2.0 ARCON 2.0 User's Guide

The ARCON 2.0 User's Guide consists of four sections. The first section provides information to assist the user in getting started. It describes the hardware requirements for and installation of the code. The second section describes how to run the code. It covers the user interface and data entry. The third section describes the input required by ARCON 2.0. It provides a description of each item and gives acceptable ranges for the items. The fourth section contains example problems and lists partial ARCON 2.0 output for each problem.

2.1. Getting Started

This section of the User's Guide covers the installation of the ARCON 2.0 code on your computer and starting the program once it has been installed.

2.1.1. Computing Requirements

ARCON 2.0 is a Fortran program with a Windows graphical user interface (GUI). User entries are made using the Windows GUI and the Fortran code, which performs the computations, is called at runtime. The ARCON 2.0 setup and GUI have been tested successfully on Windows 7, Windows 8, and Windows 10.

2.1.2. Installation

The ARCON 2.0 software can be installed by running the SETUP.exe file from the installation drive. The setup program will create a directory on your computer (e.g., C:\ARCON 2.0) and copy program files from the installation drive to the ARCON 2.0 directory. Core files installed from the setup include those listed in Table 2.1.

Table 2.1. ARCON 2.0 installation files.

File	Description
ARCON2.exe	Windows GUI executable
ARCON2F.exe	Fortran executable
ARCON_Intro.rtf	Rich text file containing the introductory information displayed by the GUI
ARCON2_User_Guide.pdf	A pdf version of the ARCON User's Guide

A "Test_Cases" subfolder is also created. It contains six example input files (.RSF), a meteorology file (EXAMPLE.MET), and associated output files (.LOG and .CFD).

2.1.3. Starting ARCON 2.0

After the ARCON 2.0 software has been installed, the application can be launched in one of four ways:

1. Browse to the directory where ARCON 2.0 was installed then double-click on the file named ARCON2.exe.

2. From a Windows command prompt, change to the directory where ARCON 2.0 was installed. Type ARCON2.exe at the command prompt and press Enter.
3. From the Windows Start menu, select ARCON 2.0 from the All Programs list.
4. Double-click on the ARCON 2.0 shortcut icon on the Windows Desktop.

2.1.4. Closing ARCON 2.0

There are two methods by which a user can close the ARCON 2.0 application:

1. Select Exit under the File menu.
2. Click the Exit button found on the upper right-hand corner of the interface.

2.2. ARCON 2.0 Inputs

When ARCON 2.0 is started, the program overview form is displayed (as shown in Figure 2.1).

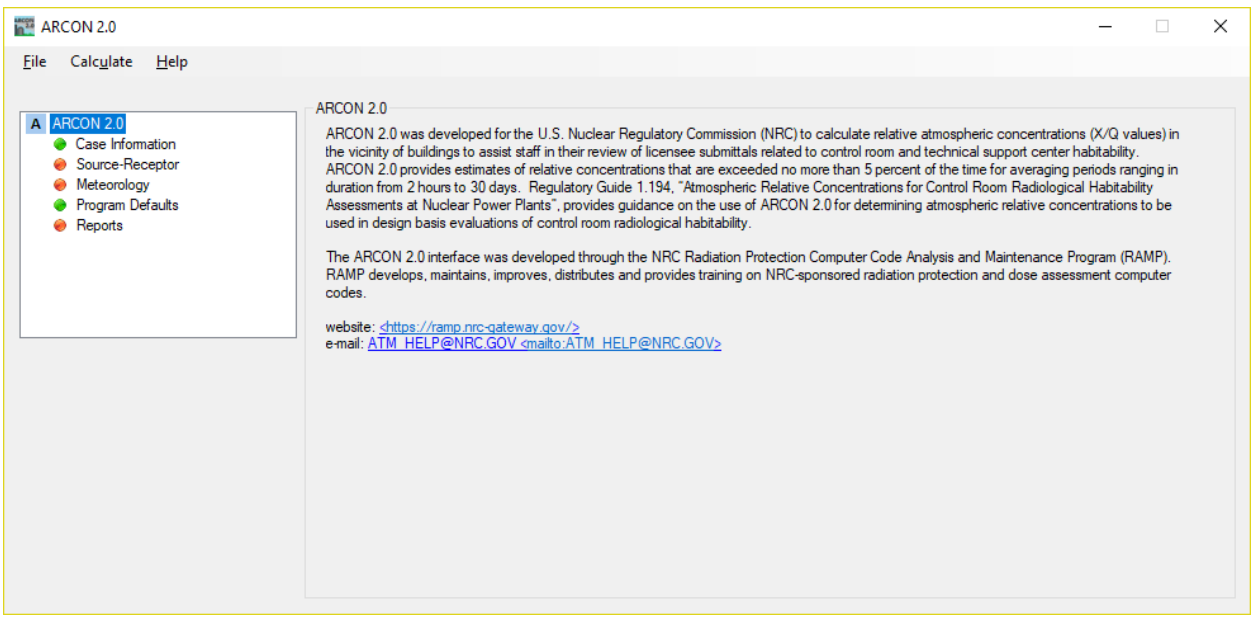

Figure 2.1. ARCON 2.0 program overview form.

ARCON 2.0 includes menu options at the top of the application for opening and saving simulations and basic input forms accessible from the left tree-view panel for entering model input. The input panels are organized into four categories: Case Information, Source-Receptor, Meteorology, and Program Defaults. A fifth panel, called Reports, can be used to view the input and output files created by the software. Input forms in the tree-view panel with "green" nodes are complete and require no further input; "red" nodes require additional inputs. This section discusses the ARCON 2.0 menu options followed by the input forms.

2.2.1. ARCON 2.0 Menus

ARCON 2.0 has three main menus: “File”, “Calculate”, and “Help”. The “File” menu is used to manage input files. The “Calculate” menu is used to run an ARCON 2.0 simulation. Finally, the “Help” menu is used to access the ARCON 2.0 User’s Guide and version information. Each menu option is discussed further below.

2.2.1.1. File Menu

The ARCON 2.0 “File” menu is used to manage input files and exit the program. In addition, the four most recent simulations will appear at the bottom of the menu for quick access. The “File” menu options are shown in Figure 2.2; a description of each menu item follows.

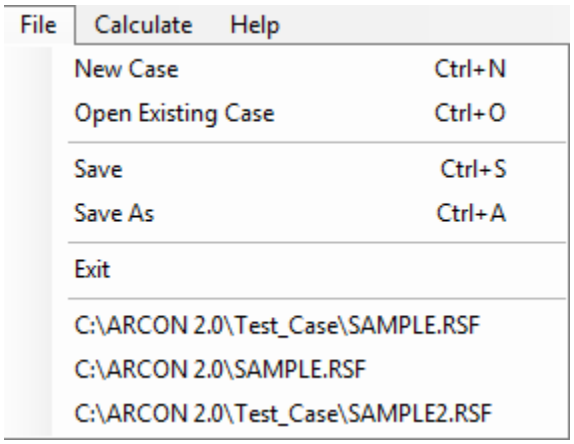

Figure 2.2. ARCON 2.0 file menu.

- New Case – Select New Case to create a new ARCON 2.0 input file. A “Save As” dialog box will appear. Select a folder, enter a filename, and click the “Save” button. All input forms will be reset, cleared, and/or set to default values.
- Open Existing Case – Select Open Existing Case to open an existing ARCON 2.0 input file. An “Open” dialog box will appear. Select the input file of interest and click the “Open” button. The input forms will be populated with data stored in the input file.
- Save – Select “Save” to save an ARCON2.0 input file. If the file has not been previously saved, a “Save As” dialog box will appear. Enter a filename and click the “Save” button.
- Save As – Select “Save As” to save an open input file under a different name. A “Save As” dialog box will appear. Enter a filename and click the “Save” button.
- Exit – Select “Exit” to close the software. The software can also be closed by clicking on the red “X” in the upper right-hand corner of the application.

2.2.1.2. Calculate

The ARCON 2.0 “Calculate” menu is used to run a simulation. Click the “Calculate” menu item after completing all required entries on the ARCON 2.0 input forms. If the inputs have not yet been saved, ARCON 2.0 will prompt the user to save the input file before running. If an input form is incomplete, an

“Invalid Data Input” window will appear, prompting the user to fix the input form. Otherwise, ARCON 2.0 will run and a “Simulation Complete” window will appear, in which a successful or unsuccessful run will be indicated. Output data from the run can be viewed on the “Reports” input form.

2.2.1.3. Help Menu

The ARCON 2.0 “Help” menu has two options (as shown in Figure 2.3): “ARCON 2.0 Help” and “About ARCON 2.0”. The first option provides access to this User’s Guide. The second option displays a window that provides version and copyright information.

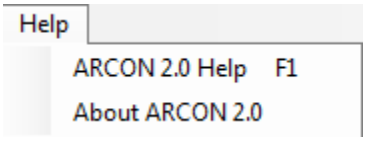

Figure 2.3. ARCON 2.0 file menu.

2.2.2. ARCON 2.0 Input Forms

User input to ARCON 2.0 is performed by traversing the four categories listed in the ARCON 2.0 application window. These input categories include

- Case Information
- Source-Receptor
- Meteorology
- Program Defaults

Incomplete categories are colored red and require user input. Categories are also colored red when invalid entries are present in the panel. Green categories are complete and require no additional user entry. The input fields on the Case Information panel are optional with no restrictions on what is entered, and as such, will always show a green status. The Program Defaults panel is prepopulated with data on new cases and will also appear with a green status in the category list.

Each category is discussed in the following subsections.

2.2.2.1. Case Information

The “Case Information” input form allows the entry of a “Site Name”, “Analyst Name”, and a “Case Description”. All fields are optional. The “Site Name” and “Analyst Name” fields can contain up to 256 characters. The “Case Description” field does not limit the number of characters entered. A sample “Case Information” panel is shown in Figure 2.4.

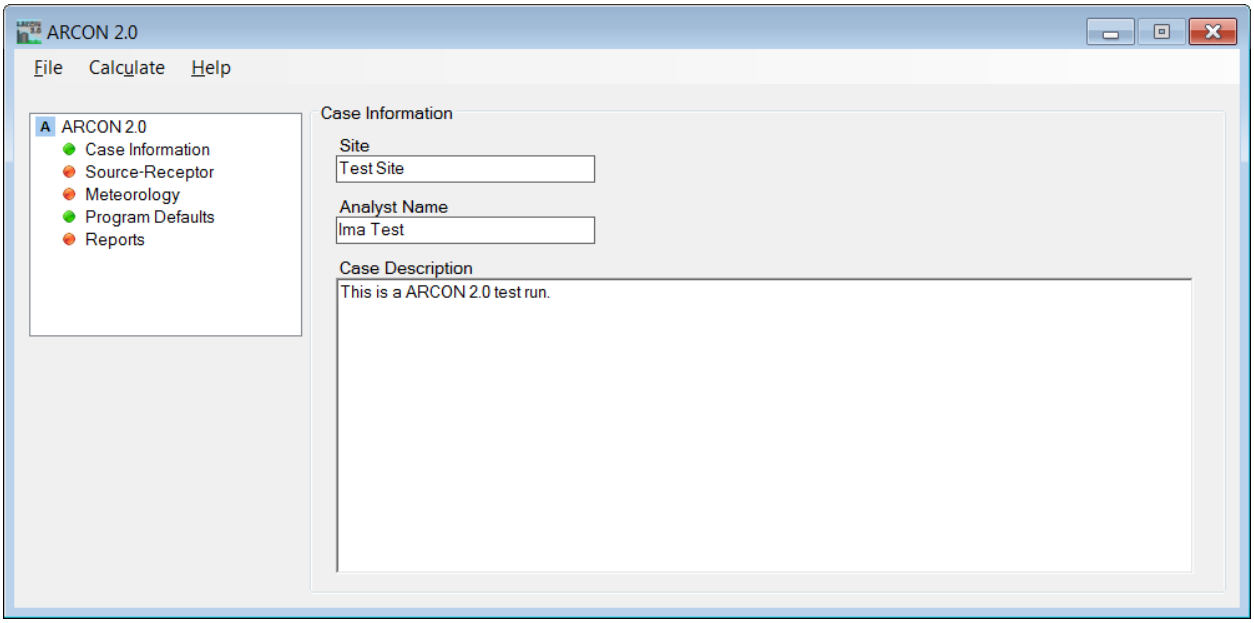

Figure 2.4. ARCON 2.0 Case Information input form.

2.2.2.2. Source – Receptor

The "Source – Receptor" input form allows for the specification of source and receptor (i.e., intake) characterization information, such as release mode, release height, vertical velocity, stack flow, stack radius, building area, elevation difference between the source and the intake locations, distance from the source to the receptor, and the direction to the source from the intake. A sample "Source-Receptor" panel is shown in Figure 2.5, followed by a description of the input fields broken out by Source and Receptor inputs.

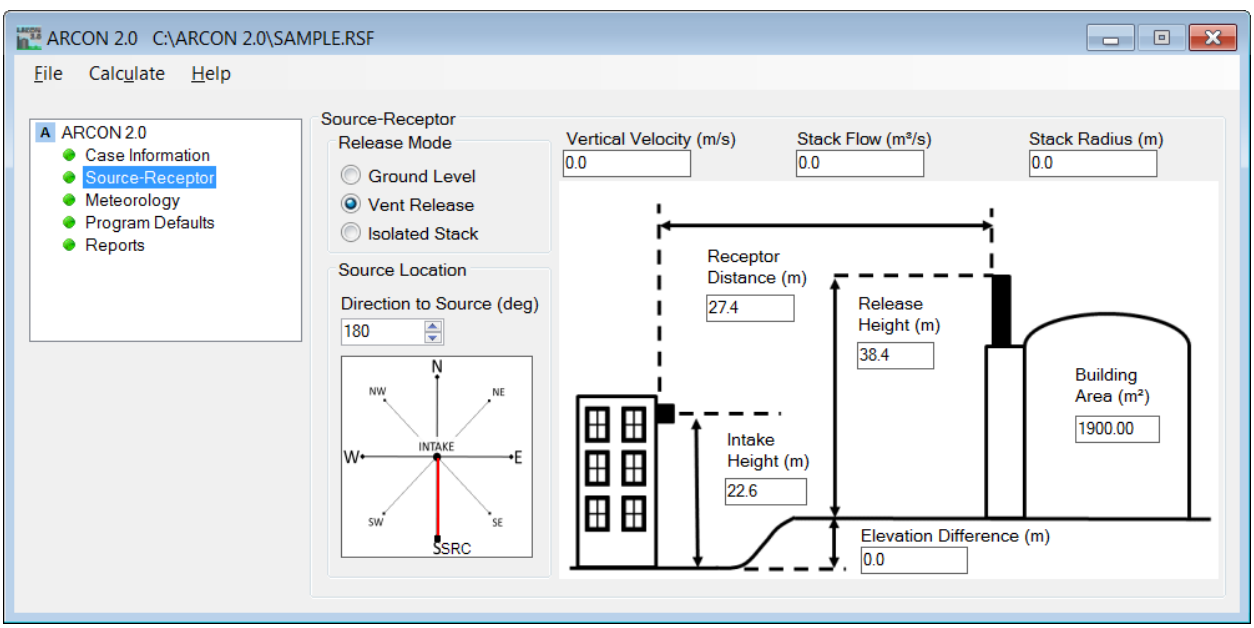

Figure 2.5. ARCON 2.0 Source-Receptor input form.

