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TECHNOLOGIES, INC.

The HEM-Screen User's Guide

Human Exposure Model-Screen,

Version 2003 (Beta)

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1. Introduction

The Human Exposure Model-Screen (HEM-Screen) is a combined air dispersion and exposure and risk model used for screening-level assessments. The model is designed with simplifying assumptions to allow operation with a minimum of information. Thus, HEM-Screen is not a tool for refined-level assessments. The HEM-Screen can estimate pollutant concentrations from an identified source and combine population data with the concentration data to estimate inhalation exposure and risk to human receptors surrounding the source. The HEM-Screen

What is HEM-Screen?
• *A combined air dispersion and exposure/risk model.*
• *A tool for screening-level assessments.*

was originally developed to screen large numbers of point sources nationwide for cancer risk. Although developed early in the 1980's, HEM-Screen continues to be a valuable screening tool because it has been updated with 1990 and 2000 U.S. Census data, additional meteorological data, and the dispersion algorithm from the 1987 Industrial Source Complex Long Term (ISCLT2) model. The 2003 (Beta) version of HEM-Screen does not change any internal function of the model from its previous version, but Version 2003 (Beta) provides an improved interface, a more clear presentation of options, and options to export HEM-Screen output data to a spreadsheet compatible format. This manual is designed to provide simple, step-by-step guidance on the use of the model for the novice user. In addition, this manual provides guidance to experienced users who wish to use concentration grids from other dispersion models, estimate risk from multiple pollutants, or estimate chronic non-cancer risk.

1.1 Organization of this User's Guide

This introductory chapter includes a brief description of HEM-Screen and information regarding the applicability of HEM-Screen, along with a discussion of the model's strengths and limitations. A brief history of the development of the model is also included. Subsequent sections of this guide cover the following topics:

1. Installing and configuring HEM-Screen (Chapter 2),
2. Creating and using a HEM-Screen data input file (Chapter 3),
3. Using ISCST3 results to create a HEM-Screen input file (Chapter 4),
4. Understanding HEM-Screen output file options and running HEM-Screen (Chapter 5),
5. Understanding HEM-Screen input data details (Chapter 6), and
6. Miscellaneous HEM-Screen technical details (Chapter 7).

1.2 Brief Description of HEM-Screen

The HEM-Screen is a combined air dispersion, and exposure and risk model. The air dispersion portion of the model estimates the concentrations of a pollutant surrounding a source based on emissions and release parameters of the pollutant from that source. The exposure and risk portion of the model combines the estimated pollutant concentrations with the known population surrounding the source to determine possible human exposure and risk. Most users run HEM-Screen with source emission and risk information to obtain both pollutant concentration distributions and human exposure and risk results. However, these two functions can be separated. For example, if another air dispersion model, such as ISCST3, is used to generate a pollutant concentration distribution for a source, HEM-Screen can be used to apply population data to those concentrations to estimate human exposure and risk.

1.2.1 Estimating Pollutant Concentrations

The HEM-Screen is a screening model designed to operate with a minimum of information. The HEM-Screen uses a simplified Gaussian dispersion model based on the ISCLT2 (EPA Report No. EPA-450/4-88-002a, 1987) to estimate pollutant concentrations. In order to reduce information required by the user and to improve computational efficiency, certain assumptions are made, including:

1. Weather data from the geographically closest meteorological station are representative of the weather data at the source,
2. Meteorological stability classes are selected based on whether the source's location is classified as an "urban" or "rural" setting,
3. All emissions from a source are released from one location with a specific set of latitude and longitude coordinates representing the center of the source (i.e., multiple release points scattered across a source are modeled as if all release points are located at the center of the source), and
4. Terrain surrounding the source is flat (i.e., no hills or valleys).

As explained later, there are ways to alter the effects of these assumptions if additional site-specific information is available for a particular source. For example, site-specific meteorological data can be used, and meteorological stability classes can be manually selected. To account for the impact of multiple emission points at different locations within a source, HEM-Screen can be run with the data from only one source (i.e., a facility) such that each emission release point within the facility is considered as a "source" and is modeled at the actual release point coordinates. However, HEM-Screen cannot account for the impact of complex terrain (hills, valleys, and steep slopes) on the dispersion of a pollutant. If this factor is important for a source, another dispersion model will have to be used to generate concentration estimates, after which HEM-Screen can be used to estimate the population exposure and risk.

