

Atmospheric Transport and Dispersion User Manual

Version 2.0

A SIERRA Module

September 2026



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Atmospheric Transport and Dispersion User Manual

Revision History

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Introduction

1.0 Introduction

This manual provides instructions for installing, configuring, using, executing, and interpreting results from SIERRA ATD. It is intended to support consistent, correct, and traceable use of the software in regulatory, licensing-related safety and environmental analysis applications, and research.

SIERRA ATD consists of modules to perform assessments for three scenarios:

- Routine Release (RR) - For the meteorological evaluation of continuous or anticipated intermittent routine radiological effluent releases using a Gaussian dispersion model with hourly meteorological data to compute relative concentration (χ/Q) and relative deposition (D/Q) values at multiple discrete distances, distance segments, and directions in accordance with Regulatory Guide (RG) 1.111 [11.4].
- Design Basis Accidents (DBA) - For evaluating onsite radiological releases impacting offsite receptor locations (e.g., site boundaries) following a design-basis accident using a Gaussian plume model to estimate downwind χ/Q s at the exclusion area boundary (EAB) and outer boundary of the low-population zone (LPZ) in accordance with RG 1.145 [11.5] or RG 1.249 [11.7].
- Control Room (CR) - For evaluating DBA onsite radiological releases used as input to control-room radiological habitability assessments based on impacts at control room normal and emergency air intakes by applying a building-wake-sensitive dispersion model that computes accident-related χ/Q values using hourly meteorological data, consistent with RG 1.194 [11.6].

The output from all three modules answer the same basic question: for each unit of radioactive material released to the air, how much of that activity is in the air or deposited on the ground at designated or receptors of interest? For air, this is the relative concentration, χ/Q , in seconds per cubic meter (s/m^3). Multiplying χ/Q by the release rate Q (in units of Curies per second (Ci/s)) gives the airborne concentration at the receptor (Ci/m^3). For the ground (provided by the Routine Release module), this is the relative deposition, D/Q , in inverse square meters ($1/m^2$). Multiplying D/Q by the release rate gives the deposition rate per unit ground area ($Ci/(m^2s)$). Because both quantities are normalized by the release rate, they depend only on the site meteorology, the release configuration, and the receptor location.

Section 2.0 provides definitions of terms and acronyms used throughout this manual. Sections 3.0 through 4.0 cover software quality assurance, installation,

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and troubleshooting. Section 5.0 describes the start-up window used to create, load, save, and export scenarios. Section 6.0 describes the program wide settings and installation tests. Sections 7.0, 8.0, and 9.0 describe the Routine Release, Design Basis Accident, and Control Room modules, respectively, with one subsection per input panel defining every input followed by the output descriptions. Section 10.0 describes the meteorological data file viewer shared amongst all modules and the expected data file format.

The following sources of information supplement the ATD User Manual:

- **Technical Manual** - The equations, model derivations, and the implementation details of the methods are documented in the ATD Technical Manual [11.3]. The user manual cross-references those sections rather than repeating them.
- **Regulatory Guidance** - The user manual tells a user how to run the code and what the inputs mean. It does not direct an applicant on how to structure a licensing analysis, which meteorological data to use, or how the staff will review the results. Where a regulatory basis exists for a default or a recommendation it is cited, and where ATD knowingly differs from guidance that difference is stated, but the manual stops short of and is not intended to prescribe an analysis approach.
- **Legacy Codes** - The user manual describes ATD, not XOQDOQ, PAVAN, or ARCON96 as standalone programs. Behaviors carried forward from the previous versions are described as ATD behaves today, without commentary on the legacy history, and consistency with the legacy codes is not asserted where it has not been demonstrated.
- **Secondary References** – References are limited to the primary references that ATD implements (e.g., RGs, NUREGs, and ATD manuals). Documents that are the technical basis for those references are not added; the user can reach them through the primary references.

The structure above is intended to avoid repeating information, creating inconsistent information, and to avoid information that is discussed from becoming 'stale' due to reference updates.

1.1. Relationship to the NRC Legacy Codes

Each module is a modern re-implementation of a legacy code (Table 1-1) and each accepts the same kinds of inputs and produces the same regulatory output or statistics as its predecessor. This table identifies the primary guidance document that supports the basis of the software as well as identifies the legacy

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manuals to provide additional historical context as needed for the user. The governing dispersion models, equations, and verification basis are documented in the SIERRA ATD Technical Manual, RCD-26-058 [11.3]. This user manual focuses on operating the software and on how each user input is used by the calculation engine.

Table 1-1. ATD module relation to legacy codes.

Module	Primary guidance	Legacy Manuals
Routine Release (Section 7.0)	RG 1.111 [11.4]	XOQDOQ (NUREG/CR-2919 [11.9])
Design Basis Accident (Section 8.0)	RG 1.145 [11.5]	PAVAN (NUREG/CR-2858 [11.10])
Control Room (Section 9.0)	RG 1.194 [11.6] (onsite) RG 1.249 [11.7] (offsite DBA)	ARCON (NUREG/CR-6331 [11.11])

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1.2. Typical Analysis Workflow

A typical analysis proceeds the same way in every module, as shown in Figure 1-1. Select the analysis type from the drop-down in the sidebar; work through the input panels (Release, then the module-specific Receptors and/or Terrain panels); load a meteorological data file on the Meteorology panel; press Run and review any alerts raised in the Message Center; and read the results on the Results panel or in the raw engine output files. A scenario can be saved at any time and reloaded later (Section 5.0).

SIERRA ATD Analysis Workflow



Figure 1-1. Typical SIERRA ATD analysis workflow.

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Introduction

1.3. The User Interface

The sidebar on the left of the main ATD window selects the Analysis Type:

- Control Room,
- Routine Release, or
- Design Basis Accident.

When an analysis type is selected the window switches to illustrate the various input panels: Release, Receptors and/or Terrain, Meteorology, and Results. Inputs can be entered in any order between or on panels. Switching the analysis type re-initializes the variable set for that module. As a result, save the current scenario first if you want to keep it. The Run button at the lower right starts the calculation engine; the alert icon next to it opens the Message Center, which collects input-validation messages.

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Introduction

1.4. Conventions and How to Read the Variable Input Tables

The internal calculational engine is based in SI units but the user, through the interface, can input either English or SI units through a dropdown selection box for each input field. The user interface handles the unit conversion to pass the input file in SI units to the calculation engine. Fields that do not apply to the selected release type are disabled (shown but grayed and un-editable) and hidden (not shown at all).

Each input variable in Sections 7.0 through 9.0 is described by a table with the following elements:

- **Description** states what the variable is, physically, and what role it plays in the model.
- **User Input Unit(s)** are the allowed units the user can select through the use of the user interface.
- **Engine Unit** is the engine (SI) unit that is expected for the physics modules. If using the user interface, automatic conversions to the necessary engine units are performed, but if using command line inputs then the raw engine units must be used.
- **Default Value** is the interface pre-fills placeholder value; the user should always fill placeholders with site-specific values.
- **Valid Range** is the accepted entry range.
- **Recommendations** gives guidance on choosing a value, including the regulatory basis where one exists.
- **Notes / Caveats** explains how the value propagates through the calculation (i.e., which direction it pushes the answer) plus any limitations of the current build.

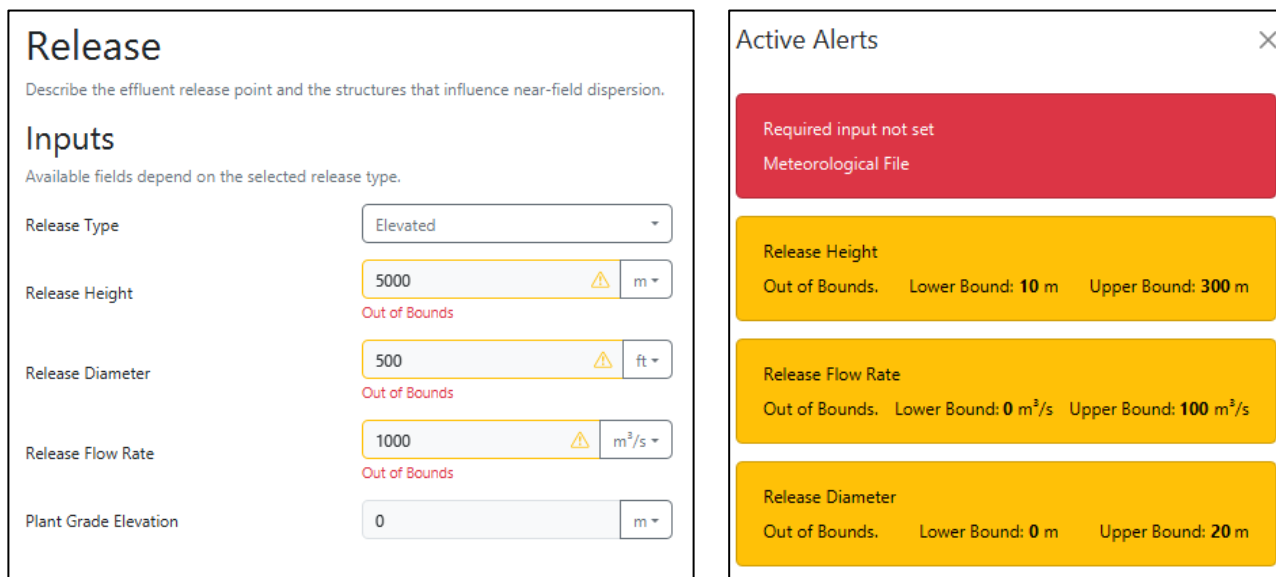
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1.5. Troubleshooting

SIERRA ATD reports problems through two methods:

- Input-validation messages are raised by the application as values are entered: a field that rejects a value is outlined and a message is posted to the Alerts Center (opened with the alert button next to Run) as shown in Figure 1-2.
- Calculation messages are produced by the physics engine during a run and are written to the ERR output file, which can be opened from the Results panel.

A run that completes without issue contains only the header line. If a run fails or produces unexpected results, review the ERR file first, then confirm the meteorological data file matches the expected format (Section 10.1) and that all inputs required by the selected release type are populated.



The figure displays two side-by-side panels from the SIERRA ATD software interface.

Release Panel (Left): This panel is titled "Release" and includes a description: "Describe the effluent release point and the structures that influence near-field dispersion." Below this is the "Inputs" section, which states "Available fields depend on the selected release type." The "Release Type" is set to "Elevated". The following inputs are shown with their values and units, each accompanied by a yellow warning triangle icon and the text "Out of Bounds":

- Release Height: 5000 m
- Release Diameter: 500 ft
- Release Flow Rate: 1000 m³/s
- Plant Grade Elevation: 0 m

Active Alerts Panel (Right): This panel is titled "Active Alerts" and contains three alert messages:

- A red alert box at the top: "Required input not set Meteorological File".
- A yellow alert box: "Release Height Out of Bounds. Lower Bound: 10 m Upper Bound: 300 m".
- A yellow alert box: "Release Flow Rate Out of Bounds. Lower Bound: 0 m³/s Upper Bound: 100 m³/s".
- A yellow alert box: "Release Diameter Out of Bounds. Lower Bound: 0 m Upper Bound: 20 m".

Figure 1-2. Example Alerts Center providing the user Warnings and Error messages.

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1.6. Requesting Help, Reporting Errors, or Requesting Changes

To request help, report a suspected error, or request a change, visit the project's repository maintained in GitLab and submit an issue:

<https://gitlab.com/RCD-1/SIERRA/ATD/-/wikis/home>

Viewing these pages does not require an account. To submit issues or join discussions, you need to create a free GitLab account.

As an alternative, an email may be sent to ramp.resource@nrc.gov. For either method, include the software version, the saved scenario file, the meteorological data file, the ERR and OUT files from the run, and a description of the expected versus observed behavior.

Atmospheric Transport and Dispersion User Manual
Definitions and Acronyms

2.0 Definitions and Acronyms

Term / Acronym	Definition
$\Delta T/\Delta z$	Vertical temperature gradient used to determine atmospheric stability class.
χ/Q	Atmospheric relative concentration normalized by emission rate.
ϕ (Phi)	Ratio of vertical vent velocity to adjusted wind speed used to determine vent/mixed-mode release fractions.
σ_y	Lateral plume spread coefficient.
σ_z	Vertical plume spread coefficient.
ATD	Atmospheric Transport and Dispersion module within the SIERRA software package.
Briggs Models	Empirical rural/urban dispersion parameterizations used in Gaussian plume models.
Calm Wind	Condition where wind speed falls below the user-specified wind speed calm threshold value, triggering special treatment for that hour of data. See specific input sections on treatment.
CL (Centerline)	Dispersion results along the plume's centerline ($y = 0$), typically used for short averaging times.
CFD (Cumulative Frequency Distribution)	Distribution pairing each χ/Q level with the percent of time it is equaled or exceeded in a given period of record; the basis for the percentile results of the DBA and Control Room modules.
CR (Control Room)	ATD module for estimating χ/Q inputs to control room radiological habitability assessments using near-field, wake-sensitive dispersion methods per RG 1.194.
D/Q	Deposition rate per unit area normalized by release rate.
DBA (Design Basis Accident)	ATD module for evaluating accident-related χ/Q values at the EAB and LPZ per RG 1.145 and RG 1.249.

Atmospheric Transport and Dispersion User Manual
Definitions and Acronyms

Term / Acronym	Definition
DEC	Radioactive decay correction factor applied to plume concentration for routine releases.
DEPL	Fraction of plume remaining after dry deposition depletion during transport of routine releases.
EAB (Exclusion Area Boundary)	Minimum direction sector-specific distance around a reactor where an individual must not exceed regulatory dose limits during the first 2 hours of a DBA.
Fumigation	Short-lived condition in which an elevated plume is mixed down to the ground as a stable layer breaks up; applied automatically to elevated DBA releases.
Gaussian Plume Model	A dispersion model assuming pollutant concentration spreads with a Gaussian distribution horizontally (σ_y) and vertically (σ_z).
h_e	Effective release height of the plume; accounts for physical stack height, plume rise, terrain correction, and downwash adjustments.
JFD (Joint Frequency Distribution)	Distribution of meteorological data by stability class, wind speed, and wind direction. [11.3 Section 10.1]
LPZ (Low Population Zone)	Direction sector-specific region typically surrounding the EAB where an individual must not exceed regulatory dose limits during the entire plume passage.
P-G (Pasquill–Gifford) Curves	Empirical dispersion curves for σ_y and σ_z versus distance and stability class.
Pasquill Stability Class (A–G)	Atmospheric stability categories describing turbulence/mixing levels as defined by NRC RG 1.23 (A = extremely unstable, G = extremely stable).
RF (Recirculation Factor)	Correction factor accounting for open-terrain recirculation effects.
RG	Regulatory Guide.
RR (Routine Release)	ATD module used to evaluate long-term, continuous, or intermittent routine effluent releases

Atmospheric Transport and Dispersion User Manual
Definitions and Acronyms

Term / Acronym	Definition
	using Gaussian dispersion per RG 1.111 and hourly meteorological data.
SA (Sector-Averaged)	Averaged dispersion result across a 22.5° directional sector (one of 16 sectors centered on north, north-northeast, northeast, etc.).
SIERRA	Software Integration for Environmental Radiological Release Assessments; the broader software suite containing ATD.
Slant Range	The shortest line-of-sight distance from the release point to the control room intake, based on the differences in elevation and the horizontal intervening distance.
Stack-Tip Downwash	Reduction of the effective release height behind a stack when the exit velocity (w_0) is low relative to the wind speed (U) at the release height; ($w_0 < 1.5U$). This is applied in the Control Room module.
w_0	Stack or vent exit velocity used for plume rise and release mode classification.
z_0 (Surface Roughness Length)	Length scale describing the texture of the upwind surface; used by the Control Room module in the Monin-Obukhov wind profile (see Section 9.3.4).
ARCON	Atmospheric Relative Concentrations in building wakes; the legacy NRC control room dispersion code (NUREG/CR-6331) re-implemented by the Control Room module.
CFR	Code of Federal Regulations
ERR	Engine error/warning output file; lists messages issued during a run.
GDC	General Design Criteria for Nuclear Power Plants (Appendix A to 10 CFR Part 50).
NRC	U.S. Nuclear Regulatory Commission.
NUREG	NRC technical report series (e.g., NUREG/CR contractor reports).
OUT	Main engine output file; the full tabulated summary of a run.

Atmospheric Transport and Dispersion User Manual
Definitions and Acronyms

Term / Acronym	Definition
PAVAN	Legacy NRC design-basis-accident dispersion code (NUREG/CR-2858) re-implemented by the DBA module.
PLT	Hourly (plot) engine output file; lists the hour-by-hour intermediate values.
SI	International System of Units; the unit system used internally by the calculation engine.
XOQDOQ	Legacy NRC routine-release dispersion code (NUREG/CR-2919) re-implemented by the Routine Release module.

Atmospheric Transport and Dispersion User Manual
Software Quality Assurance

3.0 Software Quality Assurance

SIERRA ATD is developed and maintained following the guidance of NUREG/BR-0167 [11.1] as implemented in RCD's software quality assurance program [11.2]. Development is configuration-controlled, changes are peer reviewed, and every build runs an automated test suite.

Verification is performed at three levels. Automated functional tests exercise the application services and interfaces against expected behavior. Requirements traceability tests map each software requirement to one or more passing tests, and the requirements matrix is updated with each build. Finally, results are benchmarked between release versions using regression tests.

The installed application exposes the functional and requirements test suites directly to the user in the interface (Settings, Tests) (see Section 4.2 (Step 8) and Section 6.0). After installing or updating the software, the user should run both suites and retain the reported results as an installation verification record.

Atmospheric Transport and Dispersion User Manual Installation

4.0 Installation

4.1. Installation Requirements

The following are required to install and run SIERRA ATD:

- Microsoft Windows 10 or 11 (64-bit).
- 600 MB of free disk space, plus space for meteorological data files and saved scenarios.
- A display of at least 800 x 600 pixels; tested with resolutions up to 1920 x 1080 pixels with magnification between 100% - 175%.
- No separately installed Java runtime or Fortran libraries are required; the application bundles its runtime and the calculation engine.
- No network connection required. The application runs entirely on the local machine; its user interface is served over a local loopback port chosen automatically at startup.

4.2. Installation Procedure

SIERRA ATD is distributed by the NRC as a standalone installation package or as part of the SIERRA installation package.

To install:

1. Obtain the SIERRA installation package or the stand-alone ATD installation executable. This is typically obtained from logging into the Radiation Protection Computer Code Analysis and Maintenance Program (RAMP) website with your user credentials allowing access to download the installer from the RAMP website. For questions about obtaining access to the installation package see Section 1.6.
2. Run the provided installer and follow its prompts. It is likely that Microsoft Defender (commonly called Windows Defender) will display the prompt below due to it not recognizing the application. Click "More info". Click the "Run anyway" button and follow the installation steps on the screen.

Atmospheric Transport and Dispersion User Manual Installation

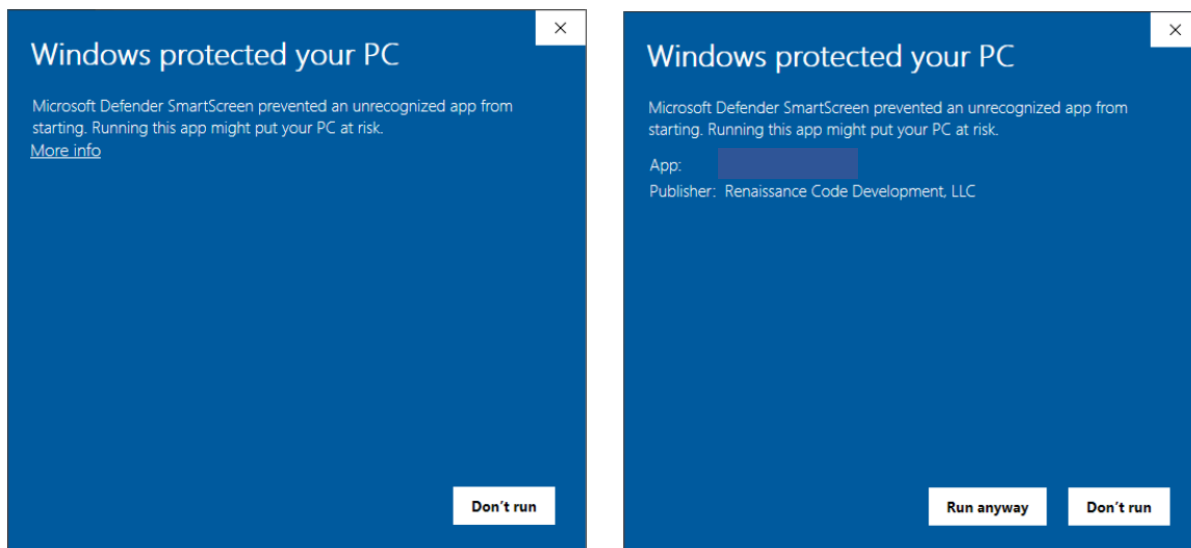


Figure 4-1. Microsoft Defender notice on install.