Source inputs include the following:

- Release Mode – “Release Mode” is set by selecting one of the three options: “Ground Level”, “Vent Release”, or “Isolated Stack”. If a ground-level release is selected, ARCON 2.0 will assume a ground-level release height and will not use the vertical velocity or stack radius, even if values have been entered in those fields.
- Release Height (m) – “Release Height” is required for a vent or elevated release and can be any value between 1 and 300 m. ARCON 2.0 does not compute plume rise. Therefore, if you wish to include plume rise in a simulation, you must combine plume rise with the release stack height to get an effective stack height and enter the effective stack height in the text box in place of the release height. Note, the release height is used to adjust wind speeds for differences between the heights of the instrumentation and the release as well as to determine slant path for ground level releases or to correct off-centerline data for elevated releases.
- Building Area (m^2) – For a ground-level or vent release, enter a “Building Area” to include building wake effects in the diffusion calculations. The building area affects the distance downwind that enhanced diffusion from building wake will occur. The range of acceptable values for building area is 0.01 to 10,000 m^2. In general, the larger the building area, the farther downwind wake effects occur. The building area depends on the problem being addressed; it is not necessarily the area of the entire building. In some instances, the appropriate area may be the projected area of a portion of the building (i.e., cross-sectional area perpendicular to the wind direction). Use a building area of 0.01 m^2 if no building is present; intake concentrations will be calculated assuming no adjustment to the diffusion coefficients from building wake.
- Vertical Velocity (m/s) – “Vertical Velocity” is used in both vent and isolated stack (i.e., elevated) releases and can range from 0 to 50 m/s. In vent release calculations, the vertical velocity of the vent exhaust is compared with the release height wind speed to determine how much of the exhaust enters the building wake. When the ratio of the vertical velocity to the wind speed exceeds 5, the exhaust rises above the wake; when the ratio is less than 1, the exhaust is completely trapped in the wake, and at intermediate ratios, part of the exhaust enters the wake. A vertical velocity of zero should be entered if the vent is capped. In isolated stack-release calculations, the vertical velocity is used to determine if the stack height should be reduced to account for downwash. Downwash is included in the calculation whenever the ratio of the vertical velocity to the release height wind speed is less than 1.5.
- Stack Flow (m^3/s) –"Stack Flow” is used in model calculations whenever entered. Its function is to ensure that effluent concentrations in the atmosphere are always less than the concentration at the release point. The closer together the release point and receptor are and the larger the flow, the more important it is to include the flow in the calculations. ARCON 2.0 accepts flows ranging from 0 to 100 m^3/s.
- Stack Radius (m) – “Stack Radius” is used only in isolated stack-release calculations. It determines the maximum stack height reduction during downwash conditions. ARCON 2.0 will accept stack radius entries from 0 to 10 m.

In reality, the exit velocity, stack flow, and stack radius are related. However, the exit velocity is not necessarily directed in the vertical. For example, vents are frequently capped or are horizontal. In this case, an exit velocity of 0 m/s may be appropriate. Be aware that ARCON 2.0 does not check that these three entries are consistent.

Receptor inputs include the following:

- Receptor Distance (m) – "Receptor Distance" is the horizontal distance between the release point and the receptor location. This distance may not exceed 10,000 m.
- Intake Height (m) – The "Intake Height" is the height of the receptor location above grade. It may not exceed 100 m. Note, the intake height is used to calculate the slant range for ground level releases and the off-centerline correction factors for stack release models.
- Elevation Difference (m) – "Elevation Difference" is the difference in grade between the positions of the receptor location and the release point. This vertical difference will normally be zero. Enter zero if the release point and the receptor location are on the same structure or the heights of the release points are measured from the same reference plane. If the release point and receptor location are widely separated, there may be a difference in the height of the reference plane. In this case, the difference in elevation should be entered. Enter the difference as a positive value if the grade elevation at the release point is higher than at the receptor location. If the grade elevation at the receptor location is higher, enter a negative value. ARCON 2.0 will accept elevation differences from -1000 m to +1000 m.
- Direction to Source (deg) – "Direction to Source" is used to determine the wind direction (in degrees) needed to carry effluents from the release point to the receptor location. Given that the wind directions in the meteorological data typically represent the direction from which the wind blows, the proper direction to the source is entered by imagining you are located at the receptor location and facing toward the release point. For example, if you are standing at the receptor location and looking north toward the source, enter 360°. Or, if at the receptor location and looking southwest toward the source, enter 225°. ARCON 2.0 transforms the wind direction in the meteorological data file to the transport direction at runtime. Direction to source can be entered in two ways: direct entry or by clicking the up/down arrows next to the input box. Any values less than 1° will default to 1° and values greater than 360° will default to 360°. A compass is provided to show the source (labeled "SRC") direction relative to the receptor location (labeled "INTAKE").

2.2.2.3. Meteorology

The “Meteorology” input form is used to set the file paths to the meteorological data file(s) being used in a simulation run, and to specify wind measurement heights and wind speed units. A sample Meteorology panel is shown in Figure 2.6 followed by a description of the meteorology input fields.

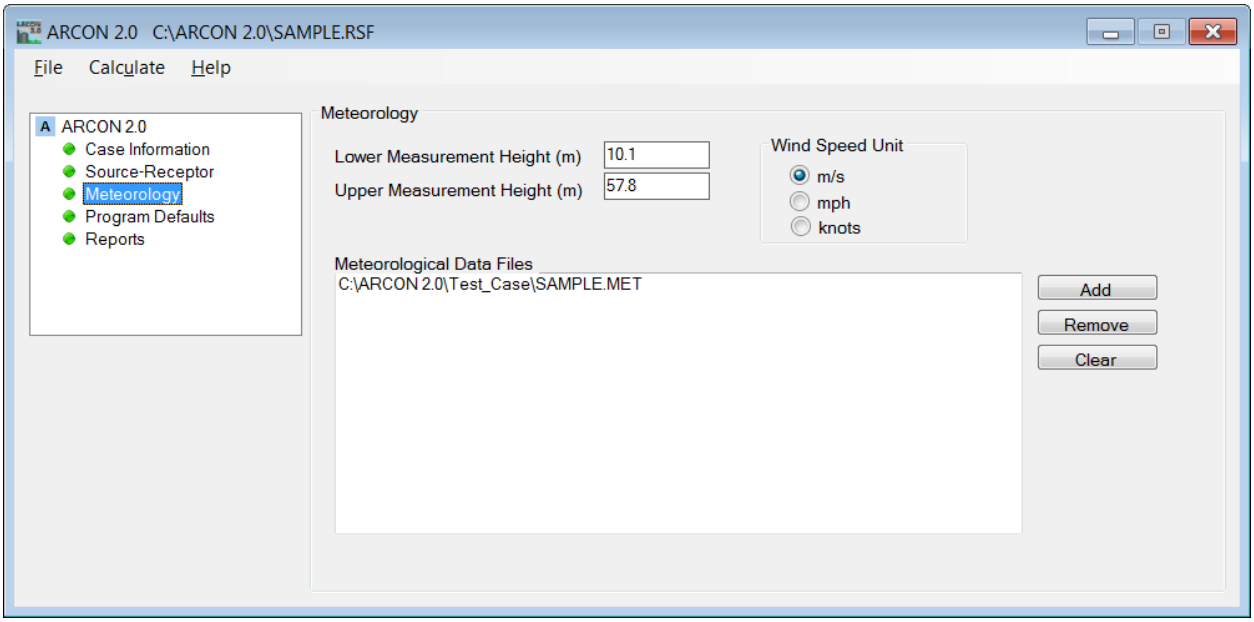

Figure 2.6. ARCON 2.0 Meteorology input form.

- Lower Measurement Height (m) –"Lower Measurement Height (m)” is the lowest wind measurement height specified by the user. The lower measurement height cannot be less than 0 m and cannot be greater than 100 m. If wind data are available for only a single measurement height, enter them in the lower measurement height field.
- Upper Measurement Height (m) – “Upper Measurement Height (m)” is the highest wind measurement height specified by the user. The upper measurement height must be greater than the lower measurement height and cannot be greater than 300 m.
- Wind Speed Unit – “Wind Speed Unit” is used to designate the measurement unit used in the meteorology file; options include: m/s (meters per second), mph (miles per hour), or knots. The default unit is m/s.
- Meteorological Data Files – “Meteorological Data Files” list contains the meteorological data files to be used in a simulation. Files can be added and removed using the “Add”, “Remove”, and “Clear” buttons, as described below.

  Adding a meteorological data file.
  To add a meteorological data file, click the “Add” button to the right of the file listing. Once clicked, an open file dialog window will be displayed and can be used to select a meteorological data file. By default, the open file dialog window will only allow for files with a .MET extension to be selected. After selecting a file, click the “Open” button and the file and path will be added to the file listing. The ARCON 2.0 software is unable to accept meteorological data files with

paths longer than 140 characters (including the file name); a longer path will cause an error message to be displayed and the file will not be added to the list. Also, the ARCON 2.0 software will only allow for the selection of 10 data files. Attempting to add more than 10 files will result in the software displaying an error message. Appendix A to Regulatory Guide 1.194 Revision 0 describes the required meteorological data file format. Figure 2.7 shows an example of the open file dialog window.

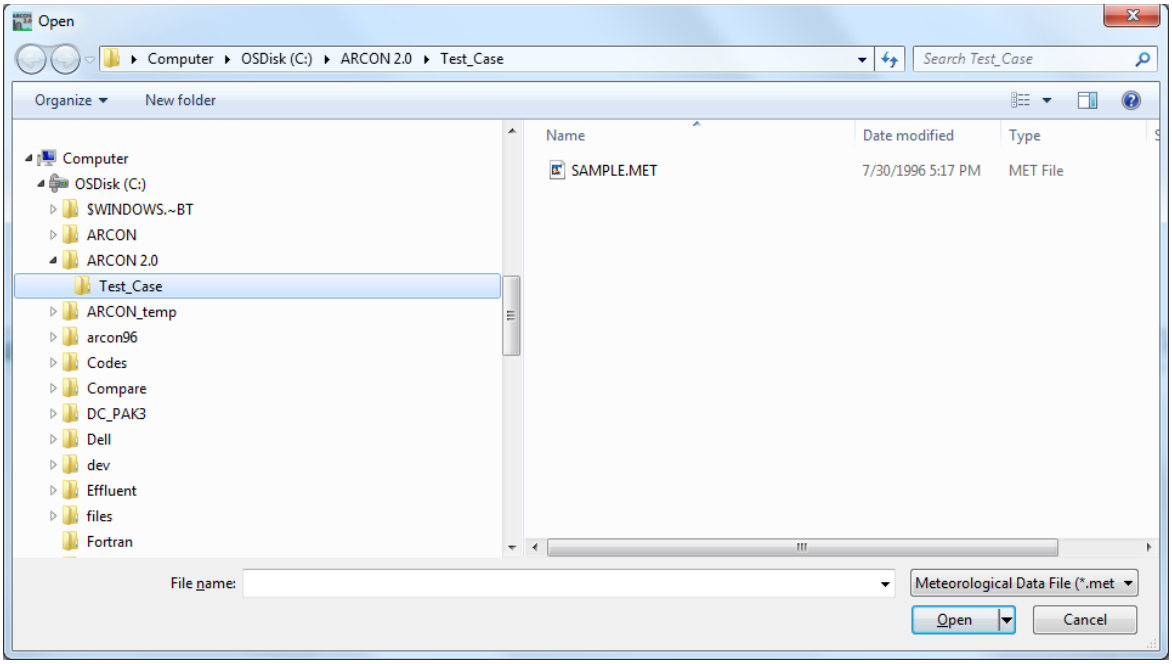

Figure 2.7. Open file dialog window.

Removing a meteorological data file

To remove a meteorological data file, select the file path in the list and click on the “Remove” button to the right of the file list.

Clearing the file list

To clear all files from the file listing, click on the “Clear” button to the right of the file list.

2.2.2.4. Program Defaults

The "Program Defaults" input form is used to change default values for certain parameters used in the ARCON 2.0 dispersion model and to modify the averaging intervals for χ/Q calculations. It is generally not necessary to change the default parameters; therefore, the "Program Defaults" form does not usually need to be edited. The "Program Defaults" form is shown in Figure 2.8 with the normal default values; these are suggested values from the Regulatory Guide 1.194, Revision 0*.

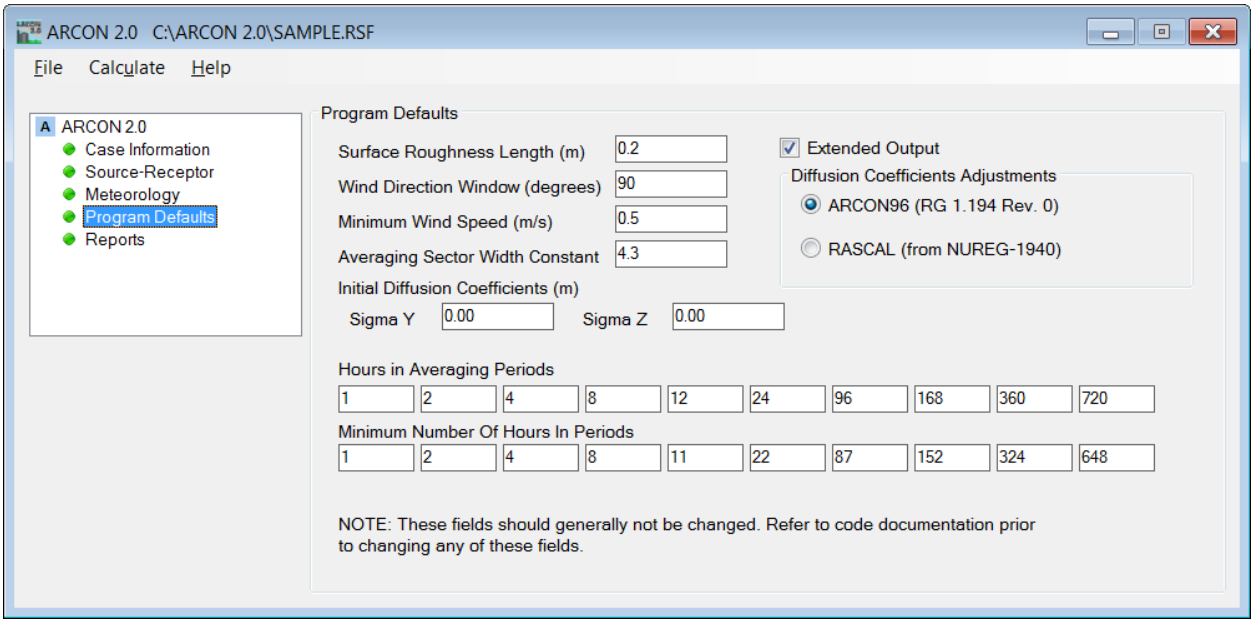

Figure 2.8. ARCON 2.0 Program Defaults input form.

