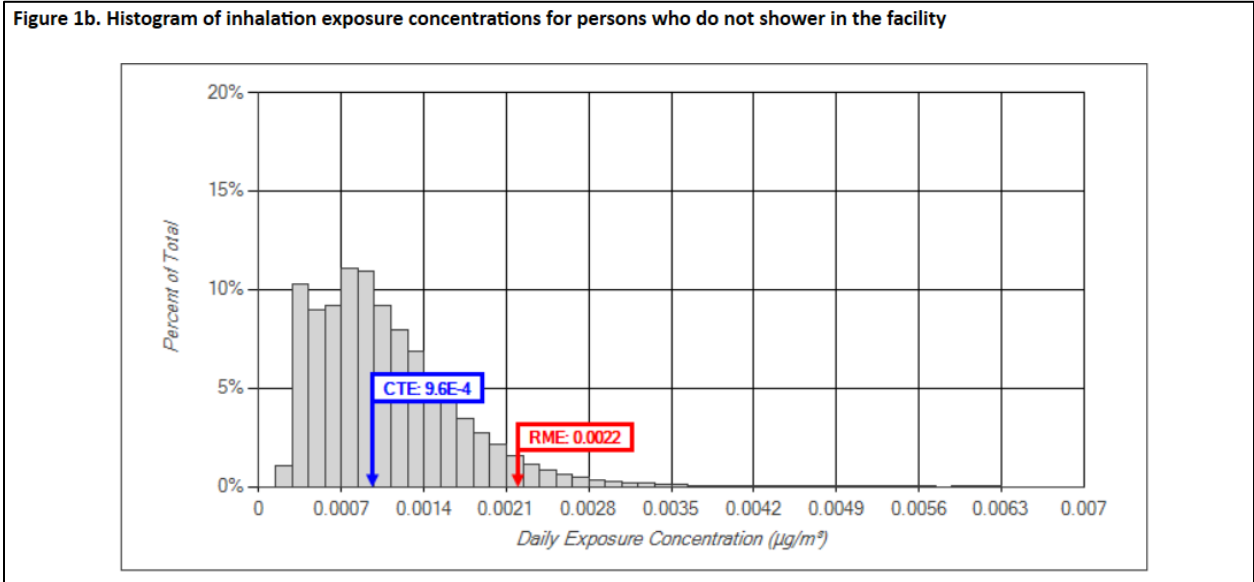
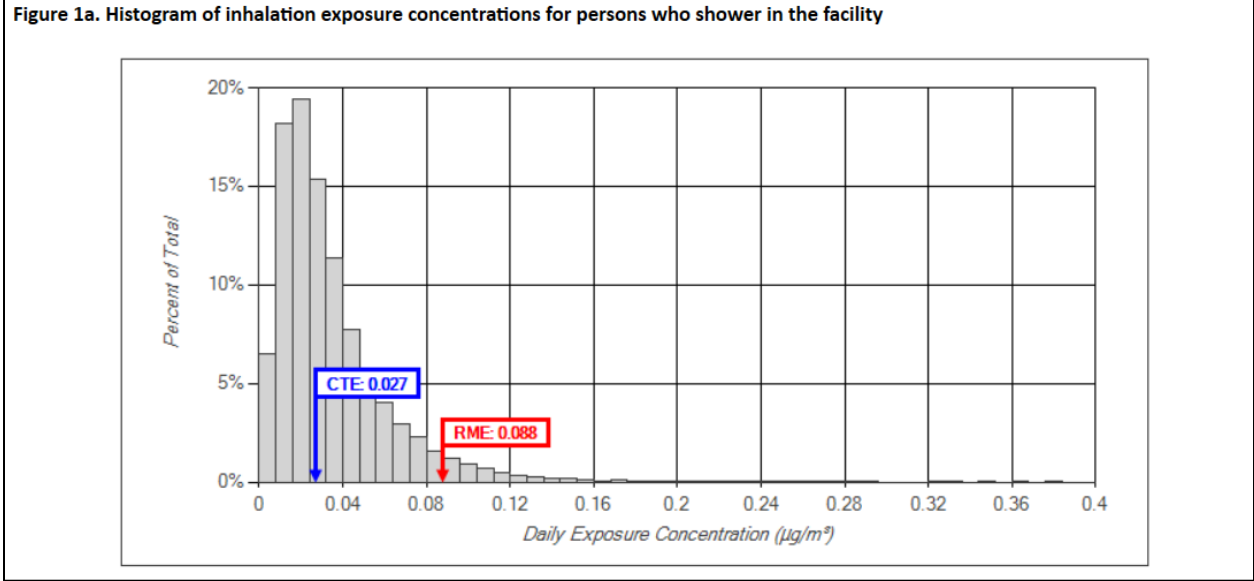