3. Continue to follow the installation prompts to identify your preferred install location. It is recommended to install the program in the user Local directory where the user does not require administrative privileges:
4. C:\Users\<user-name>\AppData\Local
5. Start the application.
6. Verify the installation, open About to confirm the version.
7. Verify the installation functions as expected by opening Settings, Tests and run both test suites. All tests should pass before the installation is used for analysis work.

To remove the software, use the Add or remove programs control within Windows Settings.

4.3. Sample Cases

A sample case with inputs and outputs for each module and release type is available at the installation directory of the software in the folder named samples. Each scenario can be loaded by adding the sample directory as Working Directory (Section 5.1).

Atmospheric Transport and Dispersion User Manual
Creating, Importing, Saving, and Exporting Scenarios

5.0 Creating, Importing, Saving, and Exporting Scenarios

The start-up splash screen (Figure 5-1) is displayed each time SIERRA ATD is opened and can be reopened at any time from the main window by clicking the New | Load button in the sidebar. The splash screen is organized in two sections by the Working Directory and a Scenario selection (Figure 5-1). The user can set any location on their local machine as the working directory. Working directories from past sessions are stored and displayed for selection upon reopening ATD as well as any scenarios in that directory. By default, the working directory for ATD is set to a user writeable location:

C:\Users\<username>\.rcd\atd\<ATD-version>

The Directory and Scenario fields at the lower right of the splash screen reflect the currently selected Directory and Scenario. The Load button becomes available only when both a working directory and a scenario are selected, and a message area beside these fields briefly confirms the status of each action taken in the splash screen (for example, “Created Scenario RR-2026”). The Working Directory panel is described in Section 5.1 and the Scenario panel in Section 5.2; saving and exporting from the main window are described in Section 5.3, and the files written to disk in Section 5.4.

With a working directory defined and selected, the scenarios within that directory can be managed. The following operations can be performed:

- Create a new scenario – Create establishes an empty scenario with the entered name in the selected working directory. The new scenario opens in the Control Room module with the default input values.
- Open an existing scenario – selecting a scenario in the list and clicking Load opens it in the main window in the module (Routine Release, Design Basis Accident, or Control Room) in which it was saved.
- Import Scenario: Input File (.json) – this creates a new scenario from an input file exported using the ATD user interface. In addition, it can import input files that were previously generated to be loaded by Fortran through command line execution. See Section 5.2.
- Import Scenario: Package (.zip) – this imports an existing scenario from a packaged (zip file) scenario created with ATD (available since ATD version 2.0). The packaging of a scenario allows for the quick sharing of an analysis. The zip package includes the input file, meteorological data file, and outputs. Creating a package is described in Section 5.3 and loading one in Section 5.2.

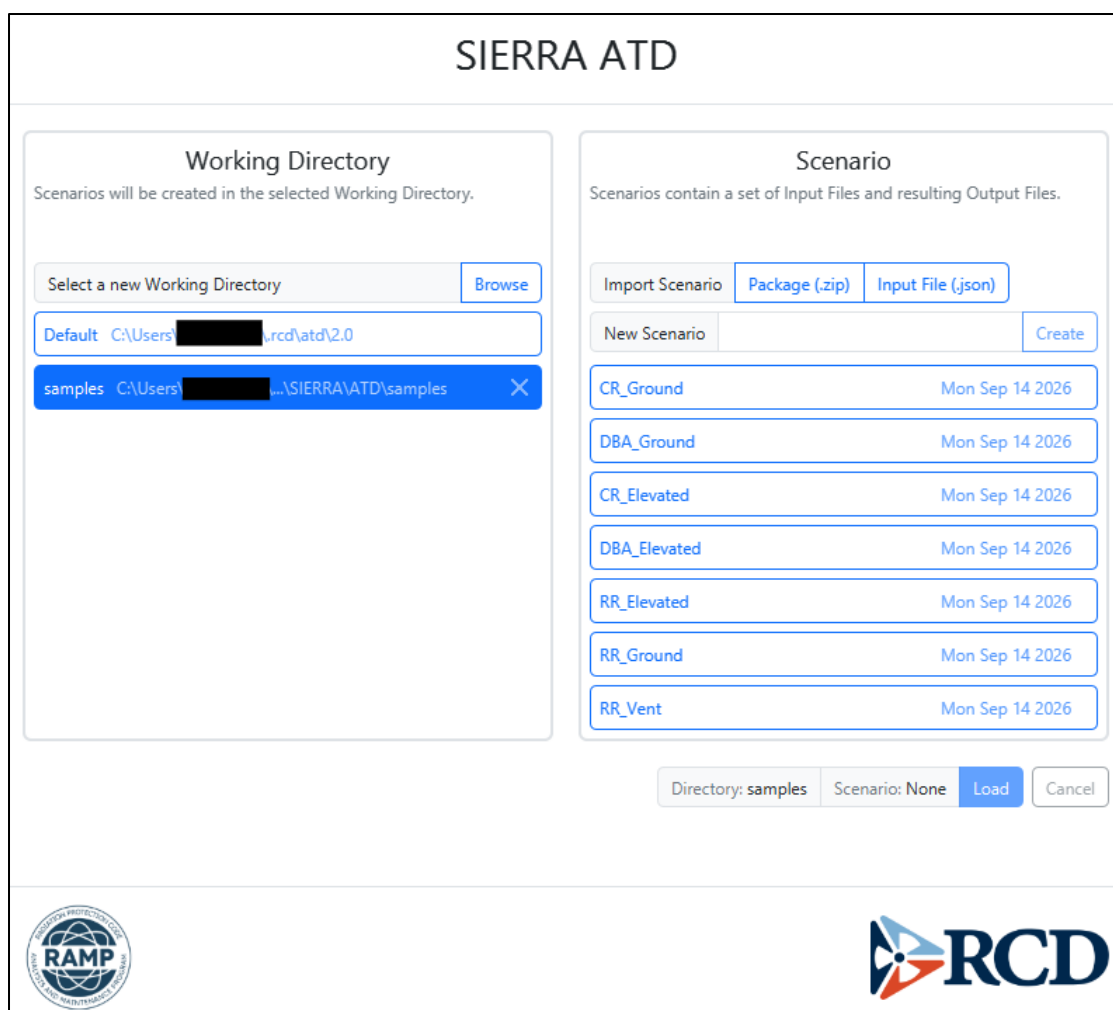
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Figure 5-1. SIERRA ATD splash screen and scenario management.

5.1. Working Directory

The Working Directory panel lists the Default directory and every other directory that has been added from earlier sessions. Each entry shows a short name (the name of the folder) followed by its full path. If the total length of the full path exceeds 55 characters, it will be truncated by omitting directories in the middle of the path. Clicking an entry makes it the active working directory and refreshes the Scenario panel to show the scenarios stored in that directory. The directory that was active when the application was last closed is selected automatically at the next start.

Browse opens a folder-selection dialog. The selected folder from this dialogue is added to the Working Directory and it becomes the active working directory

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and is remembered for future sessions. Any folder to which the user has write access may be used. A listed directory that cannot be reached when the window is displayed (for example, a location on a disconnected drive) is not shown until it is available again; if it was the active directory, the Default directory is selected in its place.

The × at the right of an entry removes that directory from the list. Removing an entry does not delete the directory or any of the scenarios it contains from disk, and the directory can be added again with Browse. The Default entry cannot be removed. All scenario files, engine input files, and calculation results are written beneath the active working directory, as described in Section 5.4.

5.2. Scenarios

A scenario is a named set of inputs together with the results of its most recent run, stored in its own folder beneath the working directory (Section 5.4). A sample structure of the ATD working directory from Figure 5-1 is shown in Figure 5-2. Each scenario is assigned its own folder where the scenario files are collected and stored.

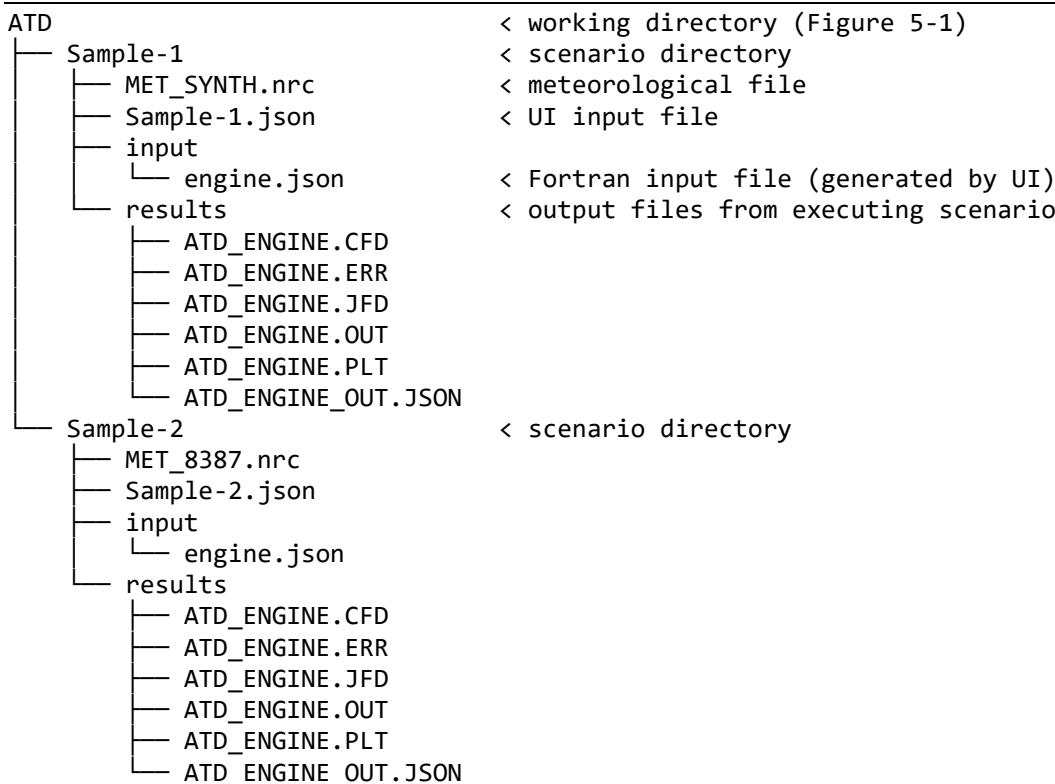


Figure 5-2. Sample scenario directory structure.

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The Scenario panel lists the scenarios in the active working directory with the most recently modified listed first; each entry shows the scenario name and the date on which it was last saved. Clicking an entry selects it, and its name appears in the Scenario field at the lower right of the window (Figure 5-1).

New Scenario. Type a name in the New Scenario field and click Create. The name identifies the scenario in the list and is also used for the scenario folder and file names on disk. It must be unique within the working directory, must not be blank, may not contain any of the characters \ / . , < > " ? * # % ; : |, and may not end with a period or a space. The names scenarios, autosave, and recovered-session are reserved and must not be used to name a scenario.

A name that is not accepted is outlined in red with an explanatory message beneath the field and Create remains unavailable until a valid name is specified. The new scenario is created in the Control Room module with the default input values and no meteorological data file identified, is saved immediately, and becomes the selected scenario. Because the name determines the folder and file names, a scenario cannot be renamed after it has been created; Section 5.3 describes how to save a copy of a scenario under a new name.

Import Scenario, Input File (.json). Opens a file-selection dialog, starting in the working directory, for a scenario input file. Two kinds of file are accepted: a scenario file written by SIERRA ATD (the saved <name>.json file from a scenario folder, or a file written with Export, Inputs (.json) as described in Section 5.3), and an engine input file of the form used to run the calculation engine from the command line. The part of the file name before its extension (before the first period) becomes the scenario name. If no scenario of that name exists in the working directory a new scenario is created from the file.

Caution: If a scenario of the same name already exists in the working directory it is replaced by the contents of the newly imported scenario without further confirmation.

A message reports whether the file was imported successfully, indicating if a scenario was created, or an existing scenario was updated.

Import Scenario, Package (.zip). Opens a file-selection dialog, starting in the working directory, for a scenario package written with Export, Scenario (.zip) (Section 5.3). The package is unpacked into the working directory as a scenario folder named after the scenario it contains, restoring the saved inputs, the copy of the meteorological data file, and the outputs of the last run that were packaged with it.

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Caution: If a scenario of the same name already exists in the working directory, the files it shares with the package are overwritten without further confirmation.

A message reports whether the scenario was imported successfully, indicating if a new scenario was created, or an existing scenario was updated.

The saved inputs record the location of the meteorological data file as a full path on the computer where the scenario was saved. When a package or scenario file is opened on a different computer, or after the original file has been moved, that path may no longer exist. In that case the scenario still loads, but a “Met file not found” message is reported, the Meteorological Data File field is left empty, and the file must be selected again on the Meteorology panel pointing the Meteorological Data File from the package next to the scenario input file.

Load. Load opens the selected scenario in the main window, switching to the module in which the scenario was saved and populating every input panel with the saved values; the number of values loaded, and any that could not be applied, are reported in the Message Center.

If the scenario includes output files from a previous analysis, and the output files correspond to the program mode stored in the scenario input file, those results will be automatically displayed in the results panel (see 7.5, 8.4, and 9.4 for results panel descriptions).

Note: The displayed results reflect the output files stored in the loaded scenario. If any input fields have been changed since the last analysis, the results may be out of date.

Cancel. Cancel closes the window and returns to the scenario that was open before the window was displayed. Cancel is available only after a scenario has been loaded once in the current session, so a scenario must be selected and loaded when the application starts.

5.3. Saving and Exporting Scenarios

Changes made in the main window are held in memory and are not written to the scenario until they are saved. Save, in the sidebar, writes the current inputs to the open scenario, replacing its previously saved inputs, and is enabled whenever unsaved changes exist.

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Caution: Inputs are not saved automatically: closing the application, loading another scenario, or switching the analysis module (which re-initializes the inputs, Section 1.3) discards unsaved changes without prompting. Save before performing any of these actions.

Export, Inputs (.json) writes the current inputs to a JSON file at a location and under a name chosen in a save dialog. The file contains the inputs only; results are not included, and the meteorological data file is referenced by its path rather than copied. It may be used to share or archive a set of inputs independently of the working directory, or to save a copy of a scenario under a new name: export the inputs as, for example, Copy.json, then open that file with Load Scenario, Input File (.json) to create a scenario named Copy.

Export, Scenario (.zip) packages the complete folder of the open scenario into a single archive: the saved inputs, the meteorological data file (when it was selected on the Meteorology panel while the scenario was open), the engine input file of the most recent run, and the results of that run. A save dialog proposes the name <scenario>.zip in the working directory. Because the package is built from the files on disk, save the scenario first so that the package reflects the current inputs. The package is the recommended way to transfer an analysis to another computer or user: opening it with Load Scenario, Package (.zip) restores the scenario, including its results, exactly as it was saved, and it contains the scenario file, meteorological data file, and output files requested when reporting a problem (Section 1.6).

5.4. Scenario Files and Session Recovery

Each scenario occupies one folder, named after the scenario, directly beneath the working directory as shown in Figure 5-2.

Scenario folders and their contents should not be renamed, moved, or edited by hand while the application is running. A renamed folder no longer matches the name recorded in its saved inputs; it is still listed under the original name but cannot be loaded. A folder beneath the working directory that does not contain a scenario file is ignored. The start-up window does not provide a delete function to prevent accidentally deleting files. To remove a scenario, delete the scenario folder from the working directory with Windows File Explorer.

Session recovery. While the application is running, a snapshot of the current inputs is written to the Default working directory every 15 seconds and is discarded when the application is closed normally. If the application ends abnormally (for example, a crash, forced termination, or loss of power), the

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snapshot is presented at the next start as a scenario named recovered-session in the Default working directory. It holds the inputs as of the last snapshot, at most 15 seconds before the interruption, and can be loaded like any other scenario. To restore the recovered inputs under a scenario name, load them and then use Export, Inputs (.json) followed by Load Scenario, Input File (.json) as described in Section 5.3.

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Program Settings

6.0 Program Settings

The Settings dialog is opened from the Settings button on the sidebar and is common to all three modules. It provides the appearance and verification functions described below:

Appearance switches the interface between the light and dark visual themes. The selection affects display only and has no effect on any calculation.

Tests runs the built-in verification suites. Two suites are provided — Run Functionality Tests and Run Requirements Tests — and their results are reported in the dialog. After installing or updating the software, run both suites and retain the reported results as an installation verification record (Section 3.0).

Scenarios are created, loaded, saved, and exported from the start-up window and from the sidebar of the main window, as described in Section 5.0.

The About dialog (sidebar) reports the installed software version and identifies the applicable user (this document) and technical manual [11.3].

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7.0 Routine Release Module

This section describes the use of models and parameters coded into the SIERRA ATD module for Routine Releases during normal plant operation. ATD modeling for routine releases is largely based on RG 1.111 [11.4].

Routine release evaluations focus on long-term (typically annual) average relative concentrations and deposition values at specified receptor locations, discrete distances, and radial segments extending outward to large distances (typically up to 50 miles). Unlike accident analyses, which assess shorter-duration and higher-consequence events, routine release models address continuous or intermittent low-level emissions incorporating meteorological datasets, sector-averaged plume geometry, and terrain-appropriate diffusion parameters. These calculations support compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20 public dose limits and Appendix I to 10 CFR Part 50, which establishes design objectives for routine effluent releases, and 10 CFR Part 51 which considers long-term environmental effects.

7.1. Release Inputs

The Release Inputs panel collects the parameters that define the characteristics of the effluent source and structures that influence its near-field dispersion component. The Routine Release module transmits these values to the calculation engine, which evaluates long-term average χ/Q and D/Q values in accordance with RG 1.111 [11.4].

The Release Type selected by the user governs which of the inputs are active. A ground release is modeled as a ground-level source for which the stack characteristics are not used (Figure 7-1) An elevated release is modeled as a point source discharging above adjacent structures (Figure 7-2). A vent release near the elevation of adjacent structures may be treated as a mixed-mode source (Figure 7-3) that partitions between ground-level and elevated behavior based on the ratio of the average vertical exit velocity to the adjusted or measured wind speed at the release height. Inputs that do not apply to the selected release type are not shown in the interface.

If the user selects a vent release, the Routine Release module considers, for each hour, the fractional amount the plume behaves as a ground-level release and when it behaves as an elevated release. The deciding quantity is the vent ratio (ϕ), the average vertical exit velocity (computed from the Release (Vent)

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Inside Diameter (or equivalent diameter based on a rectangular or square vent's area) and Average Release Flow Rate) divided by the adjusted horizontal wind speed at the height of release. When the average vertical exit velocity is at or below the adjusted wind speed (i.e., a ratio of 1.0 or less) the plume is modeled by assuming it is entrained into the building wake and treated entirely as a ground-level release. When it is several times larger (i.e., a ratio of 5.0 or more) the plume is modeled to escape the wake and is treated entirely as elevated. When the average vertical exit velocity is between 1.0 and 5.0, the two solutions are blended using the entrainment fraction. This is why the Release (Vent) Inside Diameter (or equivalent diameter based on a rectangular or square vent's area) and Average Release Flow Rate are important for a vent release even when no plume rise is credited: they set the exit velocity, and with it the split between the (higher) ground-release χ/Q and the (lower) elevated χ/Q reflected in the composite hourly χ/Q .

The tables that follow in this section define each input, using Figure 7-1 through Figure 7-3.