The parameters on this form include the "Surface Roughness Length (m)", the width of the "Wind Direction Window (degrees)", the "Minimum Wind Speed (m/s)", "Averaging Sector Width Constant", "Initial Diffusion Coefficients (m)" for "Sigma Y" and "Sigma Z", and the number of "Hours in Averaging Periods" as well as the "Minimum Number of Hours in Period". Also included is an option to select the "Diffusion Coefficients Adjustments" method (ARCON96 or RASCAL). These parameters are discussed further in Section 3.

The final option on the "Program Defaults" form is the "Extended Output" checkbox. Select this option if you would like to create a detailed output file (.EXT) of certain ARCON 2.0 calculations in addition to the standard output files.

* Regulatory Guide 1.194, Revision 0, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants". June 2003. U.S. Nuclear Regulatory Commission.

2.2.2.5. Reports

The “Reports” form is used to display input and output files created by ARCON 2.0. “Reports” include the “Input File (.RSF)” and three output files: “Output File (.LOG)”, “Frequency File (.CFD)”, and “Extended Output (.EXT)”. The “Reports” form is shown in Figure 2.9; a discussion of each ARCON 2.0 file follows.

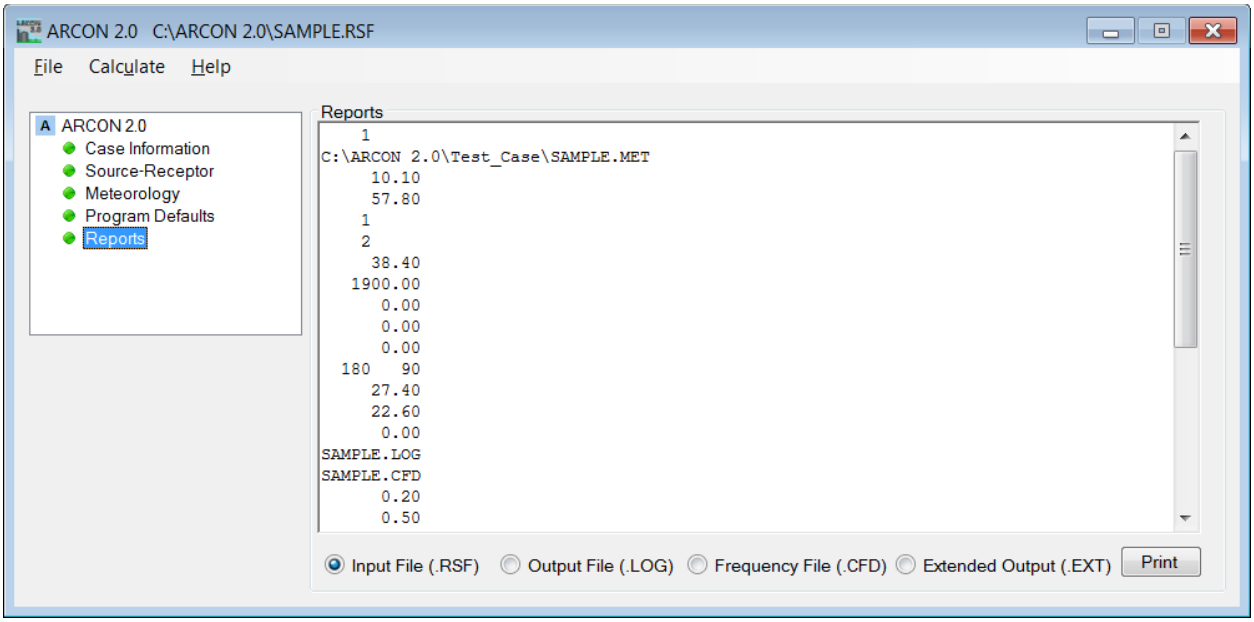

Figure 2.9. ARCON 2.0 Reports form.

- Input File (.RSF) – Click on the “Input File (.RSF)” radio button to display the ARCON 2.0 run specification input file. The Input File (.RSF) name and directory path are indicated in the program title bar. Because ARCON 2.0 creates “Input File (.RSF)” from user selections within the interface, the user generally does not need to be concerned with the “Input File (.RSF)” format. However for completeness, the format is provided in NUREG/CR-6331 Section 4.4, “Data Input”.
- Output File (.LOG) – After completing a run, click on the “Output File (.LOG)” radio button to display the primary ARCON 2.0 output file. The “Output File (.LOG)” name and directory path are the same as for “Input File (.RSF)”. “Output File (.LOG)” contains an echo of user inputs, distribution summary by averaging interval, and the 95th percentile χ/Q values for the standard averaging intervals. The contents of this file are discussed in NUREG/CR-6331 Section 2.4.
- Frequency File (.CFD) – After completing a run, click on the “Frequency File (.CFD)” radio button to display the ARCON 2.0 cumulative frequency distribution file. The “Frequency File (.CFD)” name and directory path are the same as for “Input File (.RSF)”. “Frequency File (.CFD)” contains the cumulative frequency distributions of the concentrations calculated for 10 averaging intervals and is designed to be imported into a spreadsheet for further data analysis and display. The distributions may be used to determine concentrations at percentiles other than the 95th percentile.

- Extended Output (.EXT) – the “Expanded Output (.EXT)” file is only created if the “Extended Output” option is checked on the Program Defaults input form. After completing a run, click on the “Extended Output (.EXT)” radio button to display the ARCON 2.0 extended output file. The “Extended Output (.EXT)” file name and directory path are the same as for “Input File (.RSF)”. The “Extended Output (.EXT)” file is used primarily to give advanced modelers access to intermediate information for use in code verification.

2.3. ARCON 2.0 Output File

This section describes the primary ARCON 2.0 “Output File (.LOG)”, which can be viewed on the “Reports” form after a simulation. The “Output File (.LOG)” is a standard text file and may be viewed, edited, annotated, and/or printed using a text editor or word processor outside of the ARCON 2.0 interface. The contents of “Output File (.LOG)” are divided into three sections: a header, a list of inputs to the code, and a summary of the calculation results. Each section is discussed further below.

2.3.1. Header

The header section in the primary ARCON 2.0 “Output File (.LOG)” provides general information about the code. Figure 2.10 shows a sample file header. The first three items identify the program run date/time, optional user, and project names; these three items are written at the top of all ARCON 2.0 output files. The fourth item identifies the program title (i.e., ARCON 2.0). The fifth and sixth items identify the developer and compile date. The seventh and eighth items identify NRC contact information and reference to the code documentation. Finally, the header section concludes with a disclaimer.

```
Program Run:   9/ 3/2020  at  09:44:39
User:
Project: Example 1

Program Title:  ARCON 2.0

Developed For:  U.S. Nuclear Regulatory Commission (NRC)
                Radiation Protection Computer Code
                Analysis and Maintenance Program (RAMP)

Compile Date:   September 3, 2020

NRC Contact Information:
                website: https://ramp.nrc-gateway.gov/
                e-mail: ATM_HELP@NRC.GOV

Code Documentation:  NUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither
the United States Government nor any agency thereof, nor any of their
employees, makes any warranty, expressed or implied, or assumes any legal
liability or responsibilities for any third party's use, or the results of such
use, of any portion of this program or represents that its use by such third
party would not infringe privately owned rights.
```

Figure 2.10. ARCON 2.0 Output File (.LOG) header.

2.3.2. Input Data

The input data section in the primary ARCON 2.0 “Output File (.LOG)” provides a list of user inputs used in the simulation; this is the same information provided in the “Input File (.RSF)”. Figure 2.11 shows a sample input section. ARCON 2.0 user inputs are listed followed by their values. The input section also shows the range of wind directions (i.e., “Wind direction window”) that are assumed to carry effluents from the release point to the receptor location. This range is calculated from the “Direction to Source” (on the “Source-Receptor” form) and “Wind Direction Window” (on the “Program Defaults” form) user inputs. The input data section concludes with an indication of whether the “Extended Output” file option was selected on the “Program Defaults” form.

```
******* ARCON INPUT **********

   Number of Meteorological Data Files  =  1
   Meteorological Data File Names
     C:\ARCON\ARCON2\SAMPLE.MET

   Height of lower wind instrument (m)  =     10.1
   Height of upper wind instrument (m)  =     57.8
   Wind speeds entered as meters/second

   Vent release
   Release height (m)                   =     38.4
   Building Area (m^2)                  =   1900.0
   Effluent vertical velocity (m/s)     =      0.00
   Vent or stack flow  (m^3/s)          =      0.00
   Vent or stack radius (m)             =      0.00

   Direction .. intake to source (deg)  =      180
   Wind direction sector width (deg)    =       90
   Wind direction window (deg)          =   135 - 225
   Distance to intake (m)               =     27.4
   Intake height  (m)                   =     22.6
   Terrain elevation difference (m)     =      0.0

   Output file names
     SAMPLE.LOG
     SAMPLE.CFD

   Minimum Wind Speed (m/s)             =      0.5
   Surface roughness length (m)         =      0.10
   Sector averaging constant            =      4.0

   Initial value of sigma y             =      4.00
   Initial value of sigma z             =     10.00

   Expanded output for code testing not selected
```

Figure 2.11. ARCON 2.0 Output File (.LOG) input data.

2.3.3. ARCON 2.0 Results

The final section of the primary ARCON 2.0 "Output File (.LOG)" provides the results of the ARCON 2.0 calculations. Figure 2.12 shows a sample results section.

```
  Total number of hours of data processed =   8784
  Hours of missing data                   =      2
  Hours direction in window               =   2549
  Hours elevated plume w/ dir. in window  =      0
  Hours of calm winds                     =     12
  Hours direction not in window or calm   =   6221

  DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL
 AVER. PER.          1         2         4         8        12        24        96       168       360       720
 UPPER LIM.    1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02
   LOW LIM.    1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06
ABOVE RANGE          0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   IN RANGE       2561.     2850.     3302.     3976.     4515.     5725.     8245.     8562.     8461.     8137.
BELOW RANGE          0.        0.        0.        0.        0.        0.       89.       71.        0.        0.
       ZERO       6221.     5929.     5471.     4785.     4259.     3038.      364.        0.        0.        0.
 TOTAL X/Qs       8782.     8779.     8761.     8774.     8763.     8698.     8633.     8461.     8137.
 % NON ZERO       29.16     32.46     37.64     45.38     51.46     65.33     95.82    100.00    100.00    100.00

  95th PERCENTILE X/Q VALUES
               2.91E-04  2.85E-04  2.77E-04  2.61E-04  2.19E-04  1.67E-04  9.80E-05  8.30E-05  7.30E-05  6.87E-05

  95% X/Q for standard averaging intervals

  0 to 2 hours        2.91E-04
  2 to 8 hours        2.52E-04
  8 to 24 hours       1.20E-04
  1 to 4 days         7.51E-05
  4 to 30 days        6.42E-05

                          HOURLY VALUE RANGE
                        MAX X/Q              MIN X/Q
      CENTERLINE       3.95E-03             7.87E-05
      SECTOR-AVERAGE   2.47E-03             4.93E-05
```

Figure 2.12. ARCON 2.0 Output File (.LOG) results.

The first six lines of the results section summarize the meteorological data. The first line shows the number of hours of data processed. A normal year has 8760 hours; leap years have 8784 hours. The second line shows the number of hours that ARCON2.0 was unable to calculate a χ/Q value. Generally, fewer than 10 percent of the hours processed should have missing data if the meteorological data have been obtained using a well-maintained system. The third line shows the number of hours with a wind direction in the window that carries effluent from the release point to the receptor location; this number depends on the orientation of the line between the release point and the receptor location with respect to the prevailing wind direction. If the prevailing wind direction tends to carry material from the release point to the receptor location, the number of hours in the window can approach 50 percent of the total hours. If the wind rarely blows from the release point to the receptor location, the number of hours in the window could be 10 percent or less. The fourth line gives the number of hours of elevated plumes during the time that the wind is calm or the wind direction is in the window. This number should be zero unless the user has specified an uncapped vent or a stack release. The fifth line is the number of hours of calm winds (wind speed less than the minimum wind speed set in the Program Defaults form). The final line is the number of hours for which χ/Q was assumed to be zero because the wind direction was not in the window and the wind was not calm.

The next 10 lines contain a summary of the intermediate result of the calculations by averaging period (in hours). ARCON 2.0 calculates χ/Q values and creates a χ/Q frequency distribution using χ/Q bins. The lines labeled "Upper Lim." and "Lower Lim." define the range of χ/Q bins use to compile the χ/Q frequency distribution for each averaging period. The range should cover four orders of magnitude.

Ranges for the 1- and 8-hour averaging periods will be the same, as will the ranges for the 12- through 720-hour periods. However, the ranges for these two groups of averaging periods may not be the same.

The distribution of χ/Q values calculated for each averaging period is summarized in the five lines following the line giving the lower limit for the χ/Q bins. The first of these lines gives the number of χ/Q values that were greater than the upper limit of the bins. This number should be zero unless more than 10,000 hours of data have been processed. In the latter case, the bin limits are set based on the first 10,000 χ/Q values calculated. As a result, if more than 10,000 hours of data are processed and the highest χ/Q values do not occur in the first 10,000 values, there could be a small number of χ/Q values above the range of bins. The next line gives the number of χ/Q values within the range of bins, and the following line gives the number of χ/Q values below the range. If running a vent- or elevated stack-release scenario, some χ/Q values may be listed as being below the range. These χ/Q values are within an order of magnitude of the lower limit. Values that are more than an order of magnitude lower than the lower limit are counted as zero because they are not a factor in determining the 95th percentile χ/Q. The zero line gives the number of χ/Q values that were more than an order of magnitude below the lower limit of the bins. The total χ/Q line gives the total number of hours that are the basis for calculating the 95th percentile χ/Q values.

The line labeled "95th Percentile χ/Q Values" gives the 95th percentile values for averaging periods beginning at the start of release. Thus, the 2-hour average is for the 0 to 2-hour time period. Similarly, the 8-hour value is for the 0 to 8-hour time period, and the 96-hour value is for the 0 to 96-hour time period. In general, these values should decrease as the duration of the averaging period increases. However, it is possible to have the 95th percentile value increase as the averaging interval increases. This unexpected behavior is most likely to occur with uncapped vent or elevated stack releases.