The two most significant pieces of information a user provides for the air dispersion and concentration estimation portion of HEM-Screen are:

1.   Location of the source in latitude and longitude coordinates (degrees, minutes, and seconds); and
2.   Emission rate of the pollutant (kilograms per year).

In addition, the user must provide emission release parameters which characterize how the pollutant is discharged into the atmosphere. The key release parameters include:

1.   Stack height (meters),
2.   Inner stack diameter (meters),
3.   Gas exit velocity (meters per second) and
4   Gas release temperature (Kelvin).

Based on the emission release input data, HEM-Screen generates a polar receptor grid of concentrations centered on the location provided for the source. The source location is defined by the user as a set of latitude and longitude coordinates representing the center of the source. The source may represent a group of emission release points at a facility or a single emission release point.

The polar receptor grid is based on ten radial distances from the source. As shown in Figure 1-1, these radial distances define ten concentric circles around the source. The HEM-Screen allows the user to select from 8 established sets of radial distances. The directional component of the polar receptor grid is comprised of the 16 standard meteorological wind directions from the source.
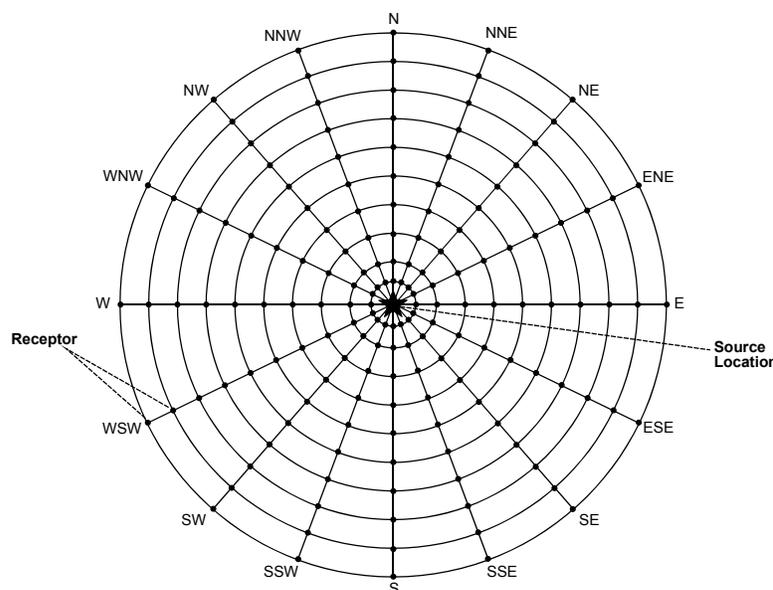
Figure 1-1. Example HEM-Screen Polar Grid

The wind directions are set by HEM-Screen and cannot be changed. The wind directions are the lines beginning at the radial distance closest to the source and radiate away from the source ending at the furthermost radial distance. Each intersection point where a distance ring and a wind direction line meet is called a receptor. The HEM-Screen estimates the annual average, ground-level pollutant concentration at each of these 160 receptors defined by the 10 distances and 16 directions.

1.2.2 Estimating Population Exposure and Risk

The HEM-Screen has both the 1990 and 2000 Census data available to the Census block level to estimate the population surrounding a source. The Census data provide:

1.   Latitude and longitude coordinates of each Census block centroid, and

2.   Number of people counted in that Census block.

In order to use this portion of the model, the user must either run HEM-Screen with source data to generate a pollutant concentration distribution or "grid," or provide a concentration grid with 160 receptors exactly as described in Chapter 4. If a concentration grid from another model is used, the latitude and longitude coordinates of the source must also be provided. If HEM-Screen generates the concentrations, the population and exposure portion of the model is run automatically.