Table 1b. Facility usage summary statistics for persons who do not shower in the facility

Parameter	Mean	50 th percentile	95 th percentile
Time in locker room	5.2 min	5.0 min	7.0 min
Time using bathroom sink	0.59 min	0.45 min	1.6 min
Time in building	2.2 hr	1.8 hr	5.3 hr

Abbreviations: hr = hours; min = minute

- **Figure 1** in the **Scenario Results – Figures** section shows a histogram of the inhalation daily exposure concentrations for all persons simulated in all the Monte Carlo iterations for the scenario. The figure also includes flags showing the CTE and RME daily exposure concentrations for persons using the facility.



- Figure 2** shows a histogram of the highest administered daily dermal doses from any exposure group for all persons simulated in all the Monte Carlo iterations for the scenario. The figure also shows the CTE and RME highest administered daily dermal doses for persons using the facility.

Figure 2a. Histogram of administered dermal doses for persons who shower in the facility

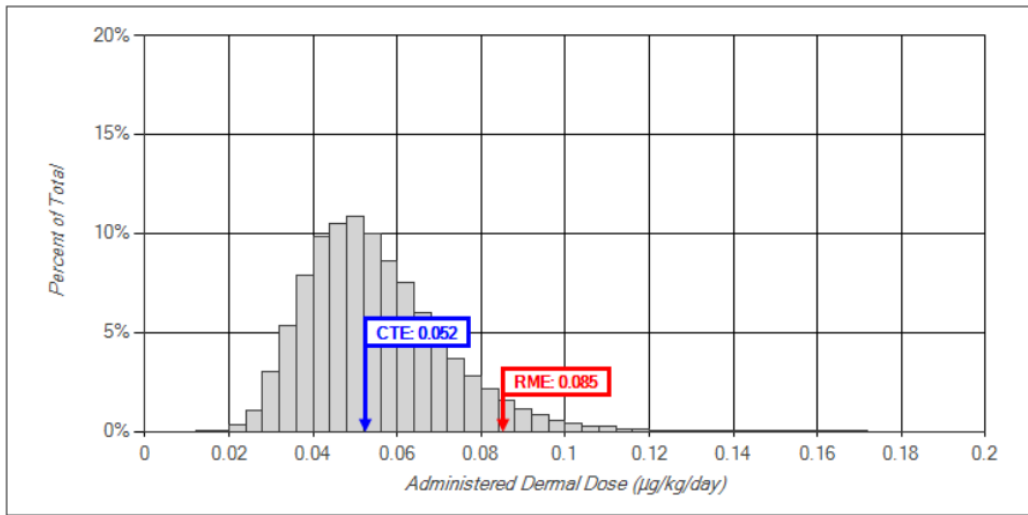
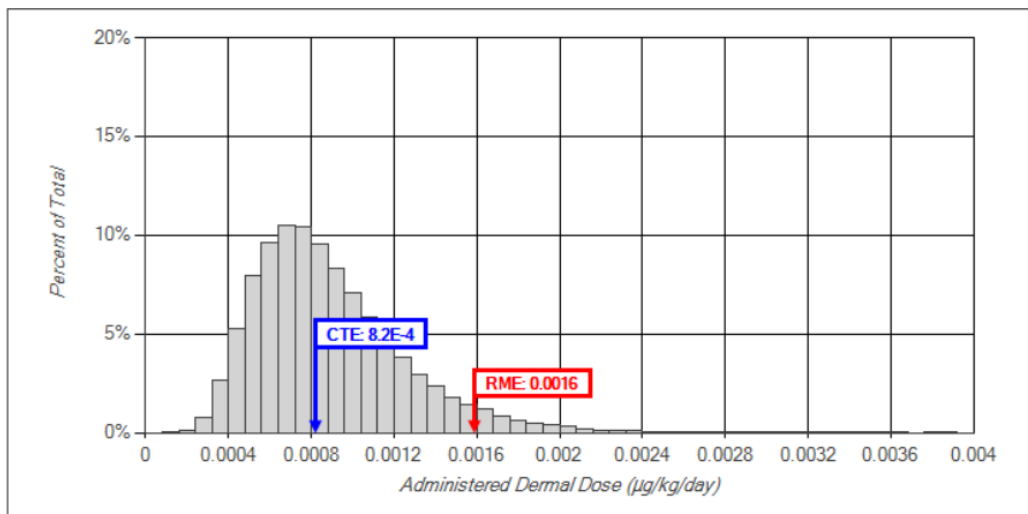