With the default averaging periods, the χ/Q values for 1, 2, 4, and 8 hours are centerline values. Average χ/Q values for periods longer than 8 hours consist of centerline χ/Q values for the first 8 hours and sector-average χ/Q values for the remainder of the period. For example, each 24-hour average χ/Q is made up of an average of 8 one-hour centerline χ/Q values followed by 16 one-hour sector-average χ/Q values. This is consistent with NRC guidance on the use of centerline and sector-average χ/Q values found in Regulatory Guides 1.111 and 1.145.

Control room habitability assessments generally involve the use of different χ/Q values as the postulated accident progresses. The χ/Q values for various intervals during the accident can be calculated directly from the 95th percentile values. Section 3.7 discusses the calculation of χ/Q values for the subsequent time periods that do not coincide with the beginning of the release. Values for five standard averaging intervals are given following the 95th percentile values. The χ/Q value for the 0 to 2-hour averaging period is usually the 1-hour value. However, if the 95th percentile 2-hour average χ/Q is larger than the 1-hour value, the 2-hour value is used. χ/Q values for 0 to 2 hours and 2 to 8 hours are based only on centerline values. Similarly, the χ/Q values for 8 to 24 hours, 1 to 4 days, and 4 to 30 days are based only on sector-average values.

If the default averaging periods are changed, the combination of centerline and sector-average χ/Q values will change. As in ARCON96, ARCON 2.0 will calculate χ/Q values for the standard averaging periods only if the averaging periods are defined as follows:

- The 0 to 2-hour χ/Q will be calculated and presented only if the first averaging period is 1 hour.
- The 2 to 8-hour χ/Q will be calculated and presented only if the first averaging period is 1 hour and the fourth averaging period is 8 hours.
- The 8 to 24-hour χ/Q will be calculated and presented only if the fourth averaging period is 8 hours and the sixth averaging period is 24 hours.
- The 1 to 4-day χ/Q will be calculated and presented only if the sixth averaging period is 24 hours and the seventh averaging period is 96 hours.
- The 4 to 30-day χ/Q will be calculated and presented only if the seventh averaging period is 96 hours and the tenth averaging period is 720 hours.

Calculation and presentation of the χ/Q values for each of the standard averaging intervals is independent of the calculation and presentation of χ/Q values for the other intervals. Thus, if the criteria are met for calculation and presentation of χ/Q for a standard averaging interval, the χ/Q will be calculated and presented. If the criteria are not met, the χ/Q will not be presented.

The last part of the results section of the log file lists the maximum and minimum 1-hour χ/Q values calculated by the centerline and sector-average models. These values may be used to check the range of χ/Q bins.

The line NORMAL PROGRAM COMPLETION should be the last line of the log file. If not, the program has ended in an error mode and the results should not be used.

2.4. Examples

This section contains six example problems. The first four examples demonstrate the use of ARCON 2.0 to assess the consequences of ground-level, capped and uncapped vent, and elevated releases. The last two examples demonstrate the use of ARCON 2.0 in calculating χ/Q values for area sources. All of the examples are included in the ARCON 2.0 "Test_Cases" folder installed in the ARCON 2.0 directory. The meteorological data used in all the examples are in a file named "EXAMPLE.MET", which is also included in the "Test_Cases" folder. However, each example makes a different set of assumptions about the meteorological data, including measurement height and wind speed units.

In the examples that follow, a scenario description is included that provides all of the information needed to create the ARCON 2.0 input files and verify the associated outputs. For brevity, the header sections of the log (.LOG) files and the lower portions of the cumulative frequency distribution (.CFD) files are not included in the write-up summary. However, both the input (.RSF) and output (.LOG and .CDF) files are included in the "Test_Cases" folder for each example. The provided files can be compared against files created by the user following the examples, thereby allowing for verification of the model installation and software execution.

2.4.1. Example 1: Ground-Level Release

The first example is a ground-level release scenario. The release point is at the base of a building with a cross-sectional area of 1,900 m^2. The direction from the intake to the release point is 326° and the distance between the intake and release point is 45 m. The intake is located 15 m above the ground. Figure 2.13 shows the completed "Source-Receptor" form for Example 1. From the "Meteorology Form" select the EXAMPLE.MET hourly meteorological data file from the "Test_Cases" folder. Assume wind speeds are in knots (nautical miles per hour) and were measured at the 10 and 53.4 m levels. Select "File" and "Save As"; name the example "arcon2_ex1".

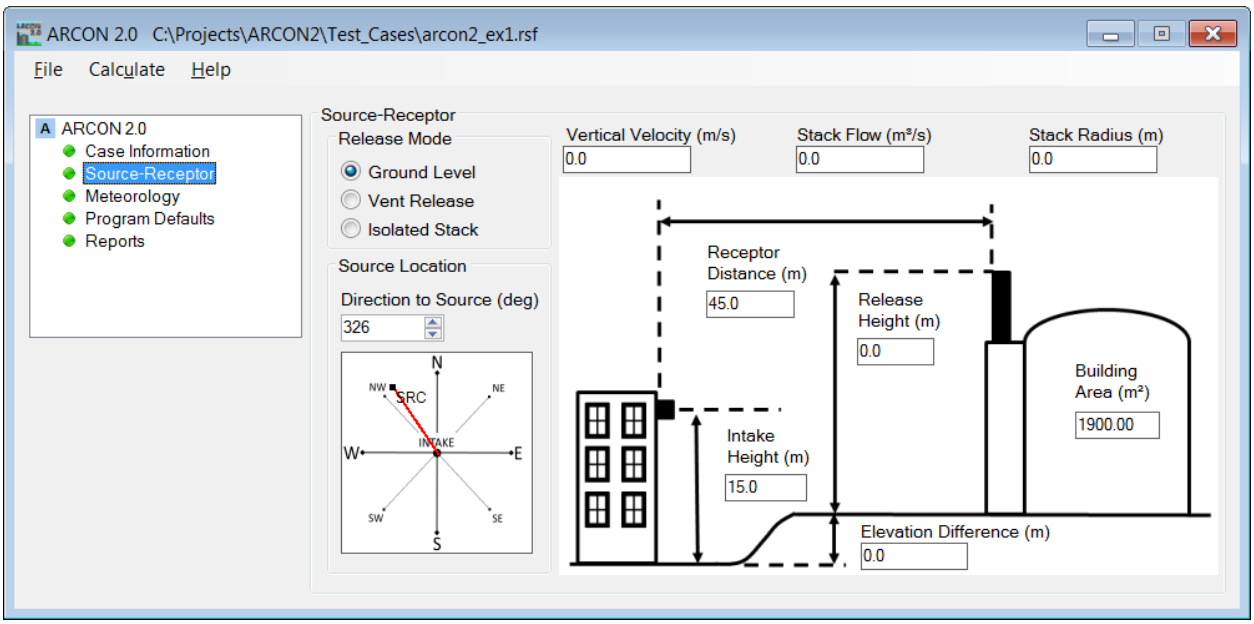

Figure 2.13. ARCON 2.0 Source-Receptor Form for Example 1.

Click the "Calculate" menu item to run Example 1. The log file (.LOG) and cumulative distribution file (.CDF) for Example 1 are shown in Figures 2.14 and 2.15, respectively; verify your results match on the "Reports" form. Notice that the cumulative frequency of 1-hour χ/Q values increases from 0 to the maximum 4663 in a χ/Q range of less than an order of magnitude. The range of χ/Q values increases as the averaging period increases up to about 96 hours (4 days). When the length of the averaging period increases beyond 4 days, the range of χ/Q values decreases until it is only about a factor of 2 for a 30-day average.

```
******* ARCON INPUT **********

   Number of Meteorological Data Files  =  1
   Meteorological Data File Names
     C:\Projects\ARCON2\Test_Cases\EXAMPLE.MET

   Height of lower wind instrument (m)  =     10.0
   Height of upper wind instrument (m)  =     53.4
   Wind speeds entered as knots

   Ground-level release
   Release height (m)                   =      0.0
   Building Area (m^2)                  =   1900.0
   Effluent vertical velocity (m/s)     =      0.00
   Vent or stack flow  (m^3/s)          =      0.00
   Vent or stack radius (m)             =      0.00

   Direction .. intake to source (deg)  =      326
   Wind direction sector width (deg)    =       90
   Wind direction window (deg)          =   281 - 011
   Distance to intake (m)               =     45.0
   Intake height  (m)                   =     15.0
   Terrain elevation difference (m)     =      0.0

   Output file names
     arcon2_ex1.LOG
     arcon2_ex1.CFD

   Minimum Wind Speed (m/s)             =      0.5
   Surface roughness length (m)         =      0.20
   Sector averaging constant            =      4.3

   Initial value of sigma y             =      0.00
   Initial value of sigma z             =      0.00

   Expanded output for code testing selected
   QA output file = C:\ARCON 2.0\arcon2_ex1.EXT

   Total number of hours of data processed =   8760
   Hours of missing data                   =     10
   Hours direction in window               =   1529
   Hours elevated plume w/ dir. in window  =      0
   Hours of calm winds                     =   3134
   Hours direction not in window or calm   =   4087

   DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL
  AVER. PER.          1          2          4          8         12         24         96        168        360        720
  UPPER LIM.    1.00E-02   1.00E-02   1.00E-02   1.00E-02   1.00E-02   1.00E-02   1.00E-02   1.00E-02   1.00E-02   1.00E-02
    LOW LIM.    1.00E-06   1.00E-06   1.00E-06   1.00E-06   1.00E-06   1.00E-06   1.00E-06   1.00E-06   1.00E-06   1.00E-06
 ABOVE RANGE          0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
    IN RANGE       4663.      5557.      6423.      7373.      7922.      8425.      8673.      8608.      8436.      8112.
 BELOW RANGE          0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
        ZERO       4087.      3185.      2303.      1321.       815.       291.         0.         0.         0.         0.
  TOTAL X/Qs       8750.      8742.      8726.      8694.      8737.      8716.      8673.      8608.      8436.      8112.
  % NON ZERO       53.29      63.57      73.61      84.81      90.67      96.66     100.00     100.00     100.00     100.00

   95th PERCENTILE X/Q VALUES
                 1.43E-03   1.31E-03   1.23E-03   1.14E-03   9.42E-04   7.16E-04   4.90E-04   4.33E-04   3.91E-04   3.64E-04

   95% X/Q for standard averaging intervals

   0 to 2 hours        1.43E-03
   2 to 8 hours        1.04E-03
   8 to 24 hours       5.05E-04
   1 to 4 days         4.15E-04
   4 to 30 days        3.45E-04

                            HOURLY VALUE RANGE
                          MAX X/Q              MIN X/Q
        CENTERLINE       2.40E-03             6.88E-04
        SECTOR-AVERAGE   1.40E-03             4.01E-04

NORMAL PROGRAM COMPLETION
```

Figure 2.14. ARCON 2.0 Log (.LOG) File for Example 1.