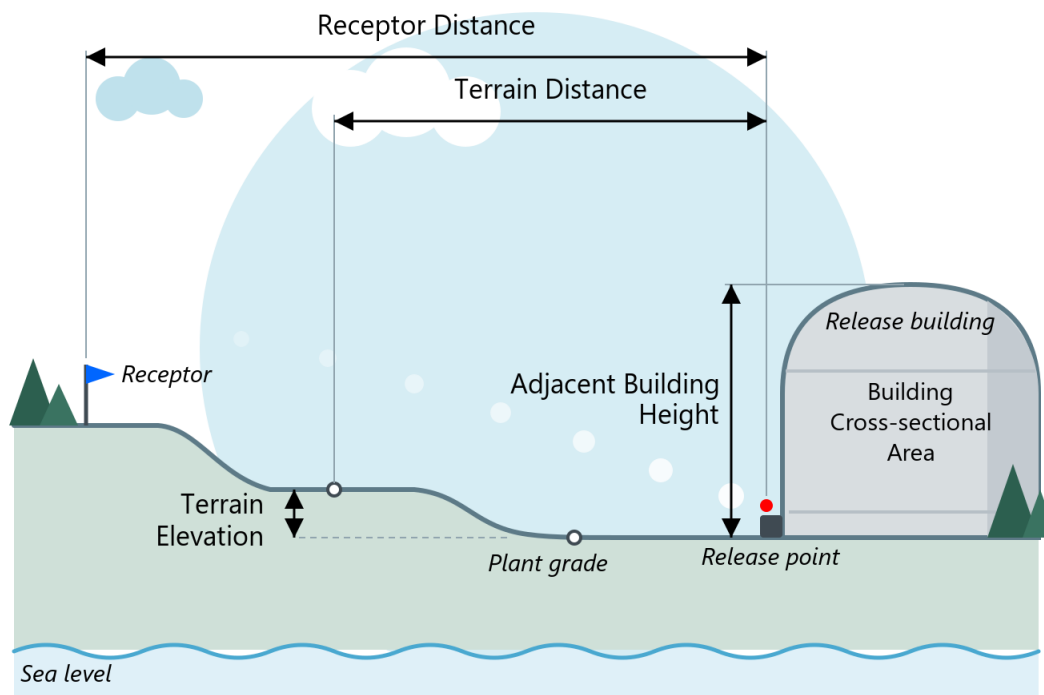


Figure 7-1. Input representation for a Routine Release ground-level release (not to scale).

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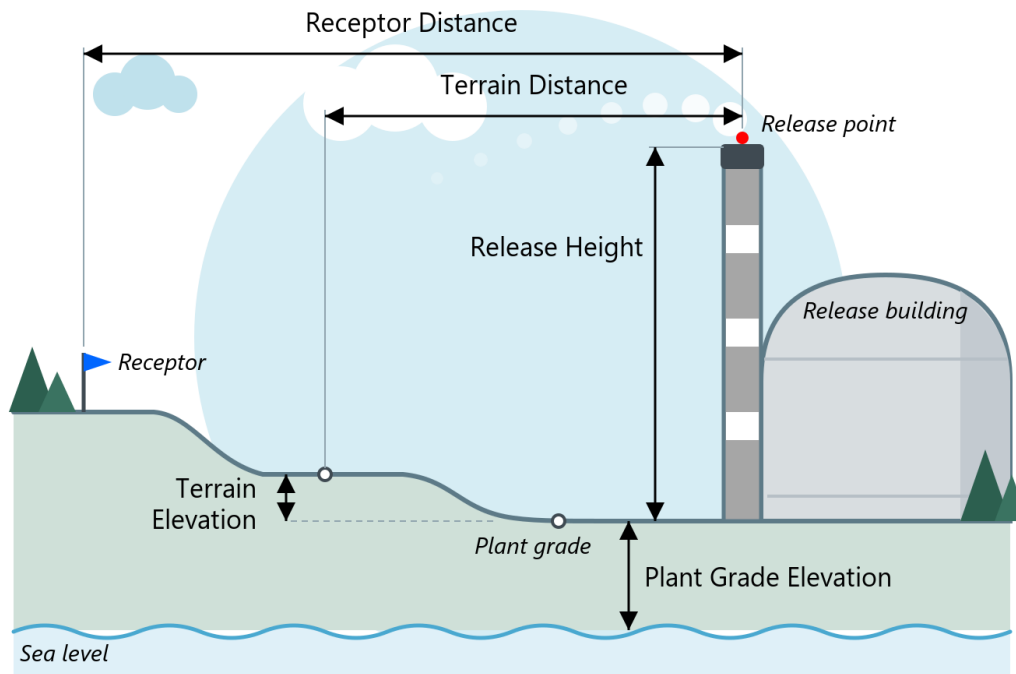


Figure 7-2. Input representation for a Routine Release elevated release (not to scale).

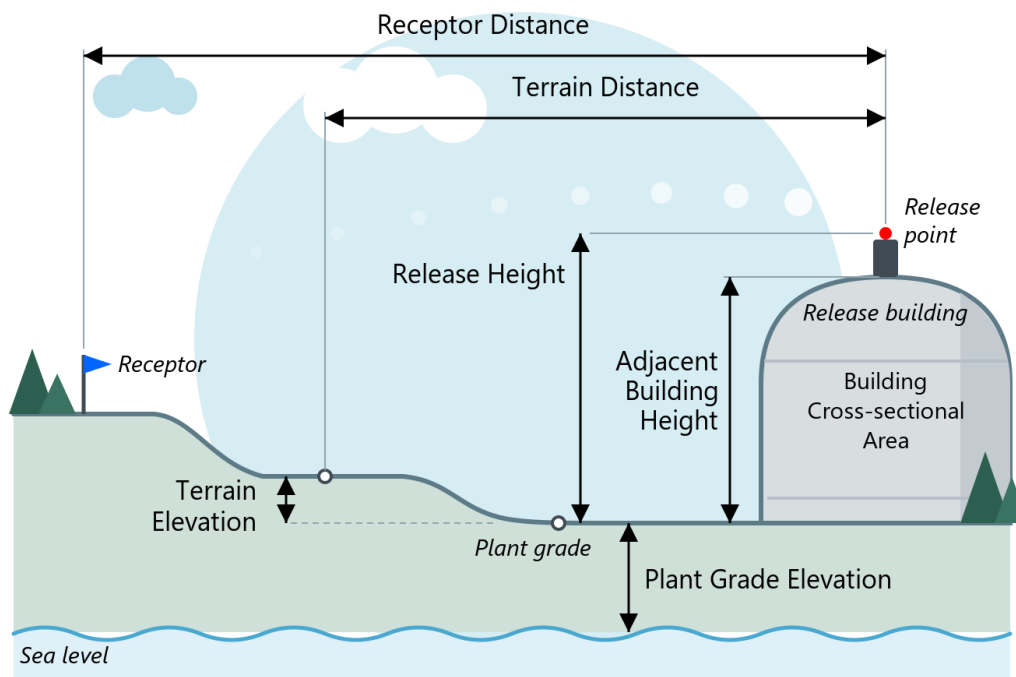


Figure 7-3. Input representation for a Routine Release vent release (not to scale).

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7.1.1. Release Type

Release Type	
Description	Defines how the source is represented in the dispersion model determining whether the release is treated as ground-level, elevated, or a mixed-mode vent release, and controls which of the other release inputs are active.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	GROUND
Valid Range	GROUND VENT ELEVATED
Recommendations	Select GROUND for releases at or near grade or whose effective height is less than twice the height of adjacent solid structures. Select ELEVATED for stack releases whose height exceeds twice the height of adjacent structures, consistent with RG 1.111, Regulatory Position C.2. Select VENT for roof or building-vent releases whose behavior is intermediate where the release point is at or above adjacent structures but does not meet the ELEVATED criterion in accordance with RG 1.111 C.2.b.
Notes / Caveats	For a ground-level release, the Release (Vent) Inside Diameter, Average Release Flow Rate, Plant Grade Elevation, and Average Vent Heat Emission Rate are not used. For an elevated release the Adjacent Building Height and Cross-sectional Area (building wake) are not used.

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7.1.2. Release Height

Release Height	
Description	Physical height of the release point (stack or vent exit) above plant grade. For elevated releases and the elevated portion of mixed-mode (vent) releases it is the basis for determining the effective release height, to which plume rise (accounting for downwash) and the plant grade elevation are added and the terrain height at a receptor is subtracted. For VENT and ELEVATED releases, the selected wind speed is then adjusted by the wind profile to the Release Height. It also determines which meteorological tower level supplies the wind data for each hour.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	10 m
Valid Range	10 - 300 m
Recommendations	Enter the actual stack or vent exit height above plant grade (at the release point). For an elevated release, the value should be at least twice the height of adjacent structures, consistent with RG 1.111 C.2(a).
Notes / Caveats	A value is required for elevated and vent releases and is disabled for ground-level releases. If an elevated release or mixed-mode (vent) release type is specified with a release height less than 10 m, the wind-speed evaluation height will be performed at 10 m for elevated portions of the evaluation and a warning is issued.

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7.1.3. Release Inside Diameter

Release Diameter	
Description	Inside diameter of the stack or equivalent diameter based on the area of the vent exit. It is combined with the Average Release Flow Rate to compute the average vertical exit velocity. The average vertical exit velocity drives plume rise and the mixed-mode partitioning of a vent release.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0 m
Valid Range	0 - 20 m
Recommendations	Enter the actual inside diameter of the stack or equivalent diameter based on the area of the vent discharge point. A representative value is required for meaningful plume-rise and vent (mixed-mode) calculations.
Notes / Caveats	Used only for elevated releases and the elevated portion of mixed-mode releases; disabled for ground-level releases. A zero diameter prevents calculation of the exit velocity and effectively disables plume rise.

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7.1.4. Average Release Flow Rate

Release Flow Rate	
Description	Average volumetric release flow rate of the exhaust gas leaving the stack or vent. Combined with the Release Inside (Vent) Diameter (or equivalent diameter based on the area of the vent exit) to compute the average vertical exit velocity used for plume rise and ground-level versus elevated release partitioning for mixed- mode vent releases.
User Input Unit(s)	cubic meters per second (m ³ /s) cubic feet per second (ft ³ /s)
Engine Unit	cubic meters per second (m ³ /s)
Default Value	0 m ³ /s
Valid Range	0 - 100 m ³ /s
Recommendations	Enter the design or measured volumetric discharge rate when crediting plume rise for an elevated release.
Notes / Caveats	Used only for elevated releases and the elevated portion of mixed-mode releases; disabled for ground-level releases. A nonzero value is needed to compute the average vertical exit velocity, plume rise, and the vent finite-flow correction. Use zero flow (zero exit velocity) to disable the momentum-driven plume rise model.

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7.1.5. Plant Grade Elevation

Plant Grade Elevation	
Description	Ground elevation of the source release location above mean sea level (plant grade). It is added to the release height (with plume rise) when computing the effective release height and serves as the reference against which the sector terrain elevations at the receptor are compared.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0 m
Valid Range	0 - 4,000 m
Recommendations	Enter the elevation of plant grade at the release point using the same reference (mean sea level) used for the terrain elevations entered on the Terrain panel.
Notes / Caveats	Used only for elevated releases and the elevated portion of mixed-mode releases and is disabled for ground-level releases.

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7.1.6. Average Vent Heat Emission Rate

Vent Heat Emission Rate	
Description	Average rate of heat released with the effluent. If applicable, it is used to compute the buoyancy contribution to plume rise for elevated releases and the elevated portion of mixed-mode releases.
User Input Unit(s)	calories per second (cal/s) calories per hour (cal/h) kilowatt (kW) watt (W)
Engine Unit	calories per second (cal/s)
Default Value	0 cal/s (buoyant plume rise is neglected and only momentum rise is considered)
Valid Range	0 - 1,000,000 cal/s
Recommendations	Enter the average heat content of the exhaust when a buoyant (thermally driven) plume rise is to be credited. Set to 0 to consider momentum rise only.
Notes / Caveats	Used only for elevated releases and the elevated portion of mixed-mode releases; disabled for ground-level releases. A value of 0 causes buoyancy to be neglected in the plume-rise calculation.

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7.1.7. Maximum Adjacent Building Height

Adjacent Building Height	
Description	Maximum height of the building or structure on which or adjacent to where the release point is located. It is used to compute building-wake corrections applied to the long-term (typically annual average) χ/Q values.
User Input Unit(s)	meters (m) feet (m)
Engine Unit	meters (m)
Default Value	0 m (no building-wake correction is applied to the sector-averaged and annual-average χ/Q values)
Valid Range	0 - 300 m
Recommendations	Enter the maximum height of the dominant structure whose wake influences the release for ground-level and the ground-level portion of mixed-mode releases where wake enhancement of dispersion is credited.
Notes / Caveats	Used only for ground-level and the ground-level portion of mixed-mode releases and disabled for elevated releases.

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7.1.8. Open Terrain Recirculation

Open Terrain Recirculation	
Description	Applies the open-terrain recirculation factor (RF) of NUREG/CR-2919, Figure 3.2, which corrects the straight-line Gaussian result for air that returns to the site under recirculating or stagnating airflow conditions (e.g., valley circulations, sea breezes).
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	On (correction applied)
Valid Range	On or Off
Recommendations	The constant mean wind direction model can only use meteorological data from a single station to represent diffusion conditions within the region of interest; RG 1.111 C.1.c. The recirculation correction factor should be used for all sites unless specific diffusion test, or other data, indicate other factors are more appropriate.
Notes / Caveats	When active, every χ/Q and D/Q is multiplied by a distance-dependent factor. This factor is the largest close to the release point (capped at 4.0) out to just beyond about 1 km, decreasing with distance, becoming 1.0 just beyond about 16 km (10 miles) and thereafter. Enabling this recirculation correction factor increases near-field results and leaves far-field results unchanged.

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7.2. Receptor Inputs

The Receptors panel defines *discrete receptors* identifying specific locations of interest such as the nearest residence, garden, animal milk or meat, or the site boundary (often the same as the EAB). At these site-specific locations (typically out to 5 miles downwind), the Routine Release module reports long-term average χ/Q and D/Q values in addition to the standard grid of 22 distances in each of the 16 direction sectors. Discrete receptors do not change the grid results; they add rows to the Discrete Receptor Outputs grid on the Results panel and to the Specific Points of Interest table in the OUT file.

For every hour of valid dispersion-related meteorological data, the downwind sector from the wind direction is determined. If that sector matches the receptor's sector being evaluated, then the sector-averaged χ/Q (for the three decay/depletion cases) and the D/Q at the receptor's exact distance is calculated. Hours whose wind blows toward any other sector contribute zero to the receptor being evaluated. The average reported for the receptor is the sum of the hourly values divided by the number of valid (non-missing) hours (see Section 7.4.1). Receptors are entered as rows of a table; each row holds a text Label, Type, Sector, and Distance from source. Rows can be added (+) or removed (x) as needed, and the entered receptors are drawn on the polar site map for visual confirmation (Figure 7-4). If no receptors are entered, then the discrete-receptor calculation is not performed.

The tables that follow in this section define each input for defining discrete receptors.

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Figure 7-4. Managing discrete receptors for Routine Release module.

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7.2.1. Receptor Label

Receptor Label	
Description	Free-text name for the receptor (for example, “Nearest Residence 1”). It identifies the receptor in the on-screen Discrete Receptor Outputs grid and in the Specific Points of Interest table of the OUT file.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	0
Valid Range	Any text less than 20 characters
Recommendations	Use short, unique names that will still make sense in the printed output, e.g. the receptor type plus its direction from the facility.
Notes / Caveats	The title has no effect on the calculated values.

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7.2.2. Receptor Type

Receptor Type	
Description	Classification of the receptor location, used to label the receptor with the exposure pathway it represents.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	Other
Valid Range	Milk Cow, Milk Goat, Meat Animal, Residence, Vegetable Garden, Site Boundary, or Other.
Recommendations	Choose the pathway category the location represents in the RG 1.109 [11.13] dose assessment (e.g., Milk Cow for the nearest dairy pathway, Site Boundary for the fence line).
Notes / Caveats	The type has no effect on the calculated values. It carries through to the output so that downstream dose calculations can associate the χ/Q and D/Q with the right exposure pathway.

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7.2.3. Receptor Sector

Receptor Sector	
Description	The 22.5° compass sector containing the receptor, selected from the 16 standard sectors (centered at N, NNE, ..., NNW). The sector is the direction from the release point toward the receptor (i.e., the downwind direction when the plume blows towards the receptor).
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	N
Valid Range	One of the 16 standard 22.5-degree direction sectors centered on N, NNE, NE, ..., NNW.
Recommendations	Determine the compass bearing relative to True North (not Plant North which is often different) from the release point to the receptor and pick the sector containing that bearing. Take care with locations near a sector boundary as moving the receptor to the neighboring sector can change its annual average X/Qs and/or D/Qs noticeably if the wind rose is strongly directional and/or if the stability class frequencies differ.
Notes / Caveats	Only hours whose wind carries the plume into this sector contribute non-zero X/Q and D/Q values to the receptor's average; all other hours contribute a value of zero to the average.

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7.2.4. Receptor Distance

Receptor Distance	
Description	Horizontal distance from the release point to the receptor.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	8,046 m (5 mi)
Valid Range	0 - 80,467 m (50 mi)
Recommendations	Enter the straight-line ground distance from the release point to each receptor. Unlike the fixed output grid, the discrete receptor is evaluated at exactly this distance.
Notes / Caveats	Distance is the receptor's strongest lever after dispersion-related meteorological conditions that affect a downwind sector. σ_y and σ_z that represent horizontal and vertical plume growth with distance, respectively. χ/Q generally falls rapidly with increasing distance while radioactive decay and dry depletion (for the decayed/depleted output types) remove additional material in transit. Similarly, D/Q values decrease with increasing distance from the source. Terrain under the plume is interpolated at this distance from the Terrain panel entries for the receptor's sector, so the terrain profile of that sector affects an elevated or vent release at the receptor.

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7.3. Terrain Inputs

The Terrain Inputs panel lets the user describe how the ground elevation varies with distance and direction around the site. SIERRA ATD uses this information to determine the elevation of the terrain beneath the plume at each evaluation point, which in turn affects the effective plume height of an elevated or the elevated portion of a mixed-mode (vent) release. Terrain data are organized on a polar grid of the sixteen standard 22.5° compass sectors (centered on N, NNE, NE, ..., NNW) and up to ten distance ranges (Range 0 through Range 9). For each direction sector and range the user supplies a Distance from the release point and the corresponding ground Elevation, defining a terrain-elevation profile that extends outward from the source location along each of the sixteen direction sectors.

Internally, the engine assembles for each of the sixteen sectors an array of distance/elevation pairs from the values entered across the ranges. The number of ranges that contain data determines the number of distance/elevation pairs in each sector's profile. The Routine Release engine evaluates relative concentration and deposition at twenty-two fixed downwind distances: 0.25, 0.50, 0.75, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 7.5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 miles. The modeled X/Qs and D/Qs at these fixed distances are also aggregated into ten separate distance segments (0.5–1, 1–2, 2–3, 3–4, 4–5, 5–10, 10–20, 20–30, 30–40, and 40–50 miles). The reported results represent a weighted average of the distance-specific values at the beginning and end of a given distance-segment range.

For each modeled hour the engine identifies the downwind sector from the wind direction and selects that sector's terrain profile. It then linearly interpolates the terrain elevation at the evaluation distance from the two bracketing distance/elevation points (after sorting the profile by distance). If the evaluation distance lies beyond the farthest entered point, the elevation of that farthest point is held constant; if it lies closer than the nearest entered point, the terrain elevation is taken as zero. The result is a direction-dependent terrain elevation at every evaluation distance. If no terrain data are supplied, the engine proceeds with flat terrain (zero elevation in every sector regardless of the plant grade elevation). The processing of the terrain data is depicted in Figure 7-5.

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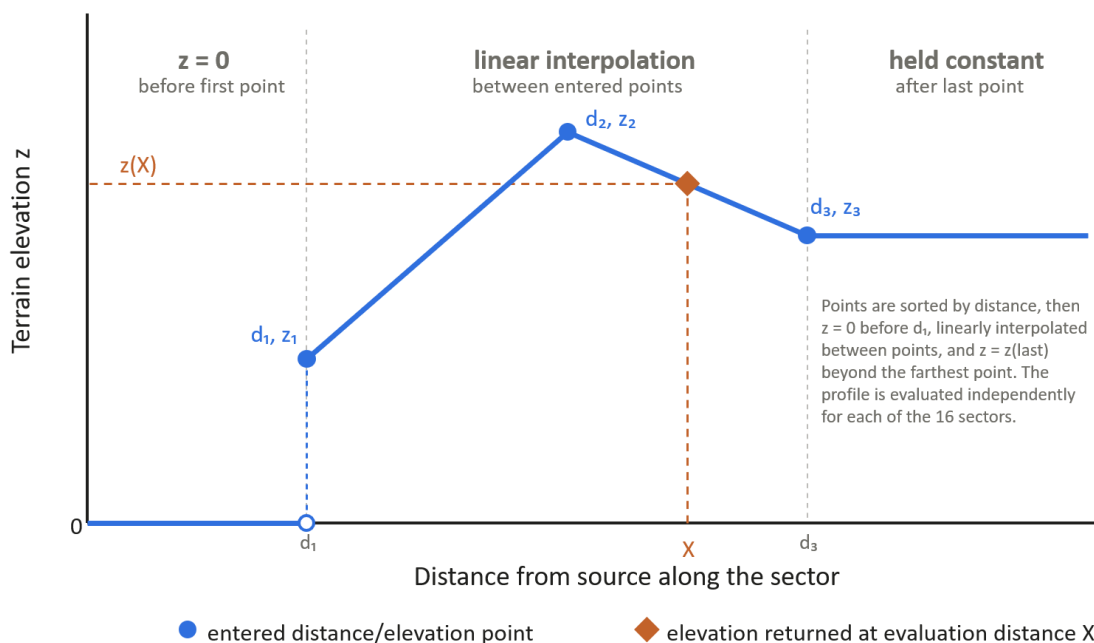


Figure 7-5. Terrain input processing for Routine Release.