The HEM-Screen can generate total population exposure for a source without a risk component. However, if the user wants a maximum individual cancer risk or annual cancer incidence result, a unit risk estimate (URE) must be entered. This is the cancer risk to an individual if they inhale 1 ug/m^3 of pollutant for a 70-year lifetime. If the user is interested in the hazard index (HI), which is a ratio of the inhalation reference concentration (RfC) and maximum concentration, they must enter the inverse of the RfC and convert to units of ug/m^3. Chapter 7 provides more information on entering these factors.

To estimate exposure, the model uses the four receptors closest to the centroid of each Census block to estimate the concentration at the Census block. The specific mathematics for interpolating the concentrations are provided in Chapter 7. The HEM-Screen then multiplies the interpolated concentration by the number of people in the Census block to determine total exposure for that Census block. This determination is based on the assumption that all of the people in the Census block reside at the centroid of the Census block and never leave that location for their lifetime. The total exposure for a source is then estimated by summing all of the total exposure values for the individual Census blocks in the modeled area. This is the total exposure used to generate the annual incidence for a source.

In the process of interpolating concentrations at each Census block, HEM-Screen selects the highest concentration estimated for any Census block. This is the maximum

concentration that determines the maximum cancer individual risk or the chronic, non-cancer health quotient (HQ) for one pollutant from that one source. This concentration is not necessarily the maximum modeled concentration. If no Census block centroids are near the source, the concentrations on the first or second radial distance may exceed the concentration estimated for the maximum individual risk. The intention is to estimate the highest concentration to which a person is likely to be exposed. It is possible that the first radial distance falls within the source property, where no one resides or is exposed.

1.3 Applicability of HEM-Screen

The HEM-Screen incorporates several simplifications and assumptions, yet the model provides relatively accurate screening-level representations of maximum risk and population exposures, assuming sound judgement is used in selecting the input data. It is important to realize that HEM-Screen yields risk estimates based solely on exposures by the inhalation route and only for pollutants dispersed in gaseous form. ***It does not model particulate matter, unless the particulate is so small that the particles move and behave like gases****.*

The HEM-Screen defines "exposure" as a pollutant concentration multiplied by the number of people subject to the pollutant concentration (concentration x people). The exposed population in a given dispersion area is assumed to be all those who reside in that area, based on U.S. Census figures. In other words, important exposure variables (e.g., duration of contact, human mobility patterns, and residential occupancy period) are not HEM-Screen variables that can be altered in the risk calculation. Hence, the exposure factors used in the model are only simple surrogates for actual exposures, and consequently, the most effective use of HEM-Screen is as a screening model.

1.3.1 Strengths

The HEM-Screen provides users with the following benefits:

1. Requires only a few data inputs which are generally easy to obtain;
2. Incorporates meteorological data from 348 sites nationwide without the need for data collection or further data processing;
3. Has both 1990 and 2000 national U.S. Census population data at the block level;
4. Generates estimated pollutant concentration values that compare favorably with values from other air dispersion models for point sources;
5. Can be adapted to model multiple pollutants as a single surrogate value;
6. Adds cumulative exposure and risk from the proximity of multiple sources;
7. Is relatively quick and easy to run; and
8. Provides organized and useful concentration, exposure, and risk outputs.

1.3.2 Limitations

Although HEM-Screen is a comprehensive tool, there are limitations that make the model most suitable for screening-level assessments. The following items can limit the use of HEM-Screen:

1. The original software language is Fortran, which limits any file names or directory names read by HEM-Screen to 8 alpha-numeric characters or fewer and does not recognize spaces in file names or directory names;
2. Models area sources as an approximated point source;
3. Does not model hilly or mountainous terrain - always assumes flat terrain;
4. Does not estimate short-term (i.e., acute) exposures - always estimates an annual average pollutant concentration;
5. Designed to model only a single pollutant;
6. Does not determine environmental reactions or transformation products of pollutants; and
7. All numerical values must be in ***metric units***.

As stated previously, HEM-Screen was developed to model only one pollutant at a time and to characterize only cancer risk. Yet, most modeled sources emit more than one pollutant. Chapter 7 explains how to adjust HEM-Screen input data to estimate the cancer risk from multiple pollutants, and chronic non-cancer risk for one or multiple pollutants.