X/Q CUMULATIVE FREQUENCY DISTRIBUTIONS

XOQ	1	2	4	8	XOQ	12	24	96	168	360	720
Abv. Lim.	0.	0.	0.	0.	Abv. Lim.	0.	0.	0.	0.	0.	0.
9.120E-03	0.	0.	0.	0.	9.120E-03	0.	0.	0.	0.	0.	0.
...											
2.512E-03	0.	0.	0.	0.	2.512E-03	0.	0.	0.	0.	0.	0.
2.291E-03	8.	2.	0.	0.	2.291E-03	0.	0.	0.	0.	0.	0.
2.089E-03	39.	14.	4.	0.	2.089E-03	0.	0.	0.	0.	0.	0.
1.905E-03	109.	60.	26.	10.	1.905E-03	0.	0.	0.	0.	0.	0.
1.738E-03	186.	130.	81.	53.	1.738E-03	0.	0.	0.	0.	0.	0.
1.585E-03	290.	211.	142.	90.	1.585E-03	18.	0.	0.	0.	0.	0.
1.445E-03	421.	294.	217.	154.	1.445E-03	42.	0.	0.	0.	0.	0.
1.318E-03	594.	432.	340.	226.	1.318E-03	81.	1.	0.	0.	0.	0.
1.202E-03	767.	570.	473.	339.	1.202E-03	136.	10.	0.	0.	0.	0.
1.096E-03	962.	721.	598.	497.	1.096E-03	211.	29.	0.	0.	0.	0.
1.000E-03	1087.	897.	758.	677.	1.000E-03	332.	55.	0.	0.	0.	0.
9.120E-04	1324.	1123.	1005.	901.	9.120E-04	490.	115.	0.	0.	0.	0.
8.318E-04	1464.	1309.	1259.	1203.	8.318E-04	701.	186.	0.	0.	0.	0.
7.586E-04	4635.	3946.	3232.	2456.	7.586E-04	961.	323.	0.	0.	0.	0.
6.918E-04	4645.	4026.	3397.	3170.	6.918E-04	1364.	501.	0.	0.	0.	0.
6.310E-04	4663.	4082.	3542.	3435.	6.310E-04	2242.	748.	17.	0.	0.	0.
5.754E-04	4663.	4194.	4383.	4003.	5.754E-04	2911.	1103.	49.	8.	0.	0.
5.248E-04	4663.	4277.	4467.	4171.	5.248E-04	3512.	1657.	250.	54.	0.	0.
4.786E-04	4663.	4352.	4585.	4685.	4.786E-04	3982.	2386.	494.	182.	0.	0.
4.365E-04	4663.	4472.	4711.	4814.	4.365E-04	4368.	3088.	843.	383.	63.	0.
3.981E-04	4663.	4963.	5020.	5140.	3.981E-04	4722.	3749.	1472.	917.	364.	0.
3.631E-04	4663.	5543.	5451.	5433.	3.631E-04	5029.	4408.	2672.	1661.	669.	419.
3.311E-04	4663.	5557.	5483.	5525.	3.311E-04	5347.	4954.	3848.	3104.	2211.	1344.
3.020E-04	4663.	5557.	5537.	5635.	3.020E-04	5611.	5488.	4894.	4638.	4096.	4495.
2.754E-04	4663.	5557.	5600.	6051.	2.754E-04	5822.	5904.	5829.	5702.	5757.	6000.
2.512E-04	4663.	5557.	5630.	6122.	2.512E-04	6065.	6233.	6487.	6652.	7127.	7297.
2.291E-04	4663.	5557.	5694.	6204.	2.291E-04	6256.	6501.	6984.	7363.	7838.	7867.
2.089E-04	4663.	5557.	5759.	6288.	2.089E-04	6442.	6699.	7334.	7750.	8135.	8035.
1.905E-04	4663.	5557.	6403.	6697.	1.905E-04	6636.	6915.	7644.	7949.	8245.	8112.
1.738E-04	4663.	5557.	6413.	6735.	1.738E-04	6766.	7079.	7900.	8127.	8386.	8112.
1.585E-04	4663.	5557.	6423.	6751.	1.585E-04	6866.	7217.	8082.	8284.	8436.	8112.
1.445E-04	4663.	5557.	6423.	6795.	1.445E-04	6994.	7358.	8198.	8397.	8436.	8112.
1.318E-04	4663.	5557.	6423.	6816.	1.318E-04	7147.	7506.	8272.	8457.	8436.	8112.
1.202E-04	4663.	5557.	6423.	6838.	1.202E-04	7209.	7611.	8345.	8480.	8436.	8112.
1.096E-04	4663.	5557.	6423.	6875.	1.096E-04	7313.	7750.	8389.	8535.	8436.	8112.
1.000E-04	4663.	5557.	6423.	6905.	1.000E-04	7389.	7799.	8419.	8568.	8436.	8112.
9.120E-05	4663.	5557.	6423.	7361.	9.120E-05	7428.	7911.	8458.	8587.	8436.	8112.
8.318E-05	4663.	5557.	6423.	7373.	8.318E-05	7445.	7969.	8490.	8590.	8436.	8112.
7.586E-05	4663.	5557.	6423.	7373.	7.586E-05	7551.	8039.	8510.	8594.	8436.	8112.
6.918E-05	4663.	5557.	6423.	7373.	6.918E-05	7563.	8082.	8516.	8597.	8436.	8112.
6.310E-05	4663.	5557.	6423.	7373.	6.310E-05	7767.	8106.	8533.	8599.	8436.	8112.
5.754E-05	4663.	5557.	6423.	7373.	5.754E-05	7769.	8123.	8544.	8603.	8436.	8112.
5.248E-05	4663.	5557.	6423.	7373.	5.248E-05	7780.	8128.	8556.	8607.	8436.	8112.
4.786E-05	4663.	5557.	6423.	7373.	4.786E-05	7786.	8168.	8565.	8608.	8436.	8112.
4.365E-05	4663.	5557.	6423.	7373.	4.365E-05	7789.	8186.	8572.	8608.	8436.	8112.
3.981E-05	4663.	5557.	6423.	7373.	3.981E-05	7796.	8241.	8582.	8608.	8436.	8112.
3.631E-05	4663.	5557.	6423.	7373.	3.631E-05	7918.	8282.	8587.	8608.	8436.	8112.
3.311E-05	4663.	5557.	6423.	7373.	3.311E-05	7922.	8290.	8592.	8608.	8436.	8112.
3.020E-05	4663.	5557.	6423.	7373.	3.020E-05	7922.	8314.	8626.	8608.	8436.	8112.
2.754E-05	4663.	5557.	6423.	7373.	2.754E-05	7922.	8329.	8626.	8608.	8436.	8112.
2.512E-05	4663.	5557.	6423.	7373.	2.512E-05	7922.	8329.	8631.	8608.	8436.	8112.
2.291E-05	4663.	5557.	6423.	7373.	2.291E-05	7922.	8329.	8631.	8608.	8436.	8112.
2.089E-05	4663.	5557.	6423.	7373.	2.089E-05	7922.	8329.	8634.	8608.	8436.	8112.
1.905E-05	4663.	5557.	6423.	7373.	1.905E-05	7922.	8420.	8634.	8608.	8436.	8112.
1.738E-05	4663.	5557.	6423.	7373.	1.738E-05	7922.	8420.	8668.	8608.	8436.	8112.
1.585E-05	4663.	5557.	6423.	7373.	1.585E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.445E-05	4663.	5557.	6423.	7373.	1.445E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.318E-05	4663.	5557.	6423.	7373.	1.318E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.202E-05	4663.	5557.	6423.	7373.	1.202E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.096E-05	4663.	5557.	6423.	7373.	1.096E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.000E-05	4663.	5557.	6423.	7373.	1.000E-05	7922.	8425.	8673.	8608.	8436.	8112.
...|											
1.000E-06	4663.	5557.	6423.	7373.	1.000E-06	7922.	8425.	8673.	8608.	8436.	8112.
Belw. Lim.	0.	0.	0.	0.	Belw. Lim.	0.	0.	0.	0.	0.	0.

Figure 2.15. ARCON 2.0 Cumulative Frequency Distribution (.CFD) File for Example 1.

2.4.2. Example 2: Uncapped Vent Release

The second example is an uncapped roof-top vent release. The direction from the air intake to the vent is 83°, and the distance is 18 m. The vent has a radius of 1 m; under accident conditions it has a nominal flow of 15.7 m^3/s, and it is uncapped. Thus, the vertical velocity (vent flow divided by vent area) is 5.0 m/s, assuming a round vent area of 3.14 m^2. The plant drawings indicate that the heights of the air intake and vent are 25 and 29 m above the plant reference elevation, respectively, and that the cross-sectional area of the building on which the vent is located is 1730 m^2. Figure 2.16 shows the completed "Source-Receptor" form for Example 2. From the "Meteorology Form", select the EXAMPLE.MET hourly meteorological data file in the "Test_Cases" folder. Assume the wind speeds are measured in meters per second and were measured at the 10 and 92.1 m levels. Select "File" and "Save As"; name the example "arcon2_ex2".

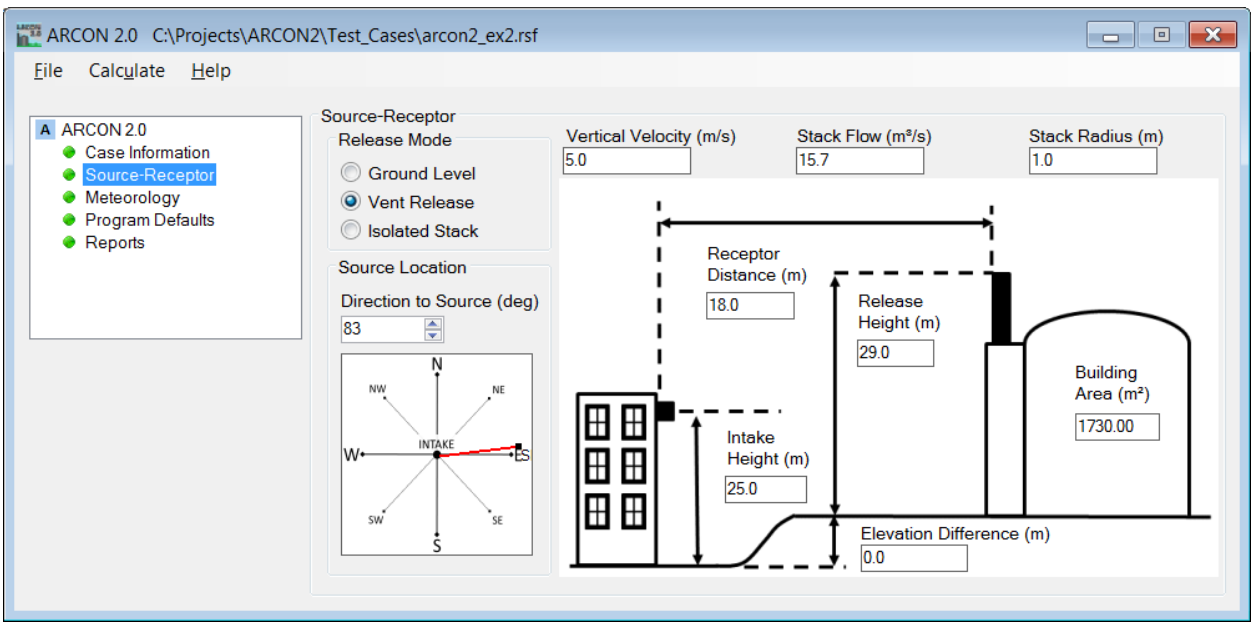

Figure 2.16. ARCON 2.0 Source-Receptor Form for Example 2.

Click the "Calculate" menu item to run Example 2. The log file (.LOG) for Example 2 is shown in Figure 2.17; verify your results match on the "Reports" form. Notice that there are a number of χ/Q values that are below the lower limit of the χ/Q bins. These values occur during light winds when the vertical velocity of the vent release is sufficiently large such that the release is treated as if it were from a stack.

```
Number of Meteorological Data Files  =  1
Meteorological Data File Names
  C:\Projects\ARCON2\Test_Cases\EXAMPLE.MET

Height of lower wind instrument (m)  =     10.0
Height of upper wind instrument (m)  =     92.1
Wind speeds entered as meters/second

Vent release
Release height (m)                   =     29.0
Building Area (m^2)                  =   1730.0
Effluent vertical velocity (m/s)     =      5.00
Vent or stack flow  (m^3/s)          =     15.70
Vent or stack radius (m)             =      1.00

Direction .. intake to source (deg)  =      083
Wind direction sector width (deg)    =       90
Wind direction window (deg)          =   038 - 128
Distance to intake (m)               =     18.0
Intake height  (m)                   =     25.0
Terrain elevation difference (m)     =      0.0

Output file names
  arcon2_ex2.LOG
  arcon2_ex2.CFD

Minimum Wind Speed (m/s)             =      0.5
Surface roughness length (m)         =      0.20
Sector averaging constant            =      4.3

Initial value of sigma y             =      0.00
Initial value of sigma z             =      0.00

Expanded output for code testing selected
QA output file = C:\ARCON 2.0\arcon2_ex2.EXT

Total number of hours of data processed =   8760
Hours of missing data                   =     10
Hours direction in window               =   1774
Hours elevated plume w/ dir. in window  =    646
Hours of calm winds                     =    750
Hours direction not in window or calm   =   6226

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL
 AVER. PER.          1         2         4         8        12        24        96       168       360       720
 UPPER LIM.    1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02
   LOW LIM.    1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06
ABOVE RANGE          0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   IN RANGE       1711.     2110.     2823.     3843.     4635.     6172.     8491.     8608.     8436.     8112.
BELOW RANGE        167.      423.      551.      654.      660.      375.      102.        0.        0.        0.
      ZERO        6872.     6209.     5352.     4197.     3442.     2169.       80.        0.        0.        0.
 TOTAL X/Qs       8750.     8742.     8726.     8694.     8737.     8716.     8673.     8608.     8436.     8112.
 % NON ZERO       21.46     28.98     38.67     51.73     60.60     75.11     99.08    100.00    100.00    100.00

95th PERCENTILE X/Q VALUES
              2.01E-03  1.96E-03  1.90E-03  1.80E-03  1.52E-03  1.09E-03  6.53E-04  5.24E-04  4.20E-04  3.24E-04

95% X/Q for standard averaging intervals

0 to 2 hours        2.01E-03
2 to 8 hours        1.73E-03
8 to 24 hours       7.37E-04
1 to 4 days         5.07E-04
4 to 30 days        2.73E-04

                          HOURLY VALUE RANGE
                        MAX X/Q          MIN X/Q
     CENTERLINE        9.35E-03         5.91E-31
     SECTOR-AVERAGE    5.80E-03         1.37E-31

NORMAL PROGRAM COMPLETION
```

Figure 2.17. ARCON 2.0 Log (.LOG) File for Example 2.

2.4.3. Example 3: Capped Vent Release

Repeat Example 2 (see Section 2.4.2), except assume that the vent is capped. In this case, set the vertical velocity to zero to represent a capped vent. Figure 2.18 shows the completed "Source-Receptor" form for Example 3. Select "File" and "Save As"; name the example "arcon2_ex3".

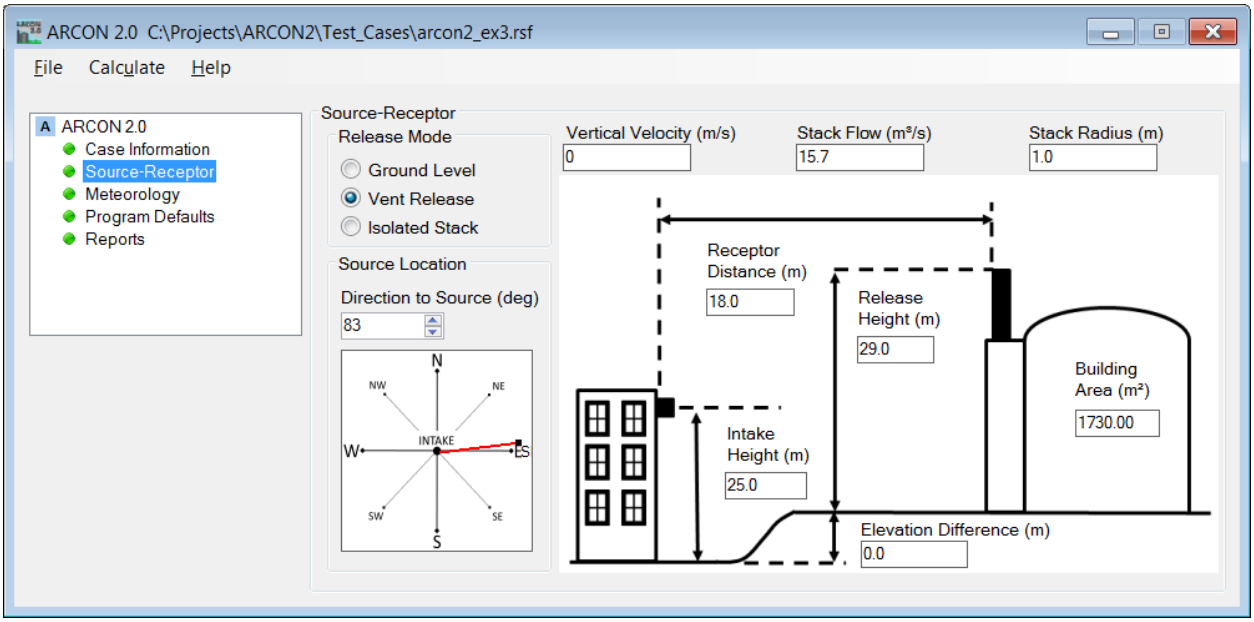

Figure 2.18. ARCON 2.0 Source-Receptor Form for Example 3.