Figure 7-6 illustrates how the terrain entries combine with the release inputs. The plume centerline starts at the release height above plant grade, gains any plume rise (due to buoyancy and/or momentum), and is referenced to mean sea level by adding the Plant Grade Elevation. As the terrain rises toward the plume at a receptor, the effective stack height (h_e) decreases, and the calculated χ/Q rises. If the terrain reaches or rises through the plume centerline, the effective height is set to zero and the receptor is treated as if it were at ground level in the plume.

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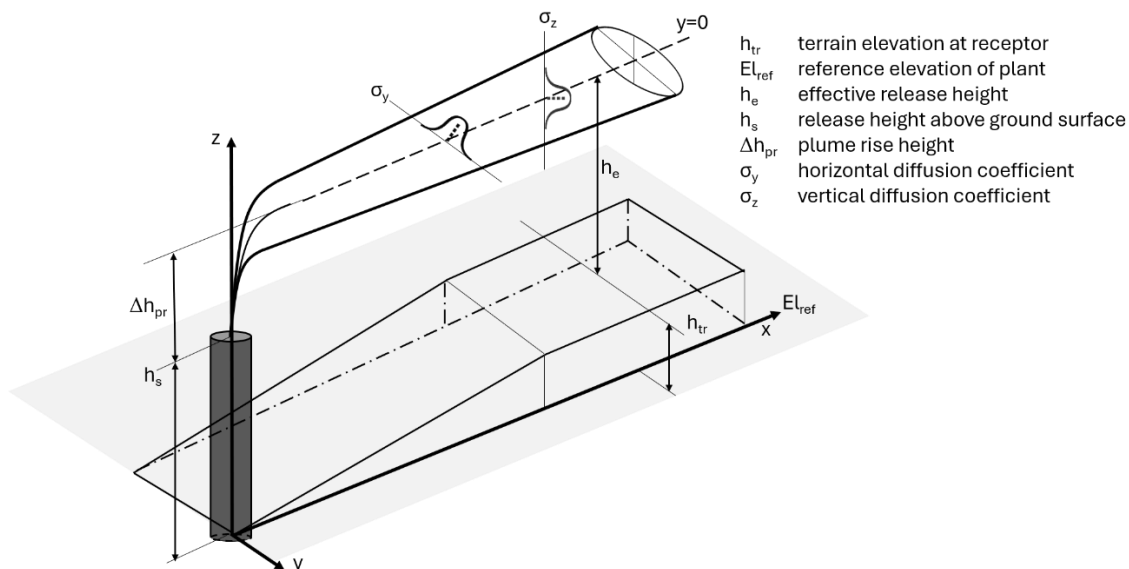


Figure 7-6. Generalized plume representation with terrain elevation change.

The interpolated terrain elevation reduces the effective release height. Using Figure 7-6 as a guide, for an elevated release or the elevated portion of a mixed-mode release, the engine computes the effective height as the release height plus any plume rise (including effects from downwash) plus the plant grade elevation, minus the terrain elevation at the receptor (a negative result is set to zero). Raising the terrain toward the plume therefore decreases the plume-to-ground clearance and generally increases the calculated χ/Q at that location. For a ground-level release the effective height is fixed at zero, so terrain data do not affect the result.

Terrain elevations are applied only to elevated releases and the elevated portion of mixed-mode releases, for which they enter the effective-height calculation described above. For a ground-level release the plume is modeled at the ground with an effective height of zero; any terrain data entered are read and echoed to the output file but do not change the computed χ/Q or D/Q . The Terrain Inputs panel may therefore be left empty when the selected release type is ground-level.

Terrain data influence the calculation only through this effective-height adjustment; they are independent of the open-terrain recirculation correction,

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which is enabled separately in the module's Release inputs panel and applies standard open-terrain recirculation factors to the sector-averaged x/Q values.

To enter terrain data, select a range using the Range 0 through Range 9 tabs at the top of the Terrain Attributes grid, then enter the Distance (Section 7.3.1) and Elevation (Section 7.3.2) for each of the sixteen sectors in that range. Repeat for as many ranges as needed; successive ranges add points farther out along each sector's profile. Although not necessary, entries need not be made in subsequent ranges of increasing distance because the engine sorts each sector's points by distance before using them. As values are entered, the Terrain Plot to the right of the grid displays the distance/elevation points on a polar grid for visual confirmation as shown in Figure 7-7.

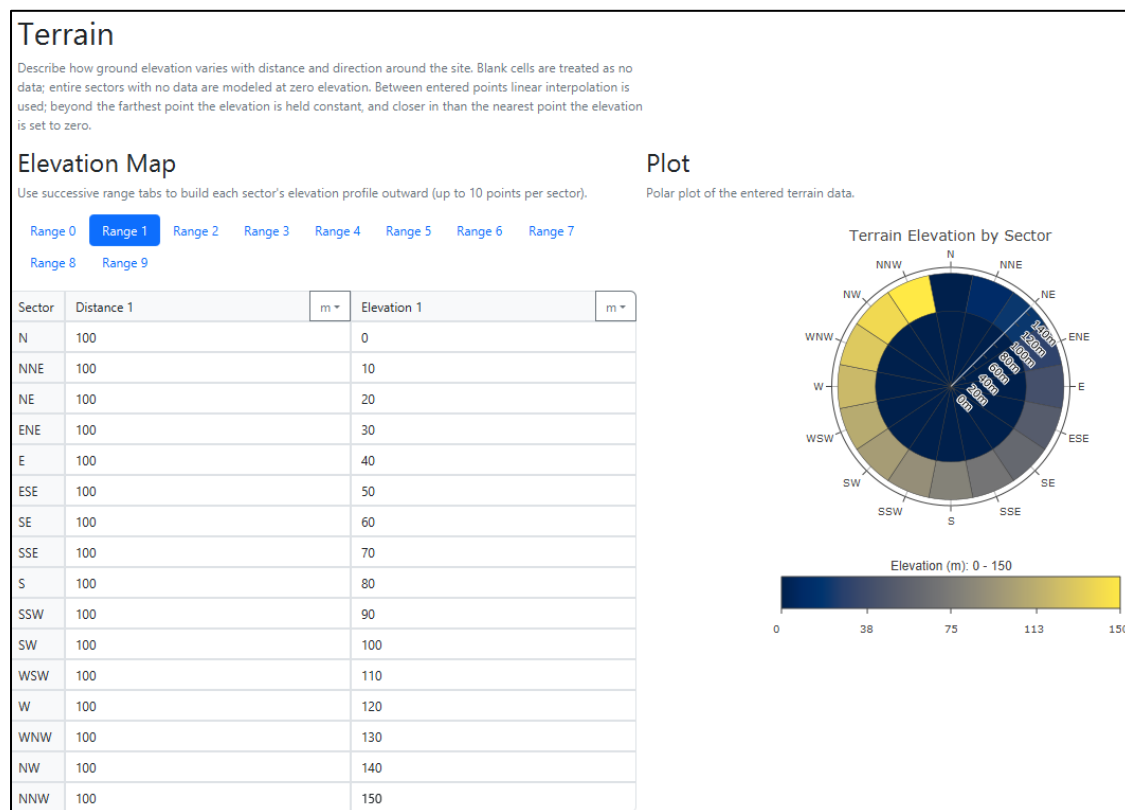


Figure 7-7. Terrain polar plot example for Routine Release module.

For a given direction and distance, the terrain height should be the highest elevation between the source and that distance anywhere within the direction sector. That is, the elevation for a given sector with increasing distance should remain constant or increase and never decrease.

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A cell left blank is treated as no data for that sector. Terrain data are optional: a simulation may be run with no terrain data entered, in which case the terrain is treated as flat at zero elevation.

For elevated releases and the elevated portion of mixed-mode releases, elevation values must use the same vertical reference (relative to mean sea level) as the Plant Grade Elevation, Release Height, and Adjacent Building Height entered on the Release panel. Using a consistent datum ensures that the terrain elevation is correctly differenced against the release elevation when the effective plume height is computed.

The tables that follow in this section define each input for defining the terrain inputs.

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7.3.1. Distance

Distance	
Description	Downwind distance from the release point to a terrain profile point, entered for each of the sixteen sectors within the selected range (0 – 9). Together with the Elevation value in the same cell row, it defines one point on that sector's terrain-elevation profile.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	Blank (no value)
Valid Range	0 - 80,467 m (50 mi)
Recommendations	Enter distances that span the receptor distances of interest. Because the engine evaluates χ/Q and D/Q at fixed distances typically out to 50 miles per Regulatory Position C.1.c of RG 1.111, provide terrain points covering the full range of the applicable sector-specific receptor distances. Distances need not be uniformly spaced or sorted; sorting of each sector's points occurs internally.
Notes / Caveats	The sixteen sectors are fixed in clockwise order beginning at North; data are associated with sectors by row position, so enter values in the displayed sector order. Each sector has its own distance set, allowing direction-specific terrain profiles. Avoid duplicate distances within a single sector.

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7.3.2. Elevation

Elevation	
Description	Ground elevation at the corresponding Distance for a given sector, defining the height of the terrain surface relative to mean sea level. It is used to determine the terrain elevation beneath the plume at each evaluation distance.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	Blank (no value)
Valid Range	0 - 4,000 m (2.49 mi)
Recommendations	Enter elevations on the same mean-sea-level datum used for the Plant Grade Elevation, Release Height, and Adjacent Building Height. Provide enough sector-specific elevations to capture significant terrain rises between the site and downwind receptors in that direction sector. For a given direction and distance, the terrain height should be the highest elevation between the source and that distance anywhere within the direction sector. That is, the elevation for a given sector with increasing distance should remain constant or increase and never decrease. At the zero distance, the plant grade elevation should be entered.
Notes / Caveats	Elevation values are paired by position with the Distance entries for the same sector and range. If terrain data for an entire sector cannot be read, the engine defaults all elevations for that sector to zero and issues a warning.

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7.4. Meteorology Inputs

The Meteorology panel supplies the hourly weather record that drives the entire calculation. Every valid hour contributes a wind direction (i.e., determines which downwind sector the plume affects), a wind speed (i.e., how much the plume is diluted), and a vertical temperature difference (i.e., how vigorously the atmosphere mixes). The panel also displays summary statistics and a wind rose for the loaded file. The displays and the expected file format are described in Section 10.0.

For each hour the engine first picks the measurement level. If the release height is above the midpoint of the two instrument heights it uses the upper-level data, otherwise the lower-level data is used. It then adjusts the measured speed to the height of interest for the plume:

- to the release height for an elevated release, and
- to the 10 m reference height for ground-level and vent releases.

The stability class for the hour is determined from the vertical temperature gradient (ΔT , which represents the difference between an upper and the lower measurement levels) normalized to degrees C per 100 m and categorized using the seven NRC stability categories of RG 1.23 [11.8 Table 10-3]. Missing hours are excluded; calm hours are retained with the substitute speed based on the Wind Speed Calm Threshold input value.

Calm hours have no defined wind direction, so they are assigned to sectors rather than using the recorded direction. Within each stability class the calm hours are counted and divided evenly among the 16 sectors: each sector's share is the class total divided by 16, rounded to the nearest whole hour. The hours are then placed in the order they occur in the meteorological file, beginning in the North sector and moving clockwise to the next sector each time a sector's share is filled.

Because the share is rounded, the number of hours placed this way is the class total rounded to the nearest multiple of 16. A class with fewer than eight calm hours therefore has a share of zero; its hours are not discarded, but are placed one per sector beginning at NNE (North receives none). When the file contains more calm hours than the rounded totals account for, the remaining hours are placed in North, NNE, NE, ... in order of occurrence and are treated as stability class G regardless of their measured class. Every calm hour is included in the sector averages, but the hours are not always spread evenly around the compass.

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All hours in the meteorological data file are used for determining long-term averages. If five years of hourly data are provided, all five years (nominally 43,824 hourly data points) are used; if only one year (nominally 8,760 data points) is provided, the results are a true annual average.

Note: The maximum number of records allowed in the meteorological data file is 43,920 hours; enough to allow for analyzing five years.

Because the Routine Release module forms its period-average χ/Q s and D/Q s by summing the hourly results and dividing by the number of valid hours actually present in the meteorological data file (hours with missing wind and/or ΔT are excluded from the count rather than treated as zero), the averaging window is defined entirely by the data provided. This allows purge releases and other short, scheduled, or intermittent releases to be modeled by supplying a meteorological data file limited to the time period of interest (the actual hours of the planned purge, or a representative or suitably conservative period bracketing it) so that the resulting χ/Q s and D/Q s reflect the dispersion conditions coincident with the release.

The file must still follow the RG 1.23 [11.8] format described in Section 10.1, and the hour-by-hour χ/Q and D/Q for the window are additionally available in the PLT file when the release rate varies during the purge. The sector-dependent χ/Q (s/m^3) and D/Q ($1/m^2$) values produced at each receptor can then be combined with the purge source term (outside of the SIERRA ATD module) to determine dose multiplying χ/Q by the release rate of each radionuclide (or by the total activity released, for a time-integrated result). When a tailored period is used in this way, confirm that the selected window of meteorological data has adequate data recovery and is representative of, or bounding for, the release scenario, since the shortened record is a deliberate departure from the annual-cycle convention noted above and should be justified in the analysis.

The tables that follow in this section define each input related to meteorological inputs.

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7.4.1. Meteorological Data File

Meteorological Data File	
Description	Path of the hourly meteorological data file used for the run. The file must follow the RG 1.23 fixed-width format described in Section 10.1, with two measurement levels and the vertical temperature difference.
Engine Unit	N/A
User Input Unit(s)	N/A
Default Value	N/A
Valid Range	Any file in the RG 1.23 format (Section 10.1).
Recommendations	Use a representative period of site data. RG 1.23 recommends hourly data with at least 90% recovery of concurrent wind speed, wind direction, and atmospheric stability values. Routine-release modeling assessments conventionally use one or more complete annual cycles (preferably consecutive) so that seasonal patterns are captured.
Notes / Caveats	All valid hours in the file are used for determining long-term averages. If five years of hourly data are provided, all five years are used to determine a composite annual average. If only one year is provided, the results are a true annual average. Hours with missing wind direction, wind speed, and/or ΔT data are excluded from the averages (they simply reduce the data count rather than contributing zeros).

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7.4.2. Wind Speed Calm Threshold

Wind Speed Calm Threshold	
Description	Wind speed below which an hour is treated as calm. Hours whose direction is coded as calm (777.7) or whose speed is below this threshold are kept in the analysis but processed with the user-specified threshold speed as a instead.
User Input Unit(s)	meters per second (m/s) feet per minute (ft/min) kilometers per hour (km/h) miles per hour (mph)
Engine Unit	meters per second (m/s)
Default Value	0.5 m/s
Valid Range	0.1 - 50 m/s
Recommendations	Use the higher starting speed of either the site's wind speed or wind direction sensor, 0.5 m/s is a typical value unless the instrument's specifications indicate otherwise.
Notes / Caveats	Because χ/Q varies as $1/(\text{wind speed})$, the lightest-wind hours produce the highest relative concentrations. The count of affected hours appears as Calm Records on the Meteorology panel and in the lowest wind-speed bin of the wind rose. Calm hours have no defined direction, so the engine distributes them equally among the 16 sectors within each stability class.

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7.4.3. Display Height Range

Display Height Range	
Description	Selects whether the Meteorology panel statistics and wind rose describe the Upper or Lower measurement level of the loaded file.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	Lower
Valid Range	Upper or Lower
Recommendations	View the level closest to the release height when judging the data; check both for completeness.
Notes / Caveats	Display only. The calculation engine independently selects the level it uses each hour by comparing the release height with the midpoint of the two measurement heights, then adjusts the speed to the release height (elevated or vent) or the 10 m reference height (ground-level). A message on the panel states which level the engine uses for the current release height.

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7.4.4. Diffusion Model

Diffusion Model	
Description	Selects the family of curves used to compute the lateral and vertical plume-spread coefficients (σ_y , σ_z) as a function of distance and stability class. They define how wide and how tall the plume has grown by the time it reaches each receptor distance.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	NRC
Valid Range	NRC DESERT_SIGMA ISC BRIGGS_RURAL BRIGGS_URBAN
Recommendations	Use NRC, the Pasquill-Gifford parameterization used by the legacy XOQDOQ code for regulatory applications. The alternates are provided for sensitivity studies or technically justified site-specific analyses.
Notes / Caveats	The choice changes every x/Q and D/Q in the run. Models that spread the plume faster will dilute the plume sooner and result in lower relative concentrations at most distances; slower-spreading models keep the plume concentrated farther downwind.

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7.5. Results Window Description

7.5.1. Summary Results View

After successful execution of the program, the Routine Release module displays its results on the Results panel. The panel provides buttons to open viewers for the raw output files produced by the calculation engine and presents the computed long-term average results on screen in summary grids and a polar plot as shown in Figure 7-8. Results are expressed as relative concentration, χ/Q (s/m^3), and relative deposition, D/Q ($1/m^2$).

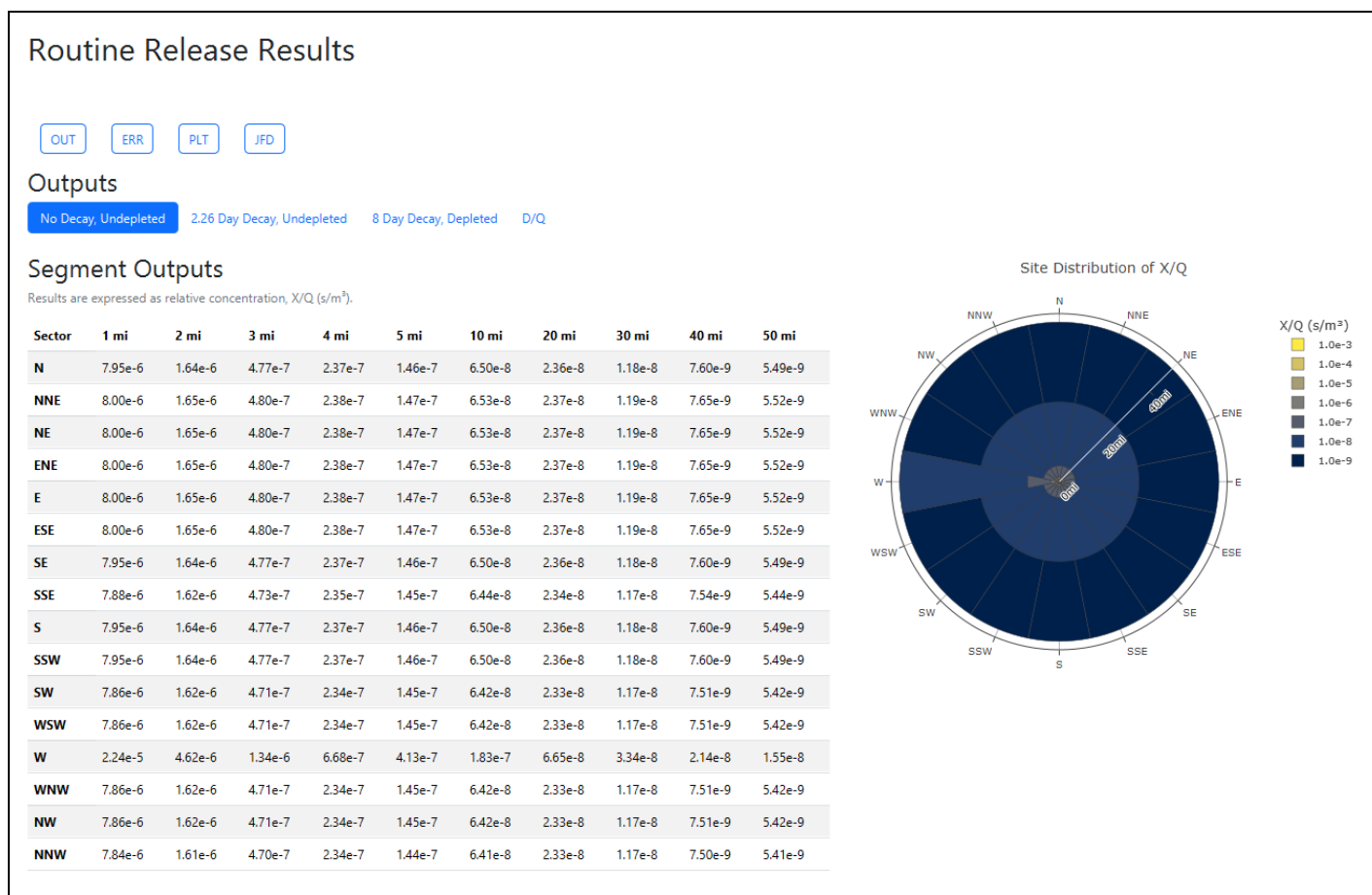


Figure 7-8. Example Routine Release module summary results panel.