Figure 2b. Histogram of administered dermal doses for persons who do not shower in the facility



The **Scenario Results – Inhalation Concentration and Dose Tables** section provides statistics on exposures in specific locations.

- **Table 2** identifies the 50th and 95th percentile exposure time and time-weighted average exposure concentration for each location simulated in the scenario.




Table 2a. 50th and 95th percentile exposure time and time-weighted average exposure concentration by location for persons who shower in the facility

Location	50 th Percentile Exposure Time (min)	50 th Percentile Time-weighted Average Exposure Concentration (µg/m ³)	95 th Percentile Exposure Time (min)	95 th Percentile Time-weighted Average Exposure Concentration (µg/m ³)
Shower area	7.0	5.0	18.0	9.4
Locker room	15.0	0.21	19.0	0.41
Main building	90.0	0	312.0	0

Abbreviations: µg/m³ = micrograms chemical per cubic meter air; min = minute




Table 2b. 50th and 95th percentile exposure time and time-weighted average exposure concentration by location for persons who do not shower in the facility

Location	50 th Percentile Exposure Time (min)	50 th Percentile Time-weighted Average Exposure Concentration (µg/m ³)	95 th Percentile Exposure Time (min)	95 th Percentile Time-weighted Average Exposure Concentration (µg/m ³)
Locker room	5.0	0.28	7.0	0.59
Main building	110.0	0	321.0	0

Abbreviations: µg/m³ = micrograms chemical per cubic meter air; min = minute

- Table 3** shows the CTE and RME daily inhalation doses for the exposure groups included in the scenario. The inhalation doses are derived from age-specific breathing rates and the average daily exposure concentrations calculated for each person in each Monte Carlo iteration.




Table 3a. CTE and RME daily inhalation doses for persons who shower in the facility

Exposure Group	CTE Inhalation Dose (µg/kg/day)	RME Inhalation Dose (µg/kg/day)
Birth to < 1 year	0.038	0.12
1 to < 2 years	0.041	0.13
2 to < 6 years	0.025	0.082
6 to < 11 years	0.013	0.044
11 to < 16 years	0.0089	0.029
16 to < 21 years	0.0065	0.021
Adult	0.0060	0.019
Pregnant & breastfeeding women	0.0082	0.027

Abbreviations: CTE = central tendency exposure; µg/kg/day = micrograms chemical per kilograms body weight per day; RME = reasonable maximum exposure