Click the "Calculate" menu to run Example 3. The Log (.LOG) file is shown in Figure 2.19; verify your results match on the "Reports" form. Notice there are no χ/Q values within an order of magnitude of the bottom of the range of bins when the vent is capped. The number of χ/Q values in the range of bins in Example 3 is larger than in Example 2. By setting the vertical velocity of the effluent to zero in Example 3, ARCON 2.0 treats the vent release as a ground-level release. Also notice that the 95th percentile χ/Q values in Example 3 are about a factor of 5 greater than those in Example 2. This difference demonstrates how capped vents can increase χ/Q values.

```
Number of Meteorological Data Files  =  1
Meteorological Data File Names
  C:\Projects\ARCON2\Test_Cases\EXAMPLE.MET

Height of lower wind instrument (m)  =     10.0
Height of upper wind instrument (m)  =     92.1
Wind speeds entered as meters/second

Vent release
Release height (m)                   =     29.0
Building Area (m^2)                  =   1730.0
Effluent vertical velocity (m/s)     =      0.00
Vent or stack flow  (m^3/s)          =     15.70
Vent or stack radius (m)             =      1.00

Direction .. intake to source (deg)  =      083
Wind direction sector width (deg)    =       90
Wind direction window (deg)          =   038 - 128
Distance to intake (m)               =     18.0
Intake height  (m)                   =     25.0
Terrain elevation difference (m)     =      0.0

Output file names
  arcon2_ex3.LOG
  arcon2_ex3.CFD

Minimum Wind Speed (m/s)             =      0.5
Surface roughness length (m)         =      0.20
Sector averaging constant            =      4.3

Initial value of sigma y             =      0.00
Initial value of sigma z             =      0.00

Expanded output for code testing selected
QA output file = C:\ARCON 2.0\arcon2_ex3.EXT

Total number of hours of data processed =   8760
Hours of missing data                   =     10
Hours direction in window               =   1774
Hours elevated plume w/ dir. in window  =      0
Hours of calm winds                     =    750
Hours direction not in window or calm   =   6226

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL
 AVER. PER.          1         2         4         8        12        24        96       168       360       720
 UPPER LIM.    1.00E-01  1.00E-01  1.00E-01  1.00E-01  1.00E-01  1.00E-01  1.00E-01  1.00E-01  1.00E-01  1.00E-01
   LOW LIM.    1.00E-05  1.00E-05  1.00E-05  1.00E-05  1.00E-05  1.00E-05  1.00E-05  1.00E-05  1.00E-05  1.00E-05
ABOVE RANGE          0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   IN RANGE       2524.     3250.     4075.     5154.     5980.     7252.     8608.     8608.     8436.     8112.
BELOW RANGE          0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      ZERO        6226.     5492.     4651.     3540.     2757.     1464.       65.        0.        0.        0.
 TOTAL X/Qs       8750.     8742.     8726.     8694.     8737.     8716.     8673.     8608.     8436.     8112.
 % NON ZERO       28.85     37.18     46.70     59.28     68.44     83.20     99.25    100.00    100.00    100.00

95th PERCENTILE X/Q VALUES
              1.05E-02  1.00E-02  9.46E-03  8.79E-03  7.26E-03  5.47E-03  3.55E-03  2.87E-03  2.41E-03  1.99E-03

95% X/Q for standard averaging intervals

0 to 2 hours        1.05E-02
2 to 8 hours        8.21E-03
8 to 24 hours       3.81E-03
1 to 4 days         2.91E-03
4 to 30 days        1.75E-03

                          HOURLY VALUE RANGE
                        MAX X/Q              MIN X/Q
     CENTERLINE        1.63E-02             3.99E-03
     SECTOR-AVERAGE    1.07E-02             2.39E-03

NORMAL PROGRAM COMPLETION
```

Figure 2.19. ARCON 2.0 Log (.LOG) File for Example 3.

2.4.4. Example 4: Stack Release

The fourth example is a stack release. In this example, a 65-m stack is located 210 m from the intake at a bearing of 284°. The radius of the stack exit is 1 m, and the nominal flow is 31.4 m^3/s. Therefore, the vertical velocity is 10 m/s out the stack. The air intake is 25 m above grade. Assume that there is no change in grade between the locations of the intake and stack. Figure 2.20 shows the completed "Source-Receptor" form for Example 4. From the "Meteorology Form", select the EXAMPLE.MET hourly meteorological data file in the "Test_Cases" folder. Assume the wind speeds are in miles per hour and were measured at the 10 and 63.9 m levels. Select "File" and "Save As"; name the example "arcon2_ex4".

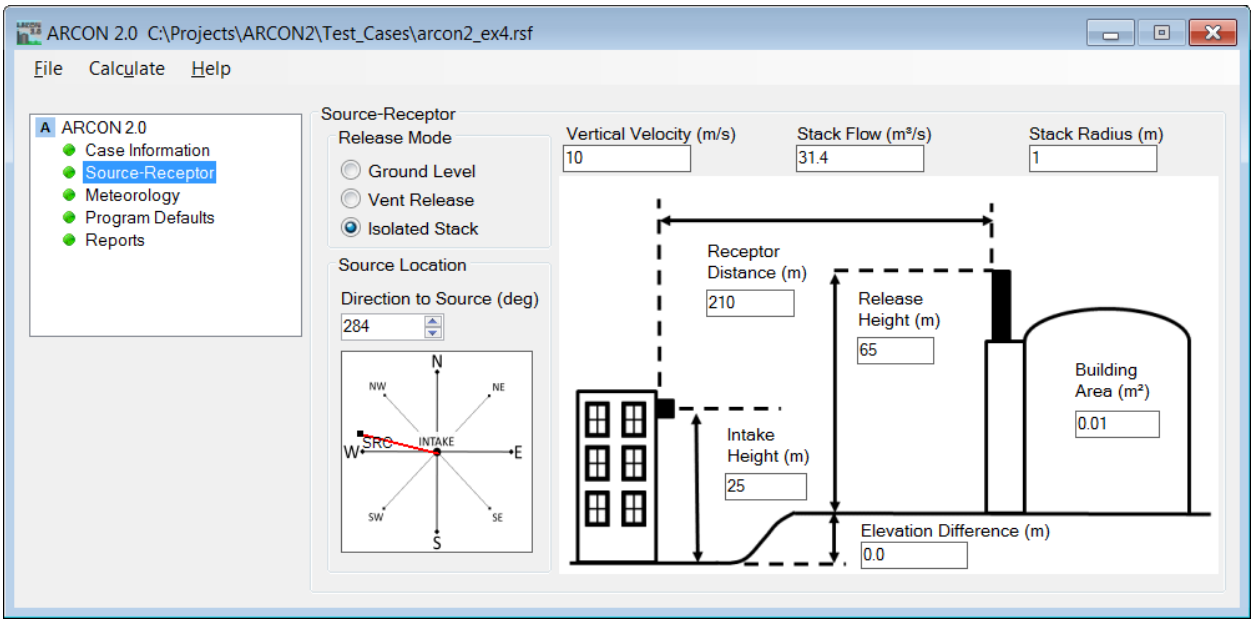

Figure 2.20. ARCON 2.0 Source-Receptor Form for Example 4.

Click the "Calculate" menu to run Example 4. The Log (.LOG) file is shown in Figure 2.21; verify your results match on the "Reports" form. Notice how the χ/Q values for a stack release are significantly lower than for the ground (Example 1) or vent (Example 2 and 3) releases. This example also shows one set of conditions under which the 95th percentile, 2-hour average χ/Q can exceed the 1-hour average. The results in Figure 2.21 show that the 95th percentile 1-hour x/Q is 2.08E-07 s/m^3 and that the 2-hour value is 1.53E-05 s/m^3. The total χ/Q values line in Figure 2.20 shows that 8750 χ/Q values were considered in calculating the 95th percentile 1-hour average χ/Q, and 8742 were considered in calculating the 2-hour value. In both cases the 95th percentile χ/Q values are exceeded by about 437 values.

To verify the result that the 1-hour value is lower than the 2-hour value is indeed correct, look at the cumulative frequency distributions in Figure 2.22 which contains an excerpt from the cumulative frequency distribution (.CFD) file. The maximum 1-hour χ/Q values exceed the maximum 2-hour values as expected. But, the tail of the distribution is long and there is a small group of values in the tail. Reducing the highest values by 50 percent gives values that are still in the upper 5th percentile of the χ/Q

distribution. As a result, the 95th percentile 2-hour average χ/Q occurs at about 1.50E-05 s/m^3, while the corresponding 1-hour average occurs at about 2.10E-07 s/m^3. Thus, it is apparent that the result is correct.

Note that if the stack were much closer to the intake in this problem, all of the predicted concentrations would be orders of magnitude smaller than they are in Figures 2.21 and 2.22. While it is likely that most of the concentrations would be near zero, there is a possibility that the concentrations experienced under light wind conditions could be much higher than predicted by ARCON 2.0. If ARCON 2.0 predicts that all concentrations are near zero, another method should be used to estimate maximum concentrations.

```
Number of Meteorological Data Files  =  1
Meteorological Data File Names
  C:\Projects\ARCON2\Test_Cases\EXAMPLE.MET

Height of lower wind instrument (m)  =     10.0
Height of upper wind instrument (m)  =     63.9
Wind speeds entered as miles per hour

Elevated release
Release height (m)                   =     65.0
Building Area (m^2)                  =      0.0
Effluent vertical velocity (m/s)     =     10.00
Vent or stack flow  (m^3/s)          =     31.40
Vent or stack radius (m)             =      1.00

Direction .. intake to source (deg)  =      284
Wind direction sector width (deg)    =       90
Wind direction window (deg)          =   239 - 329
Distance to intake (m)               =    210.0
Intake height  (m)                   =     25.0
Terrain elevation difference (m)     =      0.0

Output file names
  arcon2_ex4.LOG
  arcon2_ex4.CFD

Minimum Wind Speed (m/s)             =      0.5
Surface roughness length (m)         =      0.20
Sector averaging constant            =      4.3

Initial value of sigma y             =      0.00
Initial value of sigma z             =      0.00

Expanded output for code testing selected
QA output file = C:\ARCON 2.0\arcon2_ex4.EXT

Total number of hours of data processed =   8760
Hours of missing data                   =     10
Hours direction in window               =   3118
Hours elevated plume w/ dir. in window  =   1078
Hours of calm winds                     =    571
Hours direction not in window or calm   =   5061

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL
 AVER. PER.          1          2          4          8         12         24         96        168        360        720
 UPPER LIM.    1.00E-03   1.00E-03   1.00E-03   1.00E-03   1.00E-03   1.00E-03   1.00E-03   1.00E-03   1.00E-03   1.00E-03
   LOW LIM.    1.00E-07   1.00E-07   1.00E-07   1.00E-07   1.00E-07   1.00E-07   1.00E-07   1.00E-07   1.00E-07   1.00E-07
ABOVE RANGE          0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
   IN RANGE        702.       892.      1042.      1449.      1944.      3175.      5653.      6596.      7428.      7889.
BELOW RANGE       1551.      1765.      2111.      2236.      2770.      2991.      2744.      1987.      1008.       223.
       ZERO       6497.      6085.      5573.      5009.      4023.      2550.       276.        25.        0.         0.
 TOTAL X/Qs       8750.      8742.      8726.      8694.      8737.      8716.      8673.      8608.      8436.      8112.
 % NON ZERO       25.75      30.39      36.13      42.39      53.95      70.74      96.82      99.71     100.00     100.00

95th PERCENTILE X/Q VALUES
              2.08E-07   1.53E-05   1.58E-05   1.59E-05   1.20E-05   7.55E-06   4.47E-06   3.76E-06   3.52E-06   3.42E-06

95% X/Q for standard averaging intervals

0 to 2 hours        1.53E-05
2 to 8 hours        1.61E-05
8 to 24 hours       3.37E-06
1 to 4 days         3.44E-06
4 to 30 days        3.26E-06

                          HOURLY VALUE RANGE
                        MAX X/Q              MIN X/Q
      CENTERLINE       1.92E-04             1.36E-23
      SECTOR-AVERAGE   1.12E-04             3.74E-24

NORMAL PROGRAM COMPLETION
```

Figure 2.21. ARCON 2.0 Log (.LOG) File for Example 4.