An Output Type selector chooses which result set is displayed on screen. Four output types are available:

- χ/Q with No Decay, Undepleted,
- χ/Q with 2.260-Day Decay, Undepleted,

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- χ/Q with 8-Day Decay, Depleted, and
- Relative Deposition D/Q.

For the selected output type, the panel displays two summary grids and a plot. The Segment Outputs grid gives the sector-averaged value for each of the sixteen compass sectors (rows) across the standard downwind distance segments in miles (columns). The Discrete Receptor Outputs grid lists each user-defined receptor with its title, sector location, distance in miles and meters from the source release point, and the computed value (χ/Q or D/Q). The polar plot shows the radial distribution of the selected value by sector and distance.

7.5.2. Output File Viewer

When a run completes, the calculation engine writes a set of plain-text output files to the run's case folder (Section 5.0). Four buttons across the top of the panel each open a viewer for one of the raw output files produced by the calculation engine. The four files in the table can be opened directly from the Results panel with the viewer buttons, and all are also available in the case folder.

File	Content shown in the viewer
ERR	Error and warning messages issued by the calculation engine during the run, headed by the program run timestamp. Errors will stop the program while warnings allow the program to continue. A run that completes without issues contains only the header.
PLT	Hourly (plot) file listing the hour-by-hour intermediate values. For every processed hour and every evaluation distance it lists the year, Julian day, and hour; the wind speed at the measurement height and adjusted to the release height; the wind direction and downwind sector; the calm and missing-data flags; the stability class; the distance; the lateral and vertical diffusion coefficients (σ_y and σ_z , without the building-wake correction); the three sector-averaged χ/Q values (one per decay case); and the D/Qs. This file can become large because it holds one record per hour per distance (e.g., a five-year analysis will result in an approximate 200 MB .PLT file).

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File	Content shown in the viewer
OUT	Main output file containing the full tabulated summary of the run. It begins with program identification and a disclaimer, followed by an echo of the run inputs and a meteorological processing summary. The results section reports, for each of the four output types, the annual average value at the 22 standard distances (0.25 to 50 miles) for each of the 16 sectors, and the value for each of the 10-distance segments. A final Specific Points of Interest table lists the χ/Q (for the three decay cases) and the D/Q at each user-defined discrete receptor. The file ends with NORMAL PROGRAM COMPLETION.
JFD	Joint frequency distribution of the meteorological data by stability class, wind speed, and wind direction (the sector the wind blows from), written for each of the seven stability classes as a 16-sector by 10-speed-class table. The speed classes follow RG 1.23 Table 3 except that the <0.5 m/s class is not tabulated; hours below the Wind Speed Calm Threshold are instead reported on a separate line of calm counts by stability class. Speeds are those measured at the reference height. Provided for reference only; this dataset is not used in the dispersion calculation but provides a useful, quick summary of dispersion-related conditions for the meteorological data set.

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8.0 Design Basis Accident Module

This section describes the models and parameters coded into the SIERRA ATD module for Design Basis Accidents (DBAs) at offsite receptor locations. ATD modeling for the models and methods implemented are largely based on RG 1.145 [11.5].

The offsite DBA dispersion analysis focuses on two key boundaries:

- The Exclusion Area Boundary (EAB) is the closest boundary around a reactor, sized so that a person at the boundary during the first 2 hours (i.e., 0 to 2 hours) of an accident would not exceed the applicable dose limit.
- The Low Population Zone (LPZ) surrounds the EAB (for some advanced reactor designs may be collocated with the EAB) and must ensure that a person at its outer boundary, exposed to the entire plume passage, also remains below the specified regulatory dose limit for the other standard averaging times (i.e., 0 to 8 hours (sometimes 2 to 8 hours), 8 to 24 hours, 1 to 3 days (24 to 96 hours), and 4 to 30 days (96 to 720 hours)).

In addition, RG 1.249 [11.7] outlines an alternative use of the Control Room module (analogous code in SIERRA ATD based on the ARCON dispersion model) for modeling onsite releases to these offsite boundaries from a DBA. The basis for using the Control Room module for offsite analyses is summarized in RG 1.249 with inputs to and outputs from the ARCON code being generally consistent with the PAVAN dispersion model. Historically, differences included an improved building wake dispersion algorithm, the addition of diffuse source release modes, input of hourly meteorological observations, sector averaging, and directional dependence of dispersion conditions of which the ATD Control Room module implements (see Section 9.0). RG 1.249 outlines how to estimate χ/Q_s at the EAB and the outer boundary of the LPZ out to distances of 1,200 meters (3,937 feet) from the nearest edge of a building from which a DBA release could occur within the nuclear island. As such, the user may opt to use the Control Room Module described in Section 9.0, in lieu of the DBA module described here to perform assessment of DBAs considering guidance from RG 1.249 and its referenced regulatory guidance.

For the DBA module, two RG 1.145 [11.5] corrections are applied without user input. For ground releases under neutral and stable conditions (classes D–G) with a wind speed below 6 m/s, the centerline χ/Q is reduced for horizontal plume meander per RG 1.145 Figure 3 (applies to use of the default NRC

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diffusion option only). For elevated releases the engine flags potential fumigation hours when a stable (E–G) hour is followed by an unstable (A–C) hour. The fumigation χ/Q is computed assuming the plume is mixed to the ground through a layer with F stability class and a wind speed of 2 m/s. The Site Type input on the Release panel then dictates how that fumigation value is combined with the normal value (averaged for an Inland site, enveloped for a Coastal site).

The Control Room module applies the ARCON96 low-wind-speed and building-wake diffusion corrections; consistent with RG 1.249 [11.7 Section 2.3.2], elevated-stack cases evaluated with the Control Room module should also be evaluated with the DBA module, and fumigation is not modeled.

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8.1. Release Inputs

The Release Inputs for the Design Basis Accident (DBA) module define the characteristics of the effluent source and structures that influence its near-field dispersion. The DBA module estimates accident-related ground-level χ/Q_s at the EAB and the outer boundary of the LPZ in accordance with RG 1.145 [11.5].

The DBA module supports two release types, ground-level and elevated. Plume rise is optional for an elevated release and is enabled when any of the following are entered as non-zero values: Release Inside Diameter, Average Release Flow Rate, and Average Vent Heat Emission Rate. Inputs that do not apply to the selected release type are disabled and hidden in the interface. The following tables define each input, its units, default value, valid range, recommended usage, and any caveats.

The tables that follow in this section define each input, using Figure 8-1 and Figure 8-2 for reference.

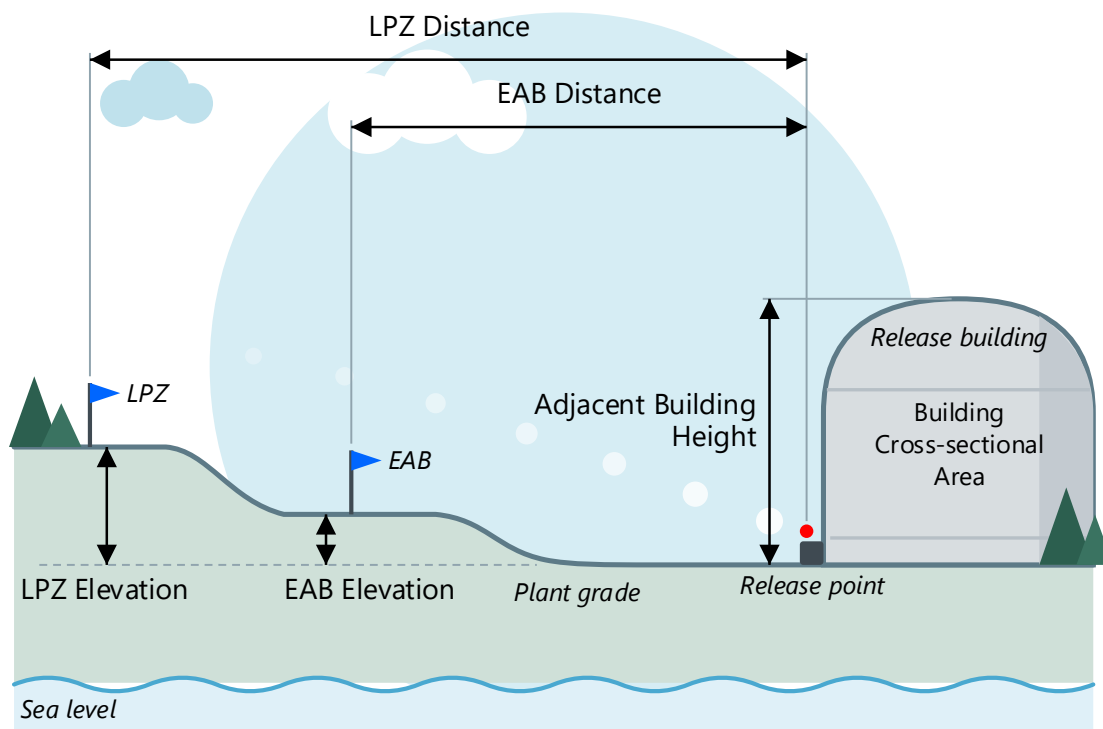


Figure 8-1. Input representation for a Design Basis Accident ground-level release (not to scale).

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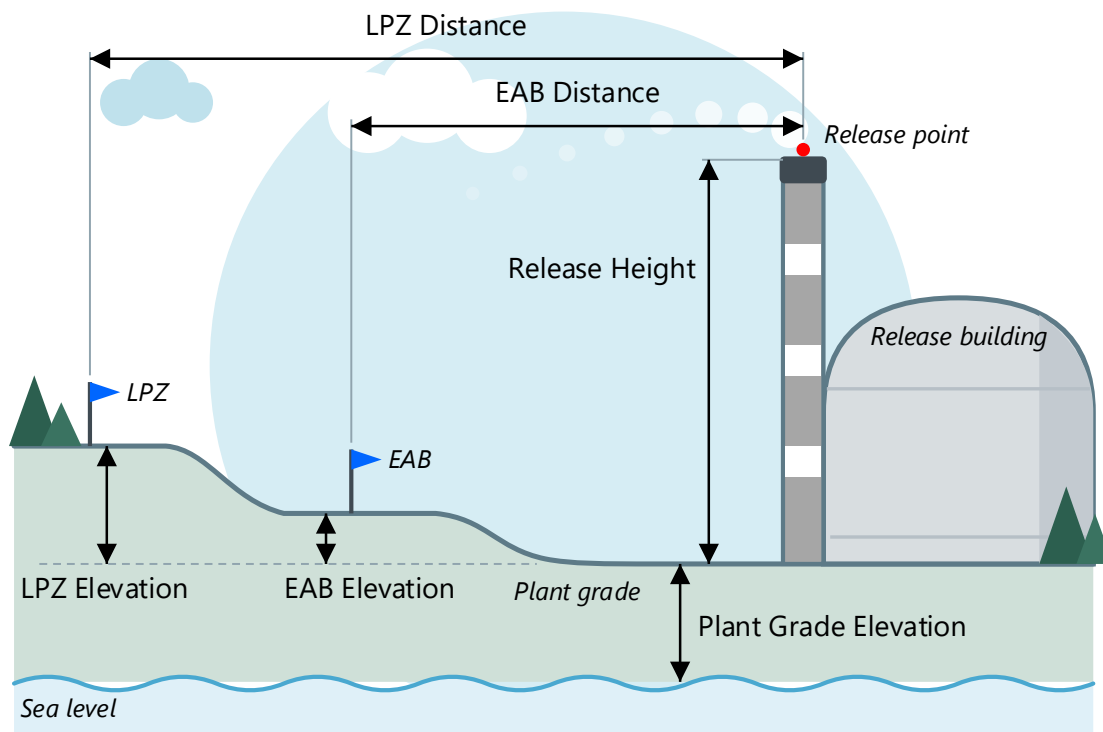


Figure 8-2. Input representation for a Design Basis Accident elevated release (not to scale).

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8.1.1. Release Type

Release Type	
Description	Selection defines how the source is represented in the dispersion model. It determines whether the release is treated as ground-level or elevated and controls which of the other release inputs are active.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	GROUND
Valid Range	GROUND ELEVATED
Recommendations	Select GROUND for releases at or near grade or whose effective height is less than 2.5 times the height of adjacent solid structures. Select ELEVATED for stack releases whose height exceeds 2.5 times the height of adjacent structures, consistent RG 1.145 C.1.3.2.
Notes / Caveats	For a ground-level release, the Release Inside Diameter, Average Release Flow Rate, Plant Grade Elevation, Average Vent Heat Emission Rate, and Site Type are not used. For an elevated release the Adjacent Building Height and Cross-sectional Area (building wake) are not used.

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8.1.2. Release Height

Release Height	
Description	Physical height of the release point (stack or vent) above plant grade. For an elevated release, it is the basis for the effective release height to which plume rise (which includes the stack-tip downwash correction) and the plant grade elevation are added and the terrain elevation at the receptor is subtracted.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	10 m
Valid Range	10 - 300 m
Recommendations	Enter the actual stack or vent exit height above plant grade. For an elevated release, the value should be at least 2.5 times the height of adjacent solid structures.
Notes / Caveats	Used only for elevated releases and disabled for ground-level releases. If an elevated release is specified with a release height less than 10 m, the wind-speed adjustment defaults to a 10 m height and a warning is issued.

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8.1.3. Release Inside Diameter

Release Diameter	
Description	Inside diameter of the stack or vent exit. It is combined with the Average Release Flow Rate to compute the average vertical exit velocity. The average vertical exit velocity drives plume rise.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0 m
Valid Range	0 - 20 m
Recommendations	Enter the actual inside diameter of the stack when crediting plume rise for an elevated release.
Notes / Caveats	Used only for elevated releases and disabled for ground-level releases. Entering a value greater than zero activates the plume rise model. A zero diameter prevents calculation of the average exit velocity and effectively disables plume rise.

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8.1.4. Average Release Flow Rate

Release Flow Rate	
Description	Average volumetric release flow rate of the exhaust gas leaving the stack or vent. Combined with the Release Inside Diameter to compute the average vertical exit velocity used for plume rise for an elevated release.
User Input Unit(s)	cubic meters per second (m ³ /s) cubic feet per second (ft ³ /s)
Engine Unit	cubic meters per second (m ³ /s)
Default Value	0 m ³ /s
Valid Range	0 - 100 m ³ /s
Recommendations	Enter the expected average volumetric discharge flow rate for the 30-day accident duration when crediting plume rise for an elevated release.
Notes / Caveats	Used only for elevated releases and disabled for ground-level releases. A non-zero value is needed to compute the average vertical exit velocity, plume rise, and the vent finite-flow correction. Use zero flow (zero exit velocity) to not consider momentum-driven plume rise (i.e., disable plume rise model).

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8.1.5. Plant Grade Elevation

Plant Grade Elevation	
Description	Ground elevation of the source location above mean sea level (plant grade). It is added to the release height (with any plume rise) when computing the effective release height and serves as the reference against which the EAB and LPZ terrain elevations are compared.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0 m
Valid Range	0 - 4,000 m
Recommendations	Enter the elevation of plant grade at the release point using the same reference (mean sea level) used for the EAB and LPZ terrain elevations entered on the Terrain panel.
Notes / Caveats	Used only for elevated releases and disabled for ground-level releases.

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8.1.6. Average Vent Heat Emission Rate

Vent Heat Emission Rate	
Description	Average rate of heat released with effluent. It is used to compute the buoyancy contribution to plume rise for an elevated release.
User Input Unit(s)	calories per second (cal/s) calories per hour (cal/h) kilowatt (kW) watt (W)
Engine Unit	calories per second (cal/s)
Default Value	0 cal/s (buoyant plume rise is neglected and only momentum rise is considered)
Valid Range	0 - 1,000,000 cal/s.
Recommendations	Enter the average heat content of the exhaust when a buoyant (thermally driven) plume rise is to be credited. Set to 0 to credit momentum rise only.
Notes / Caveats	Used only for elevated releases and disabled for ground-level releases. A value of 0 causes buoyancy to be neglected in the plume-rise calculation.

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8.1.7. Adjacent Building Height

Adjacent Building Height	
Description	Height of the nearest building or dominant solid structure adjacent to (or on which) the release point is located. It is used to compute the building-wake enhancement of the vertical plume spread (σ_z) applied to the χ/Q values.
User Input Unit(s)	meters (m) feet (m)
Engine Unit	meters (m)
Default Value	0 m (no building-wake enhancement is applied)
Valid Range	0 - 300 m
Recommendations	Enter the height of the dominant structure whose wake influences a ground-level release where wake enhancement of dispersion is credited.
Notes / Caveats	Used only for ground-level releases and disabled for elevated releases.

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8.1.8. Minimum Building Cross-sectional Area

Building Cross-sectional Area	
Description	Smallest projected cross-sectional area of the building or structure. It is used to apply building-wake corrections to χ/Q .
User Input Unit(s)	square meters (m ²) square feet (ft ²)
Engine Unit	square meters (m ²)
Default Value	0 m ² (no building-wake correction is applied)
Valid Range	0 - 10,000 m ²
Recommendations	Enter the minimum vertical cross-sectional area of the structure whose wake influences the release (e.g., the reactor building) for a ground-level release when structural-wake enhancement of dispersion is to be credited.
Notes / Caveats	Used only for ground-level releases; disabled for elevated releases. A value of 0 disables the wake correction. Larger building areas increase the building wake enhancing dispersion and therefore reduce ground-level χ/Q values. If the building area is unknown or a conservative treatment is desired, set to 0 to not account for building wake.

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8.1.9. Site Type

Site Type	
Description	Indicates whether the site is near a large body of water (coastal) or farther inland. It selects the fumigation corrections applied to an elevated release in accordance with RG 1.145.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	Inland
Valid Range	Inland Coastal
Recommendations	Select Coastal if the site is within about 2 miles of a large body of water; otherwise select Inland. Fumigation typically applies to elevated stack releases but may also apply to low-level releases that are characterized by significant plume rise due to thermal buoyancy and/or momentum.
Notes / Caveats	Used only for elevated releases; disabled for ground-level releases. Internally INLAND = 1 and COASTAL = 2.

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8.1.10. Open Terrain Recirculation

Open Terrain Recirculation	
Description	Applies the open-terrain recirculation factor (RF) of NUREG/CR-2858 [11.10] (the same factor as NUREG/CR-2919 [11.9], Figure 3.2), which corrects straight-line trajectories for recirculating or stagnating airflow.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	Off (no correction)
Valid Range	On or Off
Recommendations	Turn on when site airflow climatology shows recirculation or stagnation; otherwise leave off.
Notes / Caveats	In the DBA module, the factor is applied to the annual-average χ/Q values only; the short-term percentile values (0–2 hour through 4–30 day) are not adjusted. The factor is largest near the release point (capped at 4.0) out to just beyond about 1 km, decreasing with distance, becoming 1.0 just beyond about 16 km (10 miles) and thereafter.

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8.2. Terrain Inputs

The Terrain Inputs panel for the Design Basis Accident (DBA) module describes the location and ground elevation of the two regulatory boundaries at which accident χ/Q is evaluated:

- the exclusion area boundary (EAB) and
- the outer boundary of the low-population zone (LPZ).

For each of the sixteen standard 22.5° compass sectors (N, NNE, NE, ..., NNW) the user supplies the distance from the release point to the EAB and to the LPZ, together with the ground elevation applicable to each receptor. In identifying the distances to be assigned to a given sector for either of the two boundaries, the guidance in Regulatory Position C.1.2 of RG 1.145 should be followed (i.e., the nearest point on the building from which a given release occurs to the EAB or LPZ within a 45-degree sector centered on the compass direction of interest. For stack releases, sector-specific χ/Q estimates at additional distances beyond the EAB or LPZ may be necessary also in accordance with that guidance. In identifying the terrain height to be assigned to a given sector, the elevation should be the highest elevation between the source and that distance anywhere within the direction sector.