Table 3b. CTE and RME daily inhalation doses for persons who do not shower in the facility

Exposure Group	CTE Inhalation Dose (µg/kg/day)	RME Inhalation Dose (µg/kg/day)
Birth to < 1 year	0.0013	0.0031
1 to < 2 years	0.0015	0.0033
2 to < 6 years	8.9E-4	0.0020
6 to < 11 years	4.8E-4	0.0011
11 to < 16 years	3.2E-4	7.2E-4
16 to < 21 years	2.3E-4	5.3E-4
Adult	2.1E-4	4.9E-4
Pregnant & breastfeeding women	2.9E-4	6.7E-4

Abbreviations: CTE = central tendency exposure; µg/kg/day = micrograms chemical per kilograms body weight per day; RME = reasonable maximum exposure

The **Model Parameters** section of the model report identifies the parameter values that were used to run the default scenario. It includes the following:

- **Table 4** presents the chemical properties.
- **Table 5** presents the mean parameters used to calculate inhalation and dermal doses for the exposure groups included in the scenario.
- **Table 6** presents parameters related to the number of appliances, the size of the facility, and air exchange rates.
- **Table 7** presents the appliance parameters.
- **Table 8** presents the daily facility usage parameters.
- **Table 9** presents the activity duration distribution parameters.

4.3.2 Custom Scenarios

You can perform a custom simulation by selecting **Run Custom Scenario (optional)** on the Simulation Type screen. After entering data for the remaining fields on the Simulation Type and Chemical Information screens, proceed to the Usage Parameters, Facility Information, Appliance Parameters, and Activity Durations screens to customize the parameters in your scenario. At any point after entering data on the Chemical Information screen, you can click the **Run Custom Scenario** button to run your custom simulation.

Unlike for residential scenario reports, which included different tables in default and custom scenarios, the communal shower and bathroom default and custom scenario reports contain the same sections, tables, and figures. As with the default scenario report, the onscreen custom scenario report starts by displaying the user-entered **Site and Model Input Information**,

followed by the **Generating Hazard Quotients and Cancer Risk Estimates** section which describes how to export air concentrations and dermal doses from the SHOWER model for analysis within PHAST. To export SHOWER model scenario results, click the **Export to PHAST** button at the bottom of the Results screen.

The **Scenario Description** section provides a summary of the scenario you ran and the report contents, and the **Quick Summary** section of the model report presents tabular result data for the custom scenario. It includes the same primary result tables as those in the default report.

The **Supplemental Information** section of the model report presents additional supporting information pertaining to the scenario. This includes additional summary statistics for the Monte Carlo simulation, histograms of the simulation results, and multiple tables showing the scenario input parameters. These tables and figures present the same information as the tables and figures in the **Supplemental Information** section of the default scenario report.

For more information about the tables and figures in custom scenario reports, see Section 4.3.1.

5 References

- [ATSDR] Agency for Toxic Substances and Disease Registry. 2023. Online public health assessment guidance manual (PHAGM). Atlanta, GA: US Department of Health and Human Services, Public Health Service. URL: <https://www.atsdr.cdc.gov/pha-guidance/index.html>.
- [ATSDR] Agency for Toxic Substances and Disease Registry. 2024a. Guidance for evaluating inhalation and dermal exposure using the Shower and Household Water-use Exposure (SHOWER) model v4.0. Atlanta, GA: US Department of Health and Human Services, Public Health Service.
- [ATSDR] Agency for Toxic Substances and Disease Registry. 2024b. Technical document for the Shower and Household Water-use Exposure (SHOWER) model v4.0. Atlanta, GA: US Department of Health and Human Services, Public Health Service.
- [USEPA] US Environmental Protection Agency. 2011. Exposure factors handbook: 2011 edition (final report). EPA/600/R-09/052F. Washington, DC: National Center for Environmental Assessment. URL: <https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252&CFID=78075623&CFTOKEN=15158830>.