X/Q CUMULATIVE FREQUENCY DISTRIBUTIONS

XOQ	1	2	4	8	XOQ	12	24	96	168	360	720
Abv. Lim.	0.	0.	0.	0.	Abv. Lim.	0.	0.	0.	0.	0.	0.
...											
2.089E-04	0.	0.	0.	0.	2.089E-04	0.	0.	0.	0.	0.	0.
1.905E-04	6.	1.	0.	0.	1.905E-04	0.	0.	0.	0.	0.	0.
1.738E-04	6.	1.	0.	0.	1.738E-04	0.	0.	0.	0.	0.	0.
1.585E-04	7.	1.	0.	0.	1.585E-04	0.	0.	0.	0.	0.	0.
1.445E-04	7.	1.	0.	0.	1.445E-04	0.	0.	0.	0.	0.	0.
1.318E-04	10.	1.	0.	0.	1.318E-04	0.	0.	0.	0.	0.	0.
1.202E-04	11.	1.	0.	0.	1.202E-04	0.	0.	0.	0.	0.	0.
1.096E-04	15.	1.	0.	0.	1.096E-04	0.	0.	0.	0.	0.	0.
1.000E-04	17.	1.	0.	0.	1.000E-04	0.	0.	0.	0.	0.	0.
9.120E-05	20.	12.	3.	0.	9.120E-05	0.	0.	0.	0.	0.	0.
8.318E-05	25.	12.	4.	0.	8.318E-05	0.	0.	0.	0.	0.	0.
7.586E-05	29.	16.	6.	0.	7.586E-05	0.	0.	0.	0.	0.	0.
6.918E-05	34.	22.	9.	0.	6.918E-05	0.	0.	0.	0.	0.	0.
6.310E-05	53.	39.	11.	0.	6.310E-05	0.	0.	0.	0.	0.	0.
5.754E-05	66.	46.	14.	4.	5.754E-05	0.	0.	0.	0.	0.	0.
5.248E-05	91.	65.	25.	8.	5.248E-05	0.	0.	0.	0.	0.	0.
4.786E-05	115.	88.	53.	14.	4.786E-05	0.	0.	0.	0.	0.	0.
4.365E-05	146.	109.	65.	25.	4.365E-05	0.	0.	0.	0.	0.	0.
3.981E-05	189.	137.	96.	33.	3.981E-05	4.	0.	0.	0.	0.	0.
3.631E-05	214.	171.	116.	47.	3.631E-05	11.	0.	0.	0.	0.	0.
3.311E-05	246.	199.	153.	59.	3.311E-05	17.	0.	0.	0.	0.	0.
3.020E-05	275.	235.	191.	83.	3.020E-05	29.	0.	0.	0.	0.	0.
2.754E-05	288.	262.	222.	99.	2.754E-05	44.	0.	0.	0.	0.	0.
2.512E-05	304.	288.	259.	158.	2.512E-05	55.	0.	0.	0.	0.	0.
2.291E-05	311.	321.	298.	207.	2.291E-05	68.	0.	0.	0.	0.	0.
2.089E-05	323.	357.	329.	257.	2.089E-05	104.	2.	0.	0.	0.	0.
1.905E-05	335.	390.	367.	306.	1.905E-05	129.	5.	0.	0.	0.	0.
1.738E-05	339.	413.	389.	352.	1.738E-05	189.	16.	0.	0.	0.	0.
1.585E-05	348.	430.	435.	438.	1.585E-05	250.	23.	0.	0.	0.	0.
1.445E-05	357.	448.	461.	468.	1.445E-05	309.	46.	0.	0.	0.	0.
1.318E-05	367.	468.	490.	504.	1.318E-05	373.	61.	0.	0.	0.	0.
1.202E-05	370.	469.	536.	556.	1.202E-05	435.	96.	0.	0.	0.	0.
1.096E-05	378.	477.	568.	605.	1.096E-05	517.	128.	0.	0.	0.	0.
1.000E-05	384.	489.	609.	646.	1.000E-05	577.	198.	0.	0.	0.	0.
9.120E-06	393.	497.	637.	691.	9.120E-06	630.	256.	8.	0.	0.	0.
8.318E-06	400.	509.	660.	733.	8.318E-06	682.	363.	37.	0.	0.	0.
7.586E-06	410.	521.	682.	780.	7.586E-06	753.	432.	88.	13.	0.	0.
6.918E-06	419.	532.	696.	826.	6.918E-06	797.	504.	102.	45.	0.	0.
6.310E-06	420.	540.	712.	868.	6.310E-06	867.	617.	125.	79.	0.	0.
5.754E-06	423.	542.	714.	936.	5.754E-06	920.	764.	172.	112.	0.	0.
5.248E-06	425.	550.	722.	992.	5.248E-06	984.	911.	250.	149.	0.	0.
4.786E-06	427.	563.	734.	1040.	4.786E-06	1044.	1034.	352.	185.	118.	0.
4.365E-06	427.	573.	738.	1067.	4.365E-06	1107.	1161.	460.	229.	230.	0.
3.981E-06	429.	582.	765.	1088.	3.981E-06	1188.	1299.	595.	329.	347.	33.
3.631E-06	432.	593.	777.	1107.	3.631E-06	1235.	1423.	786.	488.	380.	174.
3.311E-06	432.	597.	792.	1143.	3.311E-06	1306.	1528.	948.	651.	499.	525.
3.020E-06	432.	600.	797.	1146.	3.020E-06	1352.	1656.	1217.	950.	767.	682.
2.754E-06	432.	605.	810.	1152.	2.754E-06	1394.	1715.	1424.	1205.	1054.	878.
2.512E-06	432.	607.	825.	1159.	2.512E-06	1430.	1777.	1676.	1448.	1229.	1249.
2.291E-06	432.	607.	836.	1173.	2.291E-06	1488.	1867.	1906.	1760.	1515.	1683.
2.089E-06	432.	607.	845.	1202.	2.089E-06	1517.	1968.	2131.	2024.	1788.	1996.
1.905E-06	432.	613.	856.	1226.	1.905E-06	1552.	2065.	2261.	2208.	2238.	2300.
1.738E-06	432.	613.	868.	1241.	1.738E-06	1564.	2134.	2368.	2498.	2475.	2579.
1.585E-06	432.	613.	871.	1255.	1.585E-06	1588.	2225.	2586.	2581.	2873.	2790.
1.445E-06	432.	613.	874.	1274.	1.445E-06	1615.	2270.	2842.	2846.	3038.	2983.
1.318E-06	432.	613.	876.	1285.	1.318E-06	1650.	2357.	2978.	3099.	3271.	3341.
1.202E-06	432.	613.	880.	1317.	1.202E-06	1662.	2438.	3070.	3262.	3408.	3456.
1.096E-06	432.	613.	880.	1327.	1.096E-06	1679.	2498.	3356.	3347.	3631.	3822.
1.000E-06	432.	613.	886.	1343.	1.000E-06	1697.	2603.	3459.	3518.	3685.	3868.
...											
1.000E-07	702.	892.	1042.	1449.	1.000E-07	1944.	3175.	5653.	6596.	7428.	7889.
Belw. Lim.	1551.	1765.	2111.	2236.	Belw. Lim.	2770.	2991.	2744.	1987.	1008.	223.

Figure 2.22. ARCON 2.0 Cumulative Frequency Distribution (.CFD) File for Example 4.

2.4.5. Example 5: Multiple Vent Release

Consider a release to the environment via a large open bay that is ventilated by 12 vents. Figure 2.23 shows a plan view of the roof. Note that there is air intake at the northwest corner of the roof. What is the relative atmospheric concentration (χ/Q) at the air intake if the release occurs in the bay? Assume the height of the roof is 20 m above ground level and the projected building area onto the intake is approximately 1500 m^2 (i.e., 20 m x 75 m = 1500 m^2). The vents are 1 m above the roof, have a radius of 0.5 m, and are capped. Each vent has a flow of 5 m^3/s. The intake is 3 m above the roof. From the "Meteorology Form", select the EXAMPLE.MET hourly meteorological data file in the "Test_Cases" folder. Assume the wind speeds are in meters per second and were measured at the 10 and 61 m levels.

An approach to estimating χ/Q at the intake is to assume that the release from the 12 vents acts as if the vents were an area source. ARCON 2.0 permits specification of initial diffusion coefficients. These coefficients may be used to define a virtual area source. Methods for determining the initial diffusion coefficients that define a virtual area source involve subjective decisions. The following discussion illustrates a way in which the initial diffusion coefficients could be defined for this example.

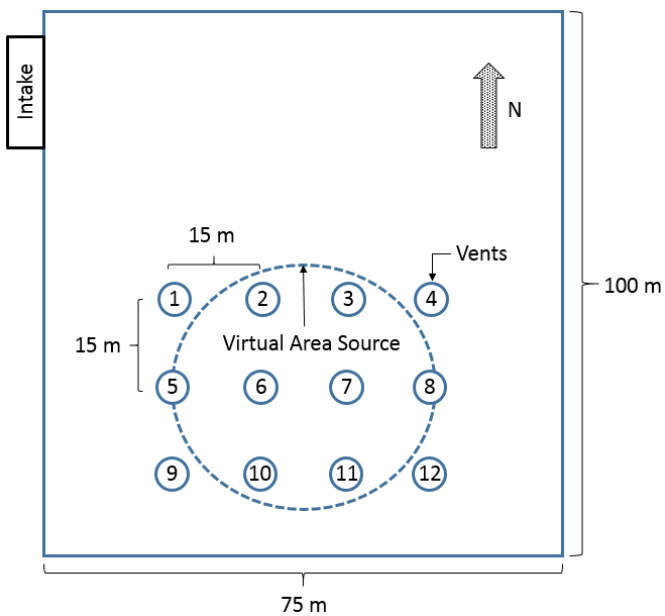

Figure 2.23. Multiple-vent release configuration for Example 5.

Assume:

1) the area covered by the virtual area source is equal to the area of the rectangle formed by joining the centers of vents 1, 4, 9, and 12,
2) the center of the virtual area source is at the center of the rectangle. The distance between vent centers is 15 m.
3) the bearing and distance from the intake to the center of the virtual area source, "A1", are 147° and 70 m, respectively (Table 2).

Table 2: Vent positions and intake χ/Q values for multiple-vent release scenario.

Vent	Bearing (degrees)	Distance (m)	0-2 hr (s/m³)	2-8 hr (s/m³)	8-24 hr (s/m³)	1-4 days (s/m³)	4-30 days (s/m³)
A1	147°	70.0	6.76E-04	4.49E-04	1.29E-04	1.49E-04	1.32E-04
A2	156°	57.0	1.03E-03	6.61E-04	1.89E-04	2.14E-04	1.89E-04

To determine the characteristics of the area source, start by calculating its radius, r_A. The radius of the area source is

$$\pi r_A^2 = 30\ x\ 45 = 1350\ m^2$$

$$r_A = 20.73\ m$$

A virtual area source with radius r_A, is shown in Figure 2.23. Figure 2.24 shows the completed "Source-Receptor" form for Example 5. Note that a stack radius of 10 m was entered. This is the upper limit of the range of acceptable values for stack radius. However, stack radius is only used for plume downwash calculations when the vertical velocity is greater than zero. If the vents had been uncapped, the radius and vertical velocity for an individual vent would need to be entered.

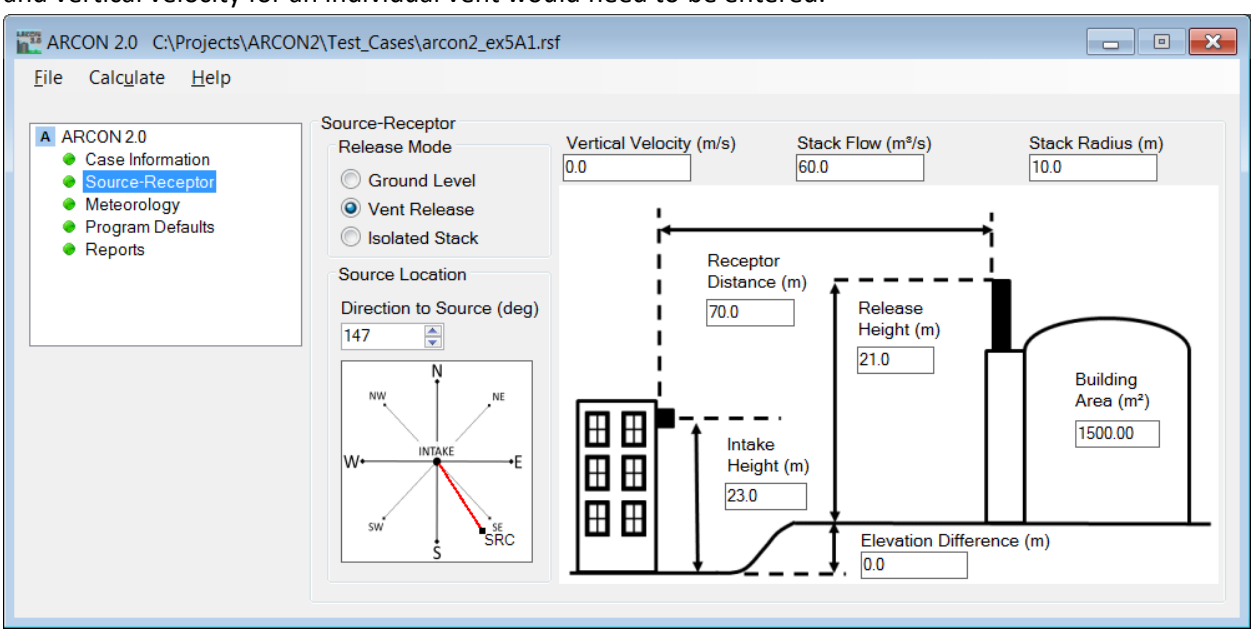

Figure 2.24. ARCON 2.0 Source-Receptor Form for Example 5.

Next, estimate the initial horizontal diffusion coefficient from the radius. In a Gaussian distribution, approximately 99% of the area under the curve is within ±2.15 σ of the center. On this basis, the edge of plumes have frequently been assumed to be 2.15 σ_y from the center, where σ_y, is a horizontal diffusion coefficient. Therefore, assume that the initial diffusion coefficient for the virtual area source σ_{yo}, is:

$$\sigma_{yo} = {}^{r_A}/_{2.15}$$

$$r_A = 9.64\ m$$

For the initial vertical diffusion coefficient, σ_{zo}, note that the vents are 1 m above the roof and capped. On this basis, assume an initial vertical diffusion coefficient of 1 m. Select "Program Defaults" and enter the initial "Sigma Y" and "Sigma Z" diffusion coefficients as shown in Figure 2.25. Select "File" and "Save As"; name the example "arcon2_ex5A1".

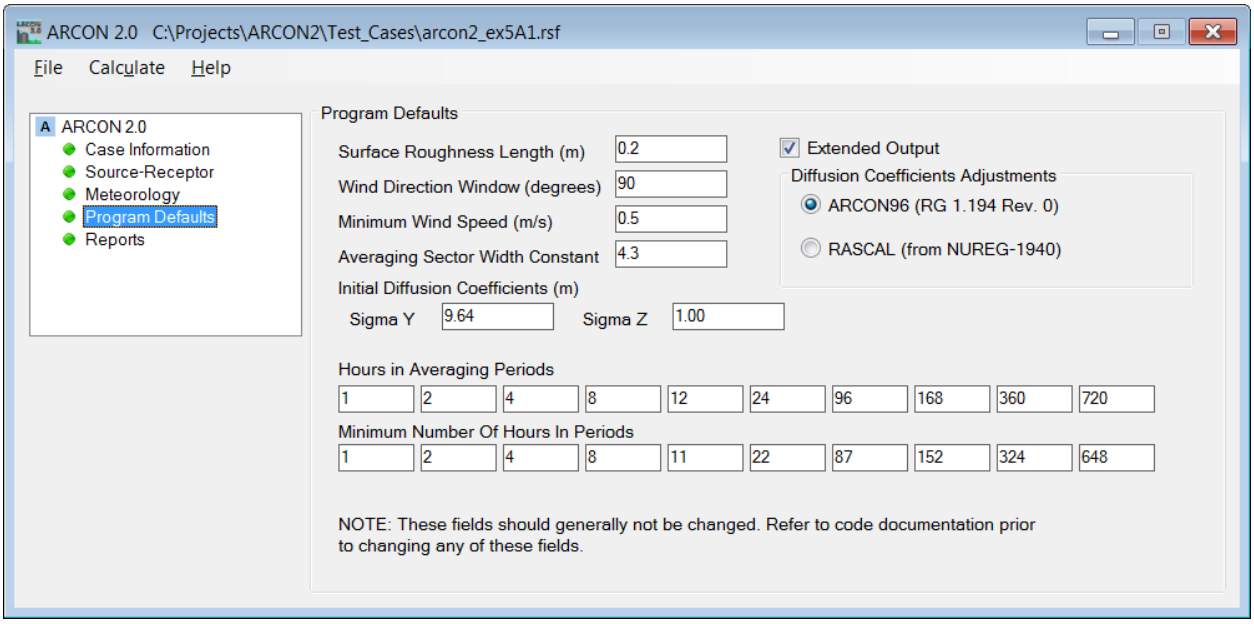

Figure 2.25. ARCON 2.0 Program Defaults Form for Example 5.

Click the "Calculate" menu item to run Example 5. The input data and results sections of the ARCON 2.0 output (.LOG) file for this example are shown in Figure 2.26; verify your results match on the "Reports" form. In addition, the 95th percentile relative concentrations for the "A1" virtual source are listed in Table 2.