SIERRA ATD uses this information to locate each boundary and to determine the terrain elevation beneath the plume, which alters the effective height of an elevated release. For each modeled hour the engine identifies the downwind sector from the wind direction and evaluates the relative concentration (χ/Q) at the corresponding EAB and LPZ distances in that sector.

Terrain data are organized into two ranges, EAB and LPZ, selected with the Range control. Each range presents a grid of the sixteen sectors in which the user enters a Distance and an Elevation, and the polar grid display shows the entered points for visual confirmation. Elevation values must use the same reference (mean sea level) as the Plant Grade Elevation, Release Height, and Adjacent Building Height entered on the Release panel.

At each boundary, the engine searches outward from the boundary distance, linearly interpolating the terrain elevation along the sector profile (holding the LPZ elevation constant beyond the LPZ) and computing the effective release height as the release height plus plume rise (which includes the stack-tip downwash correction) plus the plant grade elevation, minus the interpolated terrain elevation. The maximum relative concentration found over this search is

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taken as the sector χ/Q for that boundary, consistent with the RG 1.145 [11.5] requirement to capture the maximum sector-dependent value.

As terrain rises, the plume-to-ground clearance decreases and generally increases the calculated χ/Q . For a ground-level release the effective height is fixed at zero, so the terrain elevations do not affect the result. The DBA results report the maximum-sector and overall-site χ/Q at 0.5, 5, and 50 percent exceedance levels at both the EAB and the LPZ for each averaging period. The 0.5 percentile (also may be referred to as the 99.5 percentile) sector-dependent χ/Q means that only 0.5 percent of the calculated χ/Q s are higher for a given sector or that 99.5 percent of the calculated χ/Q s are lower for a given sector. The 50th percentile χ/Q is considered to be representative of average dispersion conditions. The 5% overall-site χ/Q represents that frequency of occurrence over all sectors. RG 1.145 uses the larger of the 0.5 percentile maximum-sector value and the 5% overall site value.

Terrain elevations affect the relative concentration for an elevated release only. The boundary distances are always used for both release types to locate the points at which χ/Q is reported; for a ground-level release, however, the effective height is fixed at zero and the entered elevation values have no effect on the computed relative concentration. The elevation entries may be left at zero when the selected release type is ground-level.

The tables that follow in this section detail each input for defining the terrain input data.

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8.2.1. Distance

Distance	
Description	Downwind distance from the nearest edge of a building from which a DBA release could occur to a given sector on the exclusion area boundary (EAB range) and to the outer boundary of the low-population zone (LPZ range). These distances locate the two boundaries at which the DBA χ/Q is evaluated and, with the Elevation values, define the terrain profile used for interpolation.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	800 m for EAB 3000 m for LPZ
Valid Range	0 - 80,467 m (50 miles)
Recommendations	In a given sector, the LPZ distance in a sector should be greater than or equal to the EAB distance.
Notes / Caveats	The DBA engine uses exactly two distance points per sector, the EAB (entered in the EAB range) and the LPZ (entered in the LPZ range). Distances are independent per sector, allowing direction-specific boundaries. See Section 8.2 for additional details.

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8.2.2. Elevation

Elevation	
Description	Ground elevation at the EAB and LPZ distances for each sector, relative to mean sea level. It is used to determine the terrain elevation beneath the plume when computing the effective release height.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0 m
Valid Range	0 - 4,000 m (2.49 mi)
Recommendations	Enter elevations on the same sea-level reference used for the Plant Grade Elevation, Release Height, and Adjacent Building Height.
Notes / Caveats	The EAB and LPZ terrain elevations affect the result for an elevated release only. The elevation entries may be left at zero when the selected release type is ground-level. A missing elevation defaults to zero. See Section 8.2 for additional details.

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8.3. Meteorology Inputs

The Meteorology panel supplies the hourly weather record that drives the accident statistics. Every valid hour contributes a wind direction (i.e., determines which downwind sector the plume affects), a wind speed (i.e., how much the plume is diluted), and a vertical temperature difference (i.e., how vigorously the atmosphere mixes). The panel also displays summary statistics, and a wind rose for the loaded file. The displays and the expected file format are described in Section 10.0.

For each hour the engine first picks the measurement level. If the release height is above the midpoint of the two instrument heights it uses the upper-level data, otherwise the lower-level data is used. It then adjusts the measured speed to the height of interest for the plume:

- to the release height for an elevated release, and
- to the 10 m reference height for ground-level and vent releases.

The stability class for the hour is determined from the vertical temperature gradient (ΔT , which represents the difference between an upper and the lower measurement levels) normalized to degrees C per 100 m and categorized using the seven NRC stability categories of RG 1.23 [11.8] (Table 10-3). Missing hours are excluded; calm hours are retained with the substitute speed based on the Wind Speed Calm Threshold user input value.

Calm hours have no defined wind direction and are assigned to sectors. Within each stability class the calm hours are counted and divided evenly among the 16 sectors: each sector's share is the class total divided by 16, rounded to the nearest whole hour. The hours are then placed in the order they occur in the meteorological file, beginning in the North sector and moving clockwise to the next sector each time a sector's share is filled. A class with fewer than eight calm hours therefore has a share of zero; its hours are not discarded but are placed one per sector beginning at NNE (North receives none). When the file contains more calm hours than the rounded totals account for, the remaining hours are placed in North, NNE, NE, ... in order of occurrence and are treated as stability class G regardless of their measured class. Every calm hour is included in the sector averages, but the hours are not always spread evenly around the compass.

The tables that follow in this section define each input related to meteorological inputs.

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8.3.1. Meteorological Data File

Meteorological Data File	
Description	Path of the hourly meteorological data file used for the run, in the RG 1.23 fixed-width format described in Section 10.1.
Engine Unit	N/A
User Input Unit(s)	N/A
Default Value	N/A
Valid Range	Any file in the RG 1.23 format (Section 10.1).
Recommendations	Use a representative period of site data. RG 1.23 recommends hourly data with at least 90% recovery of concurrent wind speed, wind direction, and atmospheric stability values. Design-basis accident modeling evaluations conventionally use one or more complete annual cycles (preferably consecutive) so that seasonal patterns are captured.
Notes / Caveats	All valid hours in the file are used to determine DBA χ/Qs for the five averaging periods listed in Section 8.0 for the EAB and LPZ. Hours with missing wind direction, wind speed, and/or ΔT are excluded from the calculation of these averages (see Section 8.4.1 for the number of hourly χ/Qs necessary for a given averaging period to be considered valid). Because the DBA results are upper-percentile (infrequent occurrence) values, the statistics are driven by the few percent of hours when poor dispersion conditions predominate.

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8.3.2. Wind Speed Calm Threshold

Wind Speed Calm Threshold	
Description	Wind speed below which an hour is treated as calm. Hours whose direction is coded as calm (777.7) or whose speed is below this threshold are kept in the analysis but processed with the user-specified threshold speed as a substitute (see below).
User Input Unit(s)	meters per second (m/s) feet per minute (ft/min) kilometers per hour (km/h) miles per hour (mph)
Engine Unit	meters per second (m/s)
Default Value	0.5 m/s
Valid Range	0.1 - 50 m/s
Recommendations	Use the higher starting speed of either the site's wind speed or wind direction sensor; 0.5 m/s is a typical value unless the instrument's specifications indicate otherwise.
Notes / Caveats	Because χ/Q varies as $1/(\text{wind speed})$, the lightest-wind hours produce the highest relative concentrations and largely contribute to the offsite DBA results. Calm hours have no defined direction, so the engine distributes them equally among the 16 sectors within each stability class. This is a modification of the approach in Section 4.1 of NUREG/CR-2858 which apportions calms in proportion to each sector's light-wind frequency.

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8.3.3. Display Height Range

Display Height Range	
Description	Selects whether the Meteorology panel statistics and wind rose describe the Upper or Lower measurement level of the loaded file.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	Lower
Valid Range	Upper or Lower
Recommendations	View the level closest to the release height when judging the data; check both for completeness.
Notes / Caveats	Display only. The calculation engine independently selects the level it uses each hour by comparing the release height with the midpoint of the two measurement heights, then adjusts the speed to the release height (elevated) or the 10 m reference height (ground). A message on the panel states which level the engine uses for the current release height.

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8.3.4. Diffusion Model

Diffusion	
Description	Selects the family of curves used to compute the lateral and vertical plume-spread coefficients (σ_y , σ_z) as a function of distance and stability class. They define how wide and how tall the plume has grown by the time it reaches each downwind distance.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	NRC
Valid Range	NRC DESERT_SIGMA
Recommendations	Use NRC, the Pasquill-Gifford parameterization for RG 1.145 applications. DESERT_SIGMA reproduces the desert diffusion curves for arid, high-desert sites where the standard curves are known to misrepresent dispersion.
Notes / Caveats	The choice changes every x/Q in the run. Note that the low-wind-speed plume meander correction (below) is applied only with the NRC option.

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8.4. Results Window Description

After successful execution, the Design Basis Accident module displays its results on the Results panel. The panel offers the user the option to adjust the tolerated amount of missing data with the input defined in the table below.

8.4.1. Missing Data Criterion

Missing Data Criterion	
Description	Maximum fraction of missing hours tolerated inside a moving averaging window (2, 8, 16, 72, or 624 hours) for that window to be counted in the χ/Q frequency distributions.
User Input Unit(s)	percent (%)
Engine Unit	percent (%)
Default Value	10%
Valid Range	0 - 100%
Recommendations	10% is the conventional value, consistent with the RG 1.23 data recovery objective.
Notes / Caveats	Windows with missing data up to the criterion are averaged over their available hours; windows exceeding it are dropped. At the default 10% criterion no missing hours are tolerated in the 2- and 8-hour windows, and up to 1, 7, and 62 missing hours are tolerated in the 16-, 72-, and 624-hour windows, respectively. A stricter (smaller) value discards more windows.

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8.4.2. Summary Results View

The Summary Data by Averaging Interval grid lists the probability (percentile) level applied and the resulting χ/Q values at the two boundaries. Provided are the Max Sector EAB and Max Sector LPZ (the highest sector-dependent value at each boundary) and the Overall Site EAB and Overall Site LPZ (the corresponding site-wide direction-independent values).

8.4.3. Output File Viewer

When a run completes, the calculation engine writes a set of plain-text output files to the run's case folder (Section 5.0). Five buttons across the top of the panel each open a viewer for one of the raw output files produced by the calculation engine. The files are summarized in the table below. The five files in the table can be opened directly from the Results panel with the viewer buttons, and all are also available in the case folder.

File	Contents
ERR	Plain-text log of the warning and error messages issued during the run, headed by the program run timestamp. Errors stop the program while warnings allow the program to continue. A run that completes without issues contains only the header.
PLT	Hourly file. For each processed hour it lists the year, Julian day, and hour; the wind speed at the measurement height and the wind speed adjusted to the release height; the wind direction and downwind sector; the calm and missing-data flags; the stability class; and the centerline and sector-average χ/Q s together with the lateral and vertical diffusion coefficients (σ_y and σ_z). The diffusion coefficients are reported without the building-wake correction. This file can become large because it holds one record per hour per distance (e.g., a five-year analysis results in an approximate 15 MB .PLT file).
CFD	Cumulative frequency distributions of the running χ/Q averages over the standard averaging periods, organized by boundary distance (EAB and LPZ) and direction sector. Each block pairs a χ/Q level with the percent of time that level is equaled or exceeded; these distributions are the basis for the percentile χ/Q values reported in the summary grids.

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OUT	Main summary output. It opens with program identification and a disclaimer, followed by an echo of the run inputs and a meteorological processing summary. The results section reports the Summary Data by Direction Sector and the Summary Data by Averaging Interval, which gives for each interval the maximum-sector and overall-site χ/Q at the EAB and LPZ for each of the 0.5%, 5%, and 50% exceedance levels (RG 1.145 uses the larger of the 0.5% maximum-sector and 5% overall-site values), plus the annual average. The file ends with NORMAL PROGRAM COMPLETION.
JFD	Joint frequency distribution of the meteorological data by stability class, wind speed, and wind direction. The wind speed classes follow RG 1.23 Table 3 (upper bounds of 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0, and 10.0 m/s plus a greater than 10 m/s class); hours below the Wind Speed Calm Threshold are reported on a separate line of calm counts by stability class. Provided for reference only; this dataset is not used in the dispersion calculation but provides a useful, quick summary of dispersion-related conditions for the input meteorological data set.

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9.0 Control Room Module

The General Design Criteria (GDC) for Nuclear Power Plants set forth in Appendix A to 10 CFR Part 50 establishes minimum requirements for the design criteria for water-cooled nuclear power plants. Specifically, GDC 19, “Control room,” requires that a control room be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions. Adequate radiation protection must be provided to permit access to and occupancy of the control room for the duration of accident conditions.

In addition, NUREG-0737, “Clarification of TMI [Three-Mile Island] Action Plan Requirements” [11.14], Item II.B.2, “Design Review of Plant Shielding and Environmental Qualification of Equipment for Spaces / Systems Which May Be Used in Postaccident Operations,” Clarification Item 3, “Dose Rate Criteria,” provides criteria for the habitability of technical support centers (TSCs). This clarification recommends that a TSC be designed such that occupants do not exceed the dose limit in GDC 19 for the duration of an accident.

This section describes the models and parameters coded into the SIERRA ATD module for Control Room (CR). ATD modeling for the models and methods implemented largely follow the guidance of RG 1.194 [11.6].

In addition, RG 1.249 [11.7] outlines an alternative use of the Control Room module (formerly ARCON) for modeling onsite releases to offsite boundaries from a DBA. The originating basis for using the CR module for offsite analyses is summarized in RG 1.249. It is based on the understanding that while the ARCON code was primarily used for onsite dispersion analyses, the code had been updated (compared to the PAVAN model) with an improved building wake dispersion algorithm, inclusion of ground-level, elevated, and diffuse source release modes, use of hour-by-hour meteorological observations, sector averaging, and directional dependence of dispersion conditions which the ATD Control Room module implements. RG 1.249 outlines how to estimate χ/Q values at the EAB and the outer boundary of the LPZ out to distances of 1,200 meters (m) (3,937 feet (ft)) from the sector-specific nearest edge of a building within the nuclear island. Therefore, dispersion modeling assessments may be performed using the Control Room Module described in this section considering the guidance in RG 1.249 as an alternative to offsite assessments of design-basis accidents with the DBA module.

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9.1. Release Inputs

The Release Inputs for the Control Room (CR) module defines the characteristics of the effluent source and building that influence its near-field dispersion. The CR module computes accident-related χ/Q values at a single onsite receptor (typically at control room air intakes) using a building-wake-sensitive dispersion model in accordance with RG 1.194 [11.6].

The Control Room module supports two release types, ground-level and elevated. Plume rise is not directly applied for this module. Instead, for an elevated release, the Release (Vent) Inside Diameter (or equivalent diameter based on a rectangular or square vent's area) and Average Release Flow Rate are used to compute the average vertical exit velocity that drives the stack-tip downwash adjustment to the effective release height. Inputs that do not apply to the selected release type are disabled and hidden.

The tables that follow in this section define each input, using Figure 9-1 and Figure 9-2.

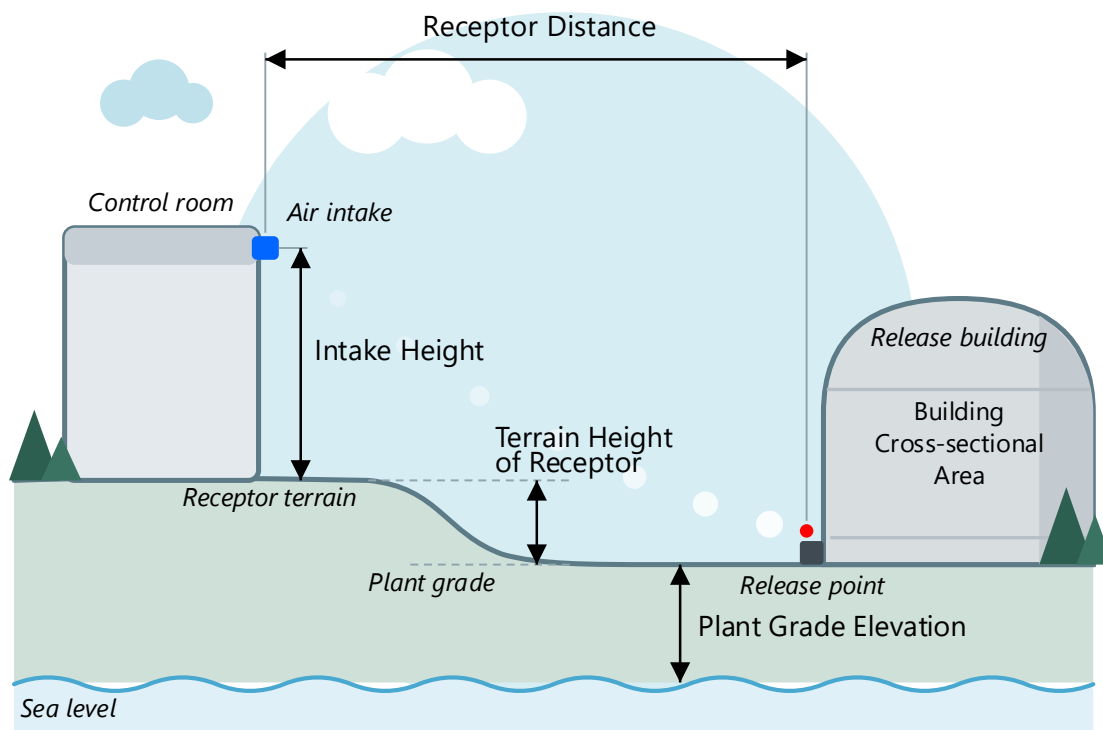


Figure 9-1. Input representation for a ground-level release for the Control Room module (not to scale).

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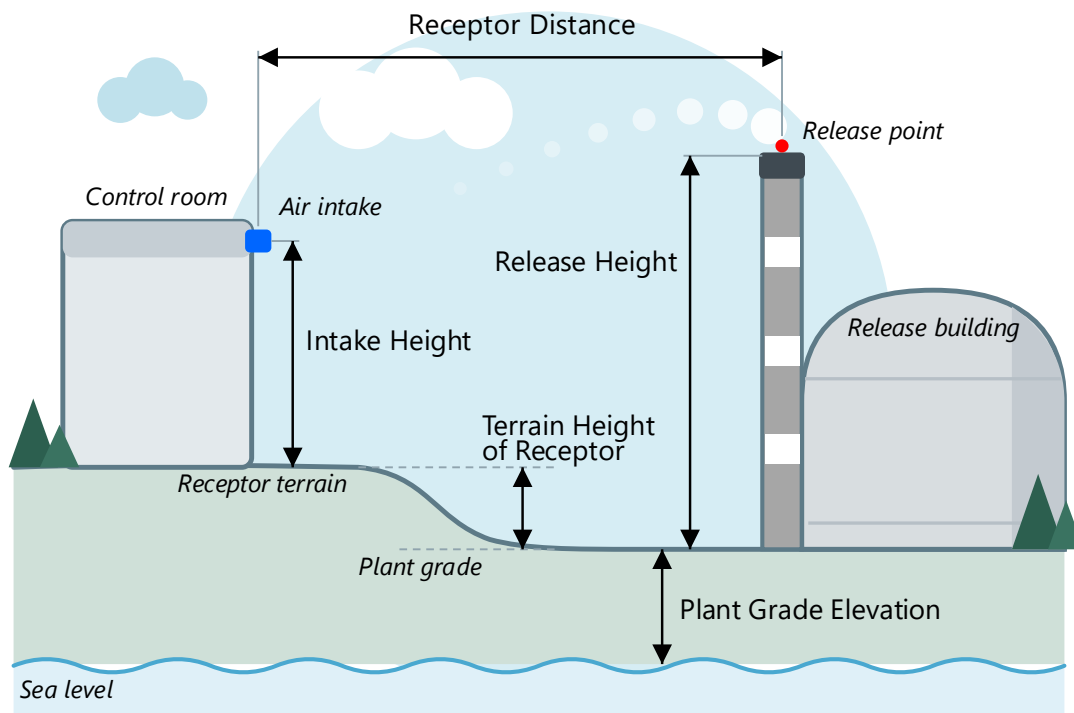


Figure 9-2. Input representation for an elevated release for the Control Room module (not to scale).