1.4 History of HEM-Screen

The prototype version of HEM-Screen (originally referred to as simply the Human Exposure Model, or HEM) was a mainframe computer program operated by punch cards. Over time this dispersion and exposure model evolved into a program that could be operated on a personal computer under the DOS operating system, and data entry was improved through the use of a batch file text editor. However, the use of batch files, along with the data-entry specifications necessitated by the Fortran coding, made running the model and entering data cumbersome and error-prone.

For Version 2 of the model (developed in 2002), the program was repackaged within Windows-based interfaces to make the

What's New in Version 2003 (Beta)?
• *Revised menu screen sequencing for improved clarity.*
• *User-specified default directories for storing / retrieving HEM-Screen input and output files.*
• *Improved help and warning pop-up messages.*
• *Option to display or not to display pop-up warning messages.*
• *HEM-Screen output files can be exported to a spreadsheet compatible format.*
• *Standard Summary Report layout reorganized for improved clarity.*
• *Previously non-functional HEM-Screen features have been removed.*

operation of the model more user-friendly. Version 2 also enabled spreadsheet (MS Excel®) data entry to replace the old batch file system.

The current version of the model – now referred to as HEM-Screen Version 2003 (Beta) to differentiate this model from HEM-3 – represents a further refinement of the model to make the screen sequencing more logical and the graphical user interface (GUI) more intuitive. The output options for HEM-Screen are more clear and the most commonly used output files are now available for export into a spreadsheet compatible (*.csv) file format rather than rigidly formatted text files. These improvements have enhanced not only the user-friendliness of HEM-Screen, but also its flexibility.

2. Installing and Configuring HEM-Screen

The installation procedures for HEM-Screen software are discussed in Section 2.1. Procedures to customize the configuration of HEM-Screen on a computer, once it is installed, are discussed in Section 2.2.

2.1 Installing HEM-Screen Software

The HEM-Screen can be installed on a computer with one of these operating systems:

- Windows NT,
- Windows 95 / 98 / 2000, and
- Windows XP (with the latest service pack(s) installed).

In addition, the computer must have a 233 MHZ processor or better, a minimum memory capacity of 32 megabytes, and at least 700 Mb of hard drive space.

The HEM-Screen _must_ run on the computer's C-drive (C:/) due to hard coding within the model. The installation program automatically installs the program in the directory C:\HEM. If a directory already exists with that name, the current files should be saved to another directory with a new name before installing HEM-Screen Version 2003 (Beta).

The HEM-Screen Version 2003 (Beta) software will be available on CD-ROM and to download from the EPA's Technology Transfer Network (TTN) Fate, Exposure, and Risk Analysis (FERA) web site: **http://www.epa.gov/ttn/fera**.

To begin installation from a CD, insert the HEM-Screen disc into the computer's CD-ROM drive and double-click the file: ***HEM_Screen_2003_INSTALLER.exe*** under the ***INSTALLER*** directory.   A message box will appear for a few minutes as the installer software is verified. Afterwards, the ***2003 Self Extractor Instructions*** message box will automatically appear. In this step, the user extracts the installation files from the CD and copies them onto the user's computer hard drive. **Note: do not change the default installation directory of C:\.** Click on the ***Extract*** button in the lower, right corner of the message box. Again, it will take a few minutes for the files to be extracted. When the extraction process is complete, the message box will not close automatically. The user will know the process is complete when the word "Complete" appears next to the computer icon in the upper, left corner of the message box. To close the application, click on the ***Close*** button in the lower, right corner of the message box. Now, the user can view that a ***C:\HEM*** directory has been created on their computer and populated with the installation files.

To begin the actual software installation, double-click on the file: **Setup.exe** in the **C:\HEM\INSTALLER** subdirectory. Once the installation file is executed, the computer will display the welcome screen shown in Figure 2-1. Clicking on **OK** will begin the installation.