Other choices can be made for the area source, particularly if there is more information about the nature of the bay area and air flow within the bay. For example, if there were partitions in the bay that made it likely that the release would occur from vents 1, 2, 5, and 6, an area source could be defined using these vents. The "A2" row in Table 2 above gives the bearing and distance to the center of this area and the corresponding χ/Q values from ARCON 2.0. This alternative case can be loaded by selecting "File" "Open Existing Case", and selecting "arcon2_ex5A2" from the "Test_Cases" folder.

```
Number of Meteorological Data Files  =  1
Meteorological Data File Names
  C:\Projects\ARCON2\Test_Cases\EXAMPLE.MET

Height of lower wind instrument (m)  =     10.0
Height of upper wind instrument (m)  =     61.0
Wind speeds entered as meters/second

Vent release
Release height (m)                   =     21.0
Building Area (m^2)                  =   1500.0
Effluent vertical velocity (m/s)     =      0.00
Vent or stack flow  (m^3/s)          =     60.00
Vent or stack radius (m)             =     10.00

Direction .. intake to source (deg)  =      147
Wind direction sector width (deg)    =       90
Wind direction window (deg)          =   102 - 192
Distance to intake (m)               =     70.0
Intake height  (m)                   =     23.0
Terrain elevation difference (m)     =      0.0

Output file names
  arcon2_ex5A1.LOG
  arcon2_ex5A1.CFD

Minimum Wind Speed (m/s)             =      0.5
Surface roughness length (m)         =      0.20
Sector averaging constant            =      4.3

Initial value of sigma y             =      9.64
Initial value of sigma z             =      1.00

Expanded output for code testing selected
QA output file = C:\ARCON 2.0\arcon2_ex5A1.EXT

Total number of hours of data processed =   8760
Hours of missing data                   =     10
Hours direction in window               =   2039
Hours elevated plume w/ dir. in window  =      0
Hours of calm winds                     =    750
Hours direction not in window or calm   =   5961

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL
 AVER. PER.          1          2          4          8         12         24         96        168        360        720
 UPPER LIM.    1.00E-02   1.00E-02   1.00E-02   1.00E-02   1.00E-03   1.00E-03   1.00E-03   1.00E-03   1.00E-03   1.00E-03
   LOW LIM.    1.00E-06   1.00E-06   1.00E-06   1.00E-06   1.00E-07   1.00E-07   1.00E-07   1.00E-07   1.00E-07   1.00E-07
ABOVE RANGE          0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
   IN RANGE       2789.      3495.      4387.      5628.      6591.      7595.      8664.      8608.      8436.      8112.
BELOW RANGE          0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
       ZERO       5961.      5247.      4339.      3066.      2146.      1121.         9.         0.         0.         0.
 TOTAL X/Qs       8750.      8742.      8726.      8694.      8737.      8716.      8673.      8608.      8436.      8112.
 % NON ZERO       31.87      39.98      50.28      64.73      75.44      87.14      99.90     100.00     100.00     100.00

95th PERCENTILE X/Q VALUES
              6.76E-04   6.29E-04   5.66E-04   5.06E-04   3.99E-04   2.55E-04   1.76E-04   1.58E-04   1.46E-04   1.38E-04

95% X/Q for standard averaging intervals

0 to 2 hours        6.76E-04
2 to 8 hours        4.49E-04
8 to 24 hours       1.29E-04
1 to 4 days         1.49E-04
4 to 30 days        1.32E-04

                          HOURLY VALUE RANGE
                        MAX X/Q            MIN X/Q
      CENTERLINE       1.03E-03           2.08E-04
      SECTOR-AVERAGE   6.19E-04           1.22E-04

NORMAL PROGRAM COMPLETION
```

Figure 2.26. ARCON 2.0 Log (.LOG) File for Example 5.

2.4.6. Example 6: Diffuse Source Release

For the final example, consider the plant design shown in Figure 2.27. Assume that an accident sequence at the plant results in releases from many openings on the southeast face of the containment in the shaded area shown in the side view. Assume a projected building area of 2000 m^2, that the bearing from the intake to the containment building wall is 240°, and that the average distance from the wall to the intake is approximately 45 m. Figure 2.28 shows the completed "Source-Receptor" form for Example 6. From the "Meteorology Form", select the EXAMPLE.MET hourly meteorological data file in the "Test_Cases" folder. Assume the wind speeds are in meters per second and were measured at the 10 and 62 m levels.

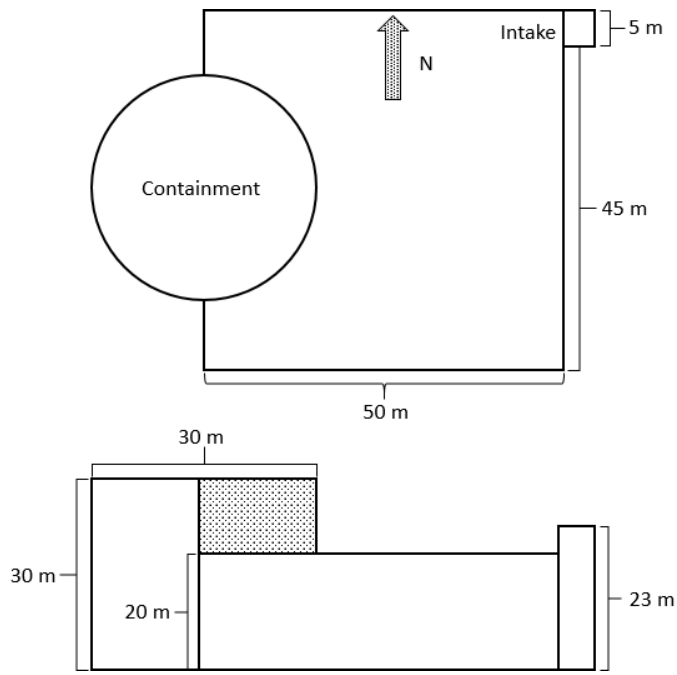

Figure 2.27. Diffuse-source release configuration for Example 6

The 95th percentile χ/Q values can be used for assessing control room habitability. Note that estimates of the initial diffusion coefficients need to be determined. One possible solution for this example is to make the following assumptions:

1. the source is a vertical area source (note that the previous example assumed a horizontal area source)
2. the release height is at the roof level (20 m)
3. the initial vertical diffusion coefficient (Sigma Z) is 1/2 of the height of the exposed height of the containment building above roof level (5.0 m)
4. the width of the area source is equal to the radius of the containment building (15 m); an estimate of the initial horizontal diffusion coefficient (Sigma Y) is this width divided by 6[†] (2.5 m)

[†] In accordance with U.S. NRC Regulatory Guide 1.194, Section 3.2.4.4.

5. the intake height is 1.5 m above the roof.

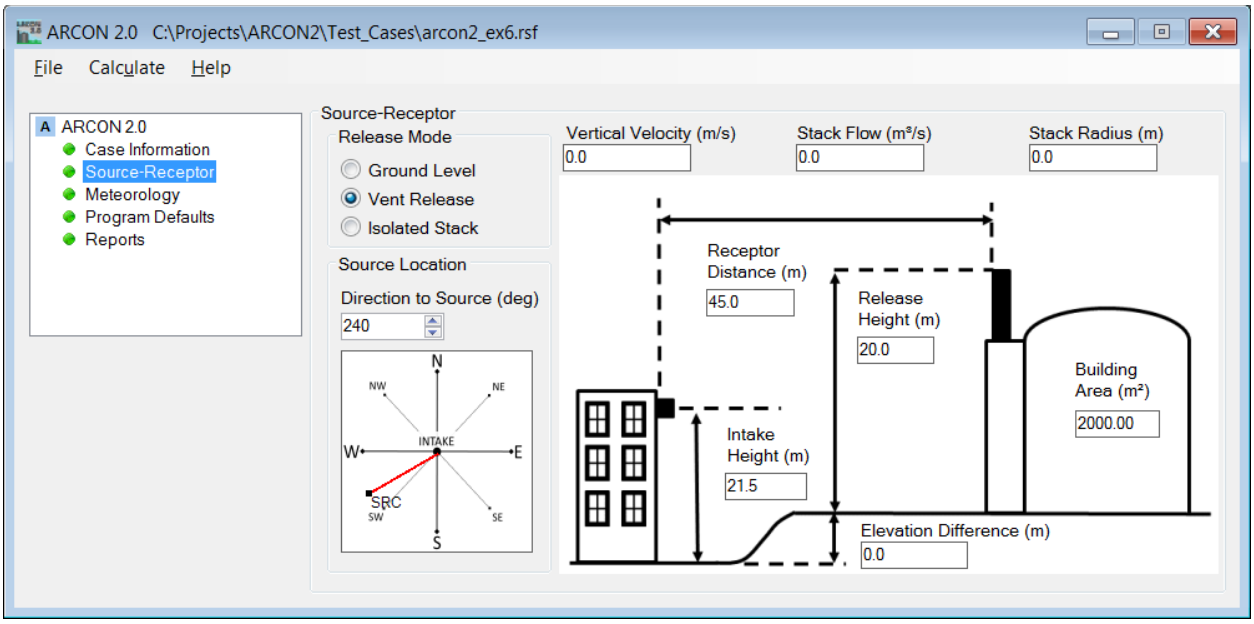

Figure 2.28. ARCON 2.0 Source-Receptor Form for Example 6.

Select "Program Defaults" and enter the initial "Sigma Y" and "Sigma Z" diffusion coefficients as shown in Figure 2.29. Select "File" and "Save As"; name the example "arcon2_ex6".

Click the "Calculate" menu item to run Example 6. The input data and results sections of the ARCON 2.0 output (.LOG) file for this example are shown in Figure 2.30; verify your results match on the "Reports" form. With the above assumptions, ARCON 2.0 calculates that the 95th percentile χ/Q at the intake for 0 to 2 hours is 1.19E-03 s/m^3.

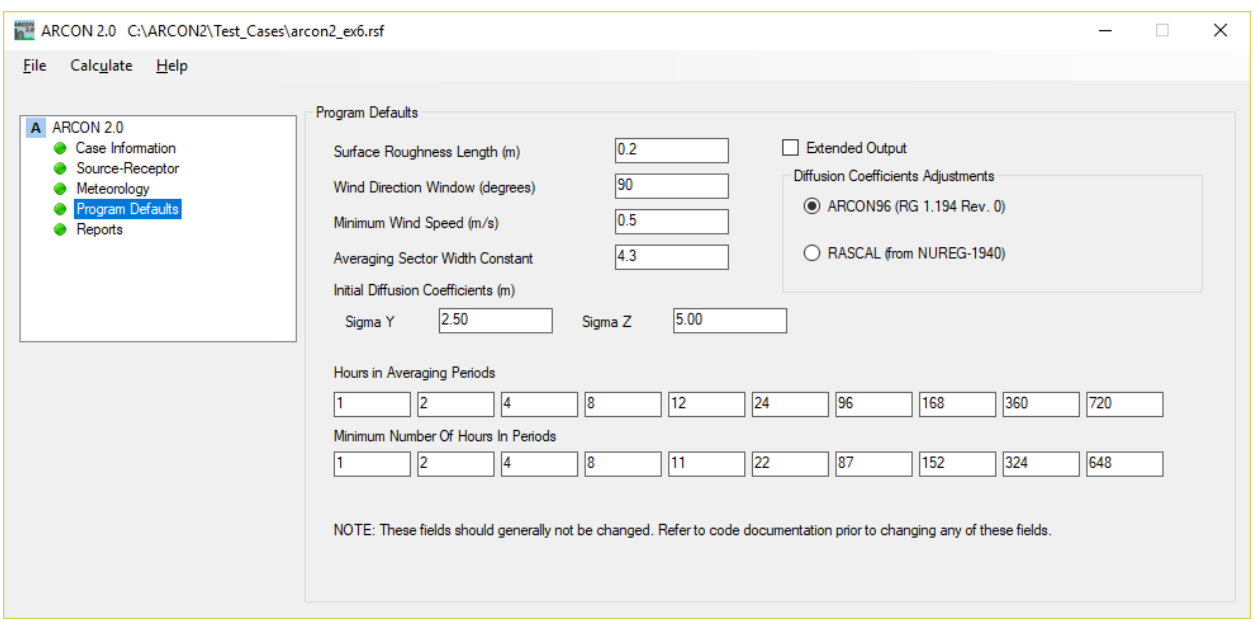

Figure 2.29. ARCON 2.0 Program Defaults Form for Example 6.

```
Number of Meteorological Data Files  =  1
Meteorological Data File Names
  C:\Projects\ARCON2\Test_Cases\EXAMPLE.MET

Height of lower wind instrument (m)  =     10.0
Height of upper wind instrument (m)  =     62.0
Wind speeds entered as meters/second

Vent release
Release height (m)                   =     20.0
Building Area (m^2)                  =   2000.0
Effluent vertical velocity (m/s)     =      0.00
Vent or stack flow  (m^3/s)          =      0.00
Vent or stack radius (m)             =      0.00

Direction .. intake to source (deg)  =      240
Wind direction sector width (deg)    =       90
Wind direction window (deg)          =   195 - 285
Distance to intake (m)               =     45.0
Intake height  (m)                   =     21.5
Terrain elevation difference (m)     =      0.0

Output file names
  arcon2_ex6.LOG
  arcon2_ex6.CFD

Minimum Wind Speed (m/s)             =      0.5
Surface roughness length (m)         =      0.20
Sector averaging constant            =      4.3

Initial value of sigma y             =      2.50
Initial value of sigma z             =      5.00

Expanded output for code testing not selected

Total number of hours of data processed =   8760
Hours of missing data                =     10
Hours direction in window            =   2677
Hours elevated plume w/ dir. in window  =      0
Hours of calm winds                  =    750
Hours direction not in window or calm   =   5323

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL
 AVER. PER.          1         2         4         8        12        24        96       168       360       720
 UPPER LIM.    1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02  1.00E-02
   LOW LIM.    1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06  1.00E-06
ABOVE RANGE          0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   IN RANGE       3427.     4395.     5515.     6630.     7291.     8049.     8659.     8608.     8436.     8112.
BELOW RANGE          0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      ZERO        5323.     4347.     3211.     2064.     1446.      667.       14.        0.        0.        0.
 TOTAL X/Qs       8750.     8742.     8726.     8694.     8737.     8716.     8673.     8608.     8436.     8112.
 % NON ZERO       39.17     50.27     63.20     76.26     83.45     92.35     99.84    100.00    100.00    100.00

95th PERCENTILE X/Q VALUES
              1.28E-03  1.20E-03  1.15E-03  1.08E-03  8.92E-04  6.66E-04  4.26E-04  3.82E-04  3.39E-04  3.06E-04

95% X/Q for standard averaging intervals

0 to 2 hours        1.28E-03
2 to 8 hours        1.01E-03
8 to 24 hours       4.60E-04
1 to 4 days         3.46E-04
4 to 30 days        2.87E-04

                          HOURLY VALUE RANGE
                         MAX X/Q              MIN X/Q
      CENTERLINE        1.61E-03             3.05E-04
      SECTOR-AVERAGE    9.37E-04             1.78E-04

NORMAL PROGRAM COMPLETION
```

Figure 2.30. ARCON 2.0 Log (.LOG) File for Example 6.