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9.1.1. Release Type

Release Type	
Description	Selection defines how the source is represented in the dispersion model. It determines whether the release is treated as ground-level or elevated, and controls which of the other release inputs are active.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	GROUND
Valid Range	GROUND ELEVATED
Recommendations	Select GROUND for releases at or near grade or whose effective height is less than 2.5 times the height of adjacent solid structures. Select ELEVATED for stack releases whose height exceeds 2.5 times the height of adjacent structures, consistent with Regulatory Position C.3.2.2 of RG 1.194.
Notes / Caveats	For a ground-level release, the Release (Vent) Inside Diameter (or equivalent diameter based on a rectangular or square vent's area), Average Release Flow Rate, and Plant Grade Elevation are not used.

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9.1.2. Release Height

Release Height	
Description	Physical height of the release point or diffuse area above plant grade at the release location. For an elevated release it is the basis for the effective release height, computed as the release height reduced by stack-tip downwash, plus the plant grade elevation, minus the intake height and the terrain elevation at the receptor.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	10 m
Valid Range	10 - 300 m
Recommendations	Enter the actual stack or release point height above plant grade. For an elevated release the value should at least 2.5 times the height of adjacent solid structures.
Notes / Caveats	Used only for elevated releases and disabled for ground-level releases. If an elevated release is specified with a release height less than 10 m, the wind-speed adjustment defaults to a 10 m height and a warning is issued. RG 1.194 Section 6 [11.6] identifies a method for a user to propose adjustments to the release height for plume rise that are due to buoyancy or mechanical jet on a case-by-case basis.

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9.1.3. Release Inside Diameter

Release Diameter	
Description	Release (Vent) Inside diameter of the stack or equivalent diameter based on the area of a rectangular or square vent exit. It is combined with the Average Release Flow Rate to compute the average vertical exit velocity which drives the stack-tip downwash adjustment for an elevated release.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0 m
Valid Range	0 - 20 m
Recommendations	Enter the actual inside diameter of the stack or equivalent diameter based on the area of a rectangular or square vent for an elevated release to account for downwash.
Notes / Caveats	Used only for elevated releases and disabled for ground-level releases. The Control Room module applies stack-tip downwash as an explicit correction (the Routine Release and DBA modules include it within the plume-rise model); the downwash lowers the effective release height when the exit velocity is low relative to the wind speed. A zero diameter prevents calculation of the exit velocity. With zero flow the exit velocity is zero, which maximizes the computed downwash resulting in a minimized effective release height.

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9.1.4. Average Release Flow Rate

Release Flow Rate	
Description	Average volumetric release flow rate of the exhaust gas leaving the stack or vent. Combined with the Release Inside Diameter or equivalent diameter based on the area of a rectangular or square vent to compute the average vertical exit velocity used for the stack-tip downwash adjustment.
User Input Unit(s)	cubic meters per second (m ³ /s) cubic feet per second (ft ³ /s)
Engine Unit	cubic meters per second (m ³ /s)
Default Value	0 m ³ /s
Valid Range	0 - 100 m ³ /s
Recommendations	Enter the design or measured volumetric discharge rate for an elevated release.
Notes / Caveats	Used only for elevated releases and disabled for ground-level releases. With zero flow the exit velocity is zero, which maximizes the computed downwash resulting in a minimized effective release height.

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9.1.5. Plant Grade Elevation

Plant Grade Elevation	
Description	Ground elevation of the source location above mean sea level (plant grade). It is added to the release height when computing the effective release height and serves as the reference against which the any receptor terrain elevation is compared.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0 m
Valid Range	0 - 4,000 m
Recommendations	Enter the elevation of plant grade at the release point using the same reference used for the receptor terrain height.
Notes / Caveats	Used only for elevated releases and disabled for ground-level releases.

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9.1.6. Building Cross-sectional Area

Building Cross-sectional Area	
Description	Smallest projected cross-sectional area of the building or structure, perpendicular to the source-to-receptor wind direction. This is used by the dispersion algorithm (Ramsdell wake corrections) to enhance the plume spread and reduce the near-field χ/Q. See Section 9.2 for the relation of this parameter to the modeling of the control room intake.
User Input Unit(s)	square meters (m²) square feet (ft²)
Engine Unit	square meters (m ²)
Default Value	0 m ² (no building-wake correction is applied)
Valid Range	0 - 10,000 m ²
Recommendations	Enter the minimum projected area of the structure whose wake influences the release (e.g., the reactor building) for a ground-level release when structural-wake enhancement of dispersion is to be credited. Larger building areas increase the building wake enhancing dispersion and therefore reducing ground-level χ/Q values. If building area is unknown or a conservative treatment is desired, set to 0 to not account for building wake.
Notes / Caveats	Read by the engine only for a ground-level release; disabled for elevated releases. A value of 0 disables the wake correction.

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9.2. Control Room Intake Inputs

For a given model run, the Control Room (CR) module evaluates relative concentrations (χ/Q_s) at a single receptor (e.g., the normal or emergency control room air intake, other points of ingress or egress, an onsite or near-field offsite TSC). The Control Room Intake Inputs panel defines the location of the intake or other receptor relative to a given release point and the range of wind directions over which it is assumed to be affected by the release. This allows for computing accident-related χ/Q values at the receptor in accordance with RG 1.194 [11.6].

On the Receptors panel, the user enters the Receptor Distance, Intake Height (or other receptor height), and Terrain Height of Receptor for the receptor in question, selects the Direction to Source (i.e., the compass bearing relative to True North from the receptor toward the release point), and specifies the Wind Direction Window. The Direction to Source is shown graphically as the selection is made.

The effective release height is determined by starting from the release height, reducing it by stack-tip downwash (for an elevated release), adding the plant grade elevation, and subtracting the Intake Height and the Terrain Height of Receptor; a negative calculated result is set to zero. The Receptor Distance and the effective height together define the slant range (i.e., the straight-line distance from the effective release point to the intake) at which the lateral and vertical dispersion coefficients are evaluated.

For a ground-level release the effective height is fixed at zero, so the Terrain Height of Receptor is not applied and may be left at its default. The Receptor Distance, Intake Height, and Plant Grade Elevation still enter the slant-range geometry for a ground-level release; only the receptor terrain term is omitted.

For each modeled hour the measured wind direction is compared with the window defined by the Direction to Source and the Wind Direction Window. The window spans one-half of the window width on either side of the direction to the source; only those valid hours with wind directions falling within this band are treated as transporting the plume toward the intake and contribute a non-zero χ/Q to the relative concentration. This directional selection applied hour by hour with the building-wake-sensitive dispersion model, yields the χ/Q values reported for the control room habitability assessment per RG 1.194.

Figure 9-3 illustrates the use of the wind direction window. The window is centered on the intake (Direction to Source) and spans half the window width to

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either side. A valid hour contributes to the intake a non-zero χ/Q only when its wind direction falls inside the shaded band (i.e., the wind blows from the source side toward the intake) or when the hour is calm (valid calm hours always contribute since a drifting plume cannot be assumed to miss the intake). Valid hours outside the window contribute χ/Q s of zero and therefore dilute any averaging intervals they occur within. Widening the window admits more hours (usually raising the 95th-percentile χ/Q) while narrowing it credits the geometry of the specific source-intake pair.

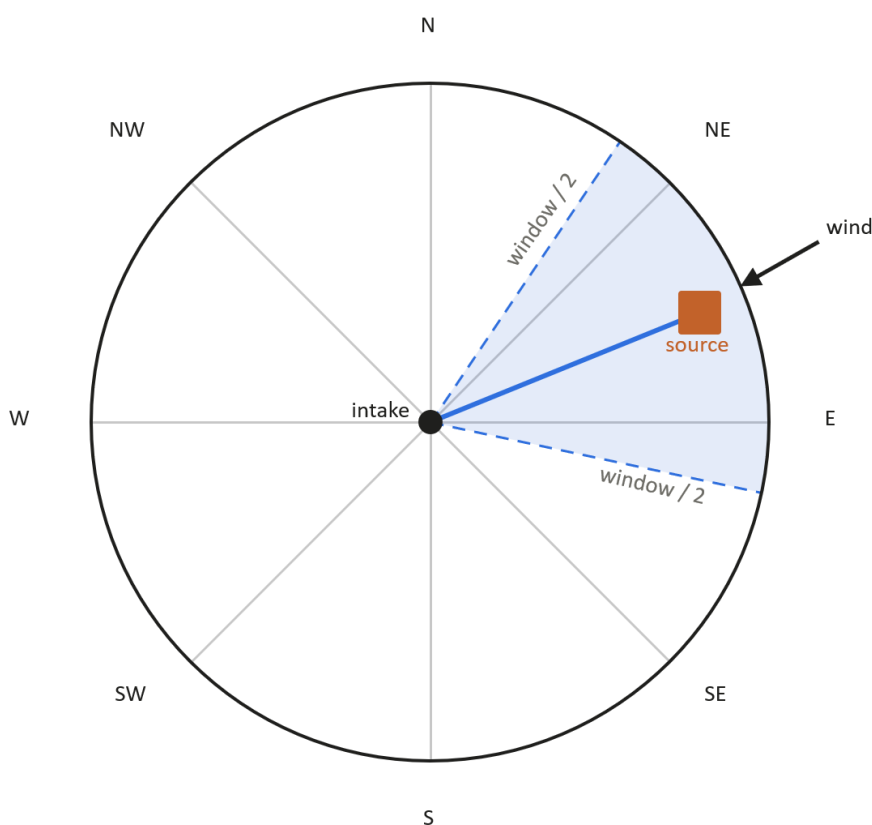


Figure 9-3. Wind-direction window centered on the Direction to Source (default 90° window shown).

The downstream side of a building sitting in the wind sheds a turbulent recirculating wake. The size of that wake scales with building area. Effluent released at or near the structure (i.e., not an elevated source) gets caught in this enhanced turbulence and is diluted faster than it would be in open terrain. This effect is modeled as enhancements to the Gaussian plume spread parameters σ_y and σ_z . Figure 9-4 provides a representation of the source, building, and wind direction and the influence of the building wake where the

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'wind perp face' is the building face perpendicular to the wind direction (the projected area).

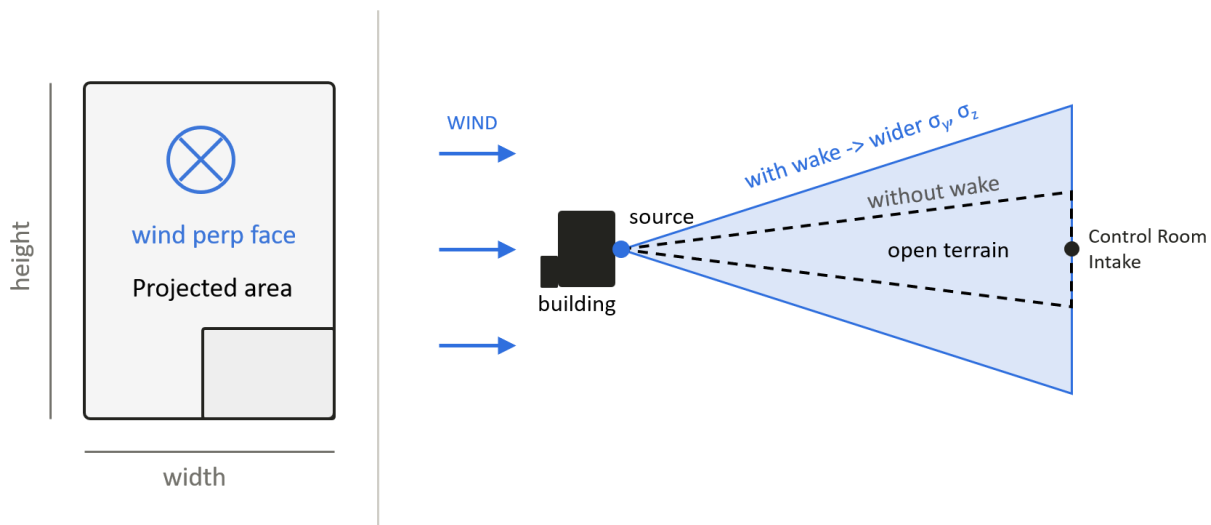


Figure 9-4. Building wake modeling for a control room (onsite receptor).

The tables that follow in this section define each input for defining the Control Room Intake parameters.

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9.2.1. Receptor Distance

Receptor Distance	
Description	Horizontal (ground-level) distance from the release point to the control room air intake or other onsite receptor. With the effective release height it forms the slant range at which the dispersion coefficients are evaluated.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	10 m
Valid Range	0 - 10,000 m
Recommendations	Enter the straight-line ground distance (not the slant range distance) from the release point to the intake (or other receptor). Distances less than about 10 m should not be evaluated with this module (RG 1.194 Regulatory Position 3.4).
Notes / Caveats	Combined with the effective release height to compute the slant range (the hypotenuse of the horizontal straight-line ground distance and the effective height); the dispersion coefficients are evaluated at this slant range.

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9.2.2. Intake Height

Intake Height	
Description	Height of the control room air intake (or other receptor) above the ground at the receptor location. It is subtracted when computing the effective release height, decreasing the plume-to-intake (receptor) separation for an elevated release.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	1 m
Valid Range	0 - 100 m
Recommendations	Enter the actual height of the intake (or other receptor) above plant grade.
Notes / Caveats	For an elevated release the effective height is computed as release height – stack-tip downwash + plant grade elevation – intake height – terrain elevation at the receptor; a negative result is set to zero.

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9.2.3. Terrain Height of Receptor

Terrain Height of Receptor	
Description	Ground elevation at the intake (or other receptor) location, relative to mean sea level. It is subtracted from the effective release height to account for any terrain rise between the source and the intake (or other receptor).
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0 m
Valid Range	0 - 4,000 m
Recommendations	Enter the terrain elevation at the intake (or other receptor) on the same mean-sea-level datum used for the Plant Grade Elevation and Release Height.
Notes / Caveats	For a ground-level release the effective height is fixed at zero, so the Terrain Height of Receptor is not applied and may be left at its default. For an elevated release, higher terrain reduces the effective release height and generally increases the calculated χ/Q at the intake (or other receptor).

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9.2.4. Direction to Source

Direction to Source	
Description	Compass bearing relative to True North from the control room intake (or other receptor) toward the release point. It defines the center of the wind-direction window used to select the meteorological hours along with valid calm hours that contribute non-zero χ/Q_s at the receptor in question.
User Input Unit(s)	degrees (°)
Engine Unit	degrees (°)
Default Value	0°
Valid Range	0 - 359°
Recommendations	Enter the compass bearing relative to True North from the intake (or other receptor) to the source; the interface displays the selected direction graphically.
Notes / Caveats	Used with the Wind Direction Window to flag the hours when the wind is blowing from the source toward the intake (or other receptor). For this input, wrapping of the compass direction is enabled. A value of 0° and 360° are equivalent, with an entered value of 360° being processed to be 0°. For other directions greater than 360°, they will be scaled to being between a value of 0 - 359° (e.g., a value of 400° will be processed to 40°).

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9.2.5. Wind Direction Window

Wind Direction Window	
Description	Total angular width of the band of valid wind directions, centered on the Direction to Source, over which the release is assumed to reach the intake (or other receptor).
User Input Unit(s)	degrees (°)
Engine Unit	degrees (°)
Default Value	90°
Valid Range	0 - 360°
Recommendations	Use the RG 1.194 default of 90 degrees unless a site-specific justification supports a different window.
Notes / Caveats	Valid hours whose wind direction falls within one-half of this window on either side of the direction to the source (and valid calm hours) contribute non-zero χ/Q s to a given averaging interval. Valid hours whose wind direction fall outside the wind direction window contribute χ/Q values of zero to a given averaging interval.

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9.3. Meteorology Inputs

The Meteorology panel supplies the hourly data record, the surface roughness, and diffusion modeling inputs for a site. The results for the control room intake or other receptor are percentile statistics over the valid hours of the input meteorological record. Only those hours whose wind blows from the source toward a given intake or other receptor (i.e., within the specified wind direction window, Section 9.2), plus any calm hours, contribute non-zero χ/Qs to a given averaging interval. Valid hours whose wind direction is outside the wind direction window contribute χ/Qs of zero to a given averaging interval. The raw meteorological file statistics are displayed in the panel. The expected meteorological file format is described in Section 10.0.

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For each hour the engine first picks the measurement level. If the release height is above the midpoint of the two instrument heights it uses the upper-level data, otherwise the lower-level data is used. It then adjusts the measured speed to the height of interest for the plume:

- to the release height for an elevated release, and
- to the 10 m reference height for ground-level and vent releases.

The stability class for the hour is determined from the vertical temperature gradient (ΔT , which represents the difference between an upper and the lower measurement levels) normalized to degrees C per 100 m and categorized by using the seven NRC stability categories of RG 1.23 [11.8 Table 10-3]. Missing hours are excluded; calm hours are retained with the substitute speed based on the Wind Speed Calm Threshold input value.

Calm hours have no defined wind direction, so the Control Room module does not apply the Wind Direction Window test to them. Every calm hour is treated as though the wind carries the plume directly from the release point to the intake. The hour's wind speed is replaced by the Calm Threshold value (not half the threshold as in the other modules), the stack-tip downwash correction is not applied, and χ/Q is computed with the same diffusion and building-wake treatment as any other in-window hour. The count of hours handled this way is reported as 'Hours of calm winds' in the output file, separate from the hours excluded because their direction fell outside the window.

The tables that follow in this section define each input related to meteorological inputs.

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9.3.1. Meteorological Data File

Meteorological Data File	
Description	Path of the hourly meteorological data file used for the run. The file must follow the RG 1.23 fixed-width format described in Section 10.1, with two measurement levels and the vertical temperature difference.
Engine Unit	N/A
User Input Unit(s)	N/A
Default Value	N/A
Valid Range	Any file in the RG 1.23 format (Section 10.1).
Recommendations	Use a representative period of site data. RG 1.23 recommends hourly data with at least 90% recovery of concurrent wind speed, wind direction, and atmospheric stability values. Design-basis accident modeling evaluations for onsite control room habitability assessments conventionally use one or more complete annual cycles (preferably consecutive) so that seasonal patterns are captured.
Notes / Caveats	All valid hours in the file are used to determine the onsite DBA χ/Q s for the five averaging periods listed in Section 9.0. Hours with missing wind direction, wind speed, and/or ΔT data are excluded from the calculation of these averages (see Section 9.4.1 for the number of hourly χ/Q s necessary for a given averaging period to be considered valid). However, valid hours outside the wind direction window contribute a χ/Q value of zero to a given averaging interval. The 95th-percentile results sample the adverse tail of this record which is what makes the wind direction window and the length of record important to the statistics.

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9.3.2. Wind Speed Calm Threshold

Wind Speed Calm Threshold	
Description	Wind speed below which an hour is treated as calm. Hours whose direction is coded as calm 777.7) or whose speed is below this threshold are kept in the analysis but processed with the user-specified threshold speed as a substitute (see below). Calm hours are retained with the threshold speed substituted and always contribute to the intake χ/Q , because a drifting plume under calm conditions cannot be assumed to miss the intake.
User Input Unit(s)	meters per second (m/s) feet per minute (ft/min) kilometers per hour (km/h) miles per hour (mph)
Engine Unit	meters per second (m/s)
Default Value	0.5 m/s
Valid Range	0.1 - 50 m/s
Recommendations	Use the higher starting speed of either the site wind speed or wind direction sensor; 0.5 m/s is a typical value unless the instrument's specifications indicate otherwise.
Notes / Caveats	Because χ/Q varies as $1/(\text{wind speed})$, the lightest-wind speed hours produce the highest relative concentrations and largely contribute to the 95th percentile DBA onsite (intake) results. Calm hours have no defined direction, so in accordance with Section 3.3 of NUREG/CR-6331 in all cases of calm wind conditions the receptor is assumed to be directly downwind of the release point.

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9.3.3. Display Height Range

Display Height Range	
Description	Selects whether the Meteorology panel statistics and wind rose describe the Upper or Lower measurement level of the loaded file.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	Lower
Valid Range	Upper or Lower
Recommendations	View the level closest to the release height when judging the data; check both for completeness.
Notes / Caveats	Display only, the calculation engine independently selects the level it uses each hour by comparing the release height with the midpoint of the two measurement heights, then adjusts the speed to the release height (elevated or vent) or the 10 m reference height (ground). A message on the panel states which level the engine uses for the current release height.