Figure 2-1. HEM-Screen Installation Welcome Screen

Next, when the computer displays the screen in Figure 2-2, the installation wizard provides an option to change the computer directory in which HEM-Screen software will be installed. This can be done by clicking on **Change Directory**, located on the right side of the screen, and specifying a new pathway for the software installation. The default installation directory will be: C:\Program Files\HEM_VB_WRAPPER_V3. ***However, for ease of operation, it is recommended to change the directory and consolidate HEM-Screen files under C:\HEM.*** Note: it is not possible to modify the installation software to make C:\HEM the automatic, default directory. To proceed with the installation of HEM-Screen software, the user must click on the ***large computer image*** located on the upper-left side of the screen. To abort the software setup, the user can click on **Exit Setup** located at the bottom center of the screen.

Figure 2-2. HEM-Screen Install and Change Directory Screen

In the next installation window, a prompt asks if programming items can be stored in a new program group called "Human Exposure Model-Screen" as shown in Figure 2-3. To proceed, the user must click on *Continue*.
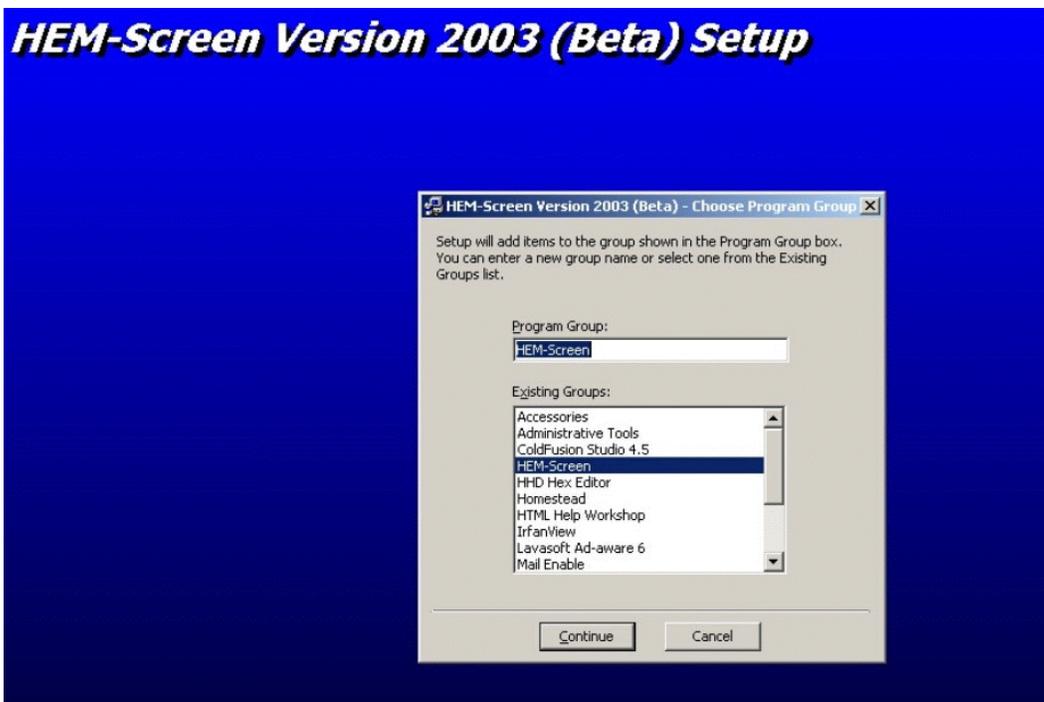
Figure 2-3. Install Software in a New Program Group Screen

The HEM-Screen installation should take only a few minutes. Upon successful completion of the installation, the screen shown in Figure 2-4 will appear. Click *OK* to proceed.

Figure 2-4. Installation Complete Screen

2.2 Configuring HEM-Screen Software

Upon the first use of HEM-Screen Version 2003 (Beta) software, a one-time message box will appear prompting the user to now configure HEM-Screen software. By agreeing to this action, a HEM-Screen configuration setup menu will appear as shown in Figure 2-5. Otherwise, the program proceeds on to the HEM-Screen Main Menu (Figure 3-1). The user can choose to configure HEM-Screen software at any time. At the top, right corner of each screen is a *Setup* button that will direct the user to the HEM-Screen configuration setup menu.