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9.3.4. Surface Roughness Length

Surface Roughness Length	
Description	Length scale (z_0) describing the general texture of the terrain upwind of the site (based on the default Wind Direction Window for a given source-receptor alignment) used to model how much the surface (grass, crops, trees, buildings) mixes the transport wind.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0.2 m (open grassland)
Valid Range	0 m – 10 m
Recommendations	RG 1.194, Appendix A (Table A—2), recommends using 0.2 m for most sites (reasonable values range from about 0.1 m for low-vegetation sites to 0.5 m for forest-covered sites); use a value representative of the site's upwind surface. Typical guides: 0.01 - 0.03 m open water/mowed grass; 0.1 - 0.25 m cropland; 0.5 - 1 m forest, urban or built-up surroundings.
Notes / Caveats	A larger (z_0) means a more sheared, more turbulent profile, which changes the wind speed extrapolated from the instrument measurement height to the release height. The effect is secondary to wind speed and stability themselves, but using an extreme value of z_0 for the site biases the speed adjustment every hour of the run: a larger value increases the shear, so a speed extrapolated upward to a release height above the measurement height increases (lowering χ/Q) and one extrapolated

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Surface Roughness Length	
	downward decreases (raising χ/Q). Unlike the other modules, the Control Room module then adjusts the speed with the Monin-Obukhov profile using the Surface Roughness Length rather than the simple power law.

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9.3.5. Diffusion Model

Diffusion Model	
Description	Selects the family of curves used to compute the lateral and vertical plume-spread coefficients (σ_y , σ_z) as a function of distance and stability class. They define how wide and how tall the plume has grown by the time it reaches the receptor distance.
User Input Unit(s)	N/A
Engine Unit	N/A
Default Value	NRC
Valid Range	NRC
Recommendations	Use the NRC diffusion model, consistent with NUREG/CR-6331 and RG 1.194.
Notes / Caveats	The modeling then augments the base NRC base coefficients with two corrections derived by Ramsdell [11.15]: a low-wind-speed meander term and a building-wake term scaled by the Cross-sectional Area. The lateral spread is capped at 1.81 times the distance.

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9.3.6. Initial Lateral Diffusion Sigma Y

Diffusion Sigma Y	
Description	Initial lateral diffusion coefficient σ_{y0} . A non-zero value tells the engine the release is not a point but an area (e.g., a bank of many small vents with simultaneous releases or leakage spread over a building face) that already has lateral width at the moment of release.
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0 m (point source)
Valid Range	>0 m
Recommendations	Specify 0 for a single stack, vent, or louver. For a diffuse or multi-vent source, follow the ARCON 2.0 guidance [11.12]: treat the source area as bounded by the $\pm 2.15 \sigma$ edges of a Gaussian distribution, such that $\sigma_{y0} \approx (\text{source width})/4.3$; RG 1.194 Regulatory Position 3.2.4.4 (Equation 3) uses $(\text{source width})/6$.
Notes / Caveats	A non-zero σ_{y0} starts the plume already diluted, lowering the near-field χ/Q ; its influence fades with distance as atmospheric growth dominates. The initial coefficients seed the σ recalculation performed when the slant range exceeds the horizontal distance by more than 1% (i.e., when the source-intake geometry has meaningful vertical offset). This input value matters most when the intake is close to the source. The initial lateral and vertical coefficients are independent; either may be zero while the other is non-zero.

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9.3.7. Initial Vertical Diffusion Sigma Z

Diffusion Sigma Z	
Description	Initial (virtual source) vertical diffusion coefficient σ_{z0} .
User Input Unit(s)	meters (m) feet (ft)
Engine Unit	meters (m)
Default Value	0 m (point source)
Valid Range	>0 m
Recommendations	Specify 0 for a discrete release point. For a source distributed over a vertical extent (e.g., openings on a building face), size it analogously to σ_y using the vertical extent of the source area ($\sigma_{z0} \approx \text{source height}/4.3$; RG 1.194 Regulatory Position 3.2.4.4, Equation 4, uses source height/6) [11.12].
Notes / Caveats	A non-zero σ_{z0} starts the plume already diluted, lowering the near-field χ/Q ; its influence fades with distance as atmospheric growth dominates. The initial coefficients seed the σ recalculation performed when the slant range exceeds the horizontal distance by more than 1% (i.e., when the source-intake geometry has meaningful vertical offset). This input value matters most when the intake is close to the source.

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9.4. Results Window Description

After a successful run, the Control Room module displays its results on the Results panel. The panel provides buttons to open viewers for the raw output files and presents the computed control room relative concentrations, χ/Q (s/m^3), at the air intake (or other receptor) in two summary grids.

The panel offers the user the option to adjust the tolerated amount of missing data and define a percentile that is of interest with inputs defined in the tables below. The 95th percentile is the RG 1.194 metric for control room habitability and is always reported; the user-defined percentile (e.g., 99.5% for offsite use per RG 1.249) is reported in addition to it.

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9.4.1. Missing Data Criterion

Missing Data Criterion	
Description	Maximum fraction of missing hours tolerated inside a moving averaging window (1 through 720 hours) for that window to be counted in the χ/Q frequency distributions.
User Input Unit(s)	percent (%)
Engine Unit	percent (%)
Default Value	10%
Valid Range	0 - 100%
Recommendations	10% is the conventional value.
Notes / Caveats	Windows with missing data up to the criterion are averaged over their available hours; windows exceeding it are dropped from the statistics. A stricter (smaller) value discards more windows. At the default 10% criterion no missing hours are tolerated in the 1- through 8-hour windows, and up to 2, 9, 16, 36, and 72 missing hours are tolerated in the 24-, 96-, 168-, 360-, and 720-hour windows, respectively.

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9.4.2. User Defined Percentile

User Defined Percentile	
Description	Adds a second percentile row to the results alongside the 95th percentile; the default of 99.5% is the RG 1.249 value for offsite receptors.
User Input Unit(s)	percent (%)
Engine Unit	percent (%)
Default Value	99.5%
Valid Range	0 - 100%
Recommendations	The additional percentile of interest can be set to other values (e.g., 99.5% for RG 1.249 offsite use, or 50% for a median value)..
Notes / Caveats	The extra row is labeled with the chosen percentile in both results grids and in the OUT file.

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9.4.3. Summary Results View

The Results Panel provides two grids to summarize the control room (or other receptor) χ/Qs , each with two value rows:

- the 95th-percentile χ/Q , which is the metric required by RG 1.194 [11.6] for onsite χ/Qs input to habitability assessments, and
- the user-defined percentile χ/Qs , whose percentile is set by the User Defined Percentile input.

The Summary Data by Averaging Interval grid presents these two rows across columns of increasing averaging period in hours. The Summary Data by Standard Time Interval grid presents the standard accident time intervals of RG 1.194 [11.6] — 0 to 2 hours, 2 to 8 hours, 8 to 24 hours, 24 to 96 hours (1 to 4 days), and 96 to 720 hours (4 to 30 days). Values are shown in scientific notation in units of s/m^3 .

9.4.4. Output File Viewer

When a run completes, the calculation engine writes a set of plain-text output files to the run's case folder (Section 5.0). The buttons across the top of the panel open a viewer for one of the raw output files produced by the calculation engine. The files are summarized in the table below. These files can be opened directly from the Results panel with the viewer buttons, and all are also available in the case folder.

File	Content shown in the viewer
ERR	Plain-text log of the warning and error messages issued during the run, headed by the program run timestamp. Errors stop the program while warnings allow the program to continue. A run that completes without issues contains only the header.
PLT	Hourly file. For each processed hour it lists the year, Julian day, and hour; the wind speed at the measurement height and the wind speed adjusted to the release height; the wind direction and downwind sector; the calm and missing-data flags; the stability class; and the centerline and sector-average χ/Qs together with the lateral and vertical diffusion coefficients (σ_y and σ_z). For ground-level releases the reported diffusion coefficients

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File	Content shown in the viewer
	include the ARCON low-wind-speed and building-wake enhancements; for elevated releases they are the base curves. This file can become large because it holds one record per hour (e.g., a five-year analysis results in an approximate 7 MB .PLT file).
CFD	Cumulative frequency distributions of the running χ/Q averages over the standard averaging periods. Each block pairs a χ/Q level with the percent of time it is equaled or exceeded. These distributions are the basis for the 95th-percentile and user-defined-percentile χ/Q values reported in the summary grids.
OUT	Main summary output. It opens with program identification and a disclaimer, followed by an echo of the run inputs and a meteorological processing summary that also reports the wind direction window and the count of hours inside and outside of the wind direction window. The results section reports the Summary Data by Averaging Interval (the 95th-percentile and a second, user-selected percentile χ/Q for averaging periods from 1 to 720 hours, with the applied upper and lower χ/Q limits), the Summary Data by Standard Time Interval (the same two percentiles for 0-2 h, 2-8 h, 8-24 h, 1-4 days, and 4-30 days), and the Hourly Value Range (the maximum and minimum centerline and sector-average χ/Q). χ/Q values are in s/m^3 . The file ends with NORMAL PROGRAM COMPLETION.
JFD	Joint frequency distributions of the meteorological data by stability class, wind speed, and wind direction. The wind speed classes follow RG 1.23 Table 3 (upper bounds of 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0, and 10.0 m/s plus a greater than 10 m/s class); hours below the Wind Speed Calm Threshold are reported on a separate line of calm counts by stability class. Provided for reference only; this dataset is not used in the dispersion calculation but provides a useful, quick summary of dispersion-related conditions for the input meteorological data set.

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10.0 Meteorological Data File Viewer

The Meteorology panel of every module displays summary statistics for the loaded (as provided) meteorological input data file together with a wind rose plot showing the cumulative percentage of wind speeds by direction sector for that data file as provided. This section describes the displayed statistics and the format of the data file that the software expects. Depending on the module, wind speeds below the calm threshold will be redistributed. For example, the Routine Release and DBA modules redistribute the calm hours among the sixteen sectors, while the Control Room module assumes every calm hour reaches the receptor (see the ATD Technical Manual [11.3]). The wind rose plot displayed in the user interface does not apply the module specific treatment of calm winds to allow the user to view the meteorological input data in order to allow for identifying any issues in the underlying data prior to processing.

SIERRA ATD processes hourly meteorological input as a continuous time series over the full user-specified Period of Record (POR). The model does not impose calendar-year segmentation or fixed 12-month analysis blocks when computing atmospheric dispersion factors. Instead, all valid hourly records are treated sequentially in the order provided, regardless of year boundaries or the starting month of the dataset.

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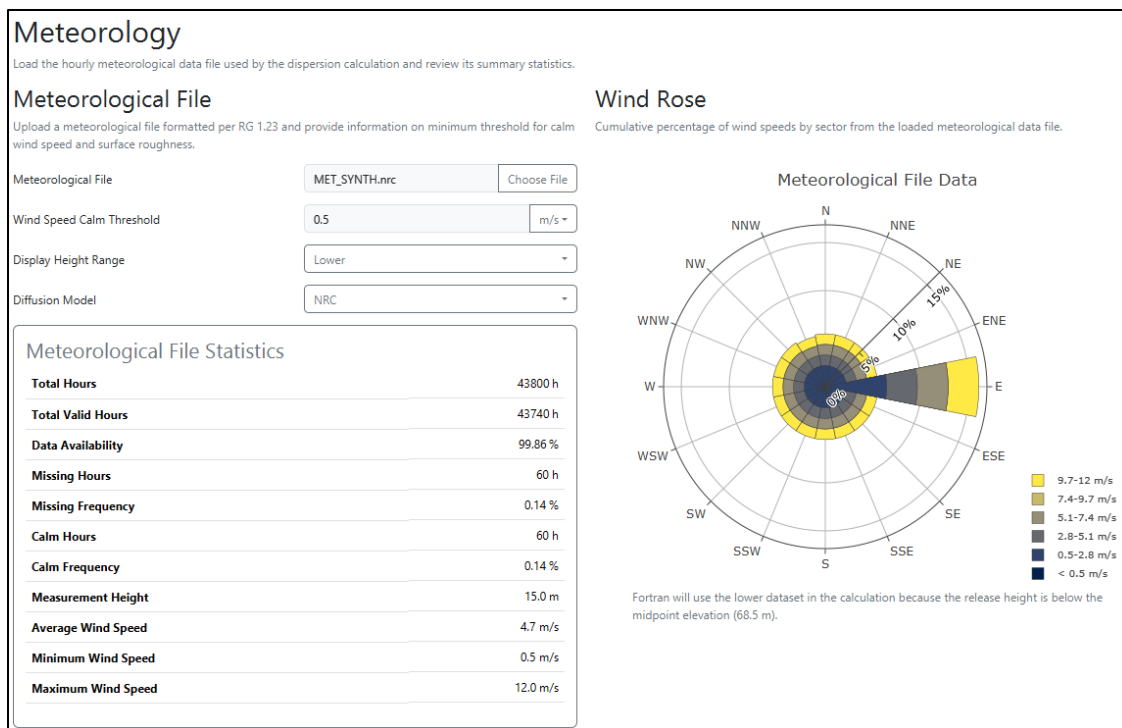


Figure 10-1. Meteorology panel (Control Room module) with a synthetic meteorological data file loaded.

Two user inputs change what the statistics describe. The Wind Speed Calm Threshold sets the floor applied to low wind speeds: hours below it are counted as Calm Records and appear in the lowest speed bin of the wind rose. The Display Height Range drop-down switches the display between the Upper and Lower measurement levels in the file. The calculation engine independently selects the level it uses each hour by comparing the release height with the midpoint of the two measurement heights. A message on the panel informs the user which level is used based on the user inputs.

The provided summary and statistic values with descriptions are defined in Table 10-1

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Table 10-1. Provided meteorological file summary and statistic values.

Parameter	Description
Total Number of Hours	Total number of hourly records in the file, including calm and missing hours.
Total Valid Hours	Hours usable by the calculation: total hours minus Missing Records.
Data Availability	Percentage of hours in which wind direction, wind speed, and ΔT stability are all valid in the same hour; compare to the RG 1.23 objective of at least 90% recovery.
Missing Hours	Number of hours in which wind direction, wind speed, or ΔT stability is missing; an hour missing any one of the three is excluded from the calculation.
Missing Frequency	Number of Missing Records as a percentage of the total number of hours.
Calm Hours	Number of hours treated as calm: direction coded calm (777.7) in the file, or speed below the Wind Speed Calm Threshold. These hours remain in the calculation with the threshold speed substituted.
Calm Frequency	Number of Calm Records as a percentage of the total number of hours.
Measurement Height	The closest measurement height in the data file to the release height.
Average Wind Speed	Average wind speed (m/s) over the valid (non-missing) hours at the selected display level, after the calm floor is applied.

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Parameter	Description
Minimum Wind Speed	Lowest valid wind speed (m/s) at the selected display level after the calm floor is applied; never below the Wind Speed Calm Threshold.
Maximum Wind Speed	Highest valid wind speed (m/s) at the selected display level.

10.1. Meteorological Data File Format

The expected file format contains an hourly fixed-width text format detailed in RG 1.23 [11.8], Appendix A: five free-text header lines (e.g., station, period of record, measurement heights), then one 160-character record per hour with the fields A4, I4, I3, I4, 25F5.1, F5.2, 3F5.1. Each record carries an identifier; the year, Julian day, and hour; then, for each of three measurement levels (upper, intermediate, lower), the measurement height, wind direction, wind speed, sigma-theta, temperature, moisture, and a spare value; then the level-to-level temperature differences (ΔT stability, normalized to °C per 100 m), precipitation, solar radiation, visibility, and two spare values. Records longer than 160 characters are dropped by the file reader and counted as missing in the panel statistics; shorter records are padded with blanks (blank fields read as zero). Decimal points should be included in each numeric field. Wind directions of 0 and 360 are both read as North.

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The calculation engine reads only the fields below; the remaining columns are skipped. Note that the engine uses the upper and lower wind measurement levels and the upper-minus-lower ΔT — the intermediate level is carried in the file but not used.

Table 10-2. Meteorological data file fields read by the calculation engine.

Field	Content
Year, Julian day, hour	Date and hour of the record (for example, 1983, day 1, hour 0100).
Upper level: height, direction, speed	Measurement height (m), wind direction (degrees from true north), and wind speed (m/s) at the upper instrument level.
Lower level: height, direction, speed	Measurement height (m), wind direction (degrees), and wind speed (m/s) at the lower instrument level.
ΔT (upper – lower)	Vertical temperature difference between the levels, normalized to °C per 100 m; the basis for the stability classification (Table 10-3).
Data codes	Missing-data sentinels recognized by the engine. Calm hours: direction coded 777.7 (the hour is kept and the calm treatment applies). Missing data: direction 7777.8 or greater, speed 200 m/s or greater (e.g., 999.9), or ΔT 777.8 or greater — the hour is excluded from the calculation.

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Atmospheric stability is classified based on the temperature gradient ($\Delta T / \Delta z$) into the seven NRC categories of RG 1.23 [11.8], Table 1. The temperature gradient is defined in units of degrees Celsius per 100 m. The stability class is the single strongest control on plume spread: class A mixes the plume away quickly, while classes F and G hold it together for kilometers which is why stable, light-wind hours dominate the high-percentile accident results. X/Q is also inversely proportional to wind speed.

Table 10-3. Stability classification from the vertical temperature difference (RG 1.23).

Class	$\Delta T / \Delta z$ (°C per 100 m)	Description
A	$\Delta T \leq -1.9$	Extremely unstable; vigorous mixing, fastest plume spread.
B	$-1.9 < \Delta T \leq -1.7$	Moderately unstable.
C	$-1.7 < \Delta T \leq -1.5$	Slightly unstable.
D	$-1.5 < \Delta T \leq -0.5$	Neutral; typical windy and/or overcast conditions.
E	$-0.5 < \Delta T \leq 1.5$	Slightly stable.
F	$1.5 < \Delta T \leq 4.0$	Moderately stable; poor dispersion.
G	$\Delta T > 4.0$	Extremely stable; weakest mixing, highest x/Q for ground-level releases.

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References

11.0 References

- 11.1. NUREG/BR-0167, Software Quality Assurance Program and Guidelines. U.S. Nuclear Regulatory Commission. (ADAMS Accession No. ML012750471)
- 11.2. RCD-19-0157, Revision 3, RCD Software Program Manual.
- 11.3. RCD-26-058, Revision 0, SIERRA ATD Technical Manual.
- 11.4. Regulatory Guide 1.111, Revision 1 (Issued for Comment), Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors. U.S. Nuclear Regulatory Commission. Washington, DC. July 1977. (ADAMS Accession No. ML003740354)
- 11.5. Regulatory Guide 1.145, Revision 1, Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants. U.S. Nuclear Regulatory Commission. Washington, DC. November 1982. (ADAMS Accession No. ML003740205)
- 11.6. Regulatory Guide 1.194, Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants. U.S. Nuclear Regulatory Commission. Washington, DC. June 2003. (ADAMS Accession No. ML031530505)
- 11.7. Regulatory Guide 1.249, Revision 0, Use of ARCON Methodology for Calculating Accident-Related Offsite Atmospheric Dispersion Factors. U.S. Nuclear Regulatory Commission. Washington, DC. August 2023. (ADAMS Accession No. ML22024A241)
- 11.8. Regulatory Guide 1.23, Revision 1, Meteorological Monitoring Programs for Nuclear Power Plants. U.S. Nuclear Regulatory Commission. Washington, DC. March 2007. (ADAMS Accession No. ML070350028)
- 11.9. NUREG/CR-2919 (PNL-4380), XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations. U.S. Nuclear Regulatory Commission. Washington, DC. September 1982. (ADAMS Accession No. ML081360412)
- 11.10. NUREG/CR-2858 (PNL-4413), PAVAN: An Atmospheric-Dispersion Program for Evaluating Design-Basis Accidental Releases of Radioactive Materials from

Atmospheric Transport and Dispersion User Manual
References

- Nuclear Power Stations. U.S. Nuclear Regulatory Commission. Washington, DC. November 1982. (ADAMS Accession No. ML12045A149)
- 11.11. NUREG/CR-6331 Revision 1 (PNNL-10521), Atmospheric Relative Concentrations in Building Wakes. U.S. Nuclear Regulatory Commission. Washington, DC. May 1997. (ADAMS Accession No. ML17213A190)
- 11.12. PNNL-28667 Revision 1, ARCON 2.0: User's Guide, Pacific Northwest National Laboratory. Richland, WA. October 2021. (ADAMS Accession No. ML22004A219)
- 11.13. Regulatory Guide 1.109, Revision 1, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I. U.S. Nuclear Regulatory Commission. Washington, DC. October 1977. (ADAMS Accession No. ML003740384)
- 11.14. NUREG-0737, Clarification of TMI Action Plan Requirements. U.S. Nuclear Regulatory Commission. Washington, DC. November 1980. (ADAMS Accession No. ML051400209)
- 11.15. PNL-10286, Ramsdell, J.V., Jr. and C.J. Fosmire, Atmospheric Dispersion Estimates in the Vicinity of Buildings. Pacific Northwest Laboratory. Richland, WA. January 1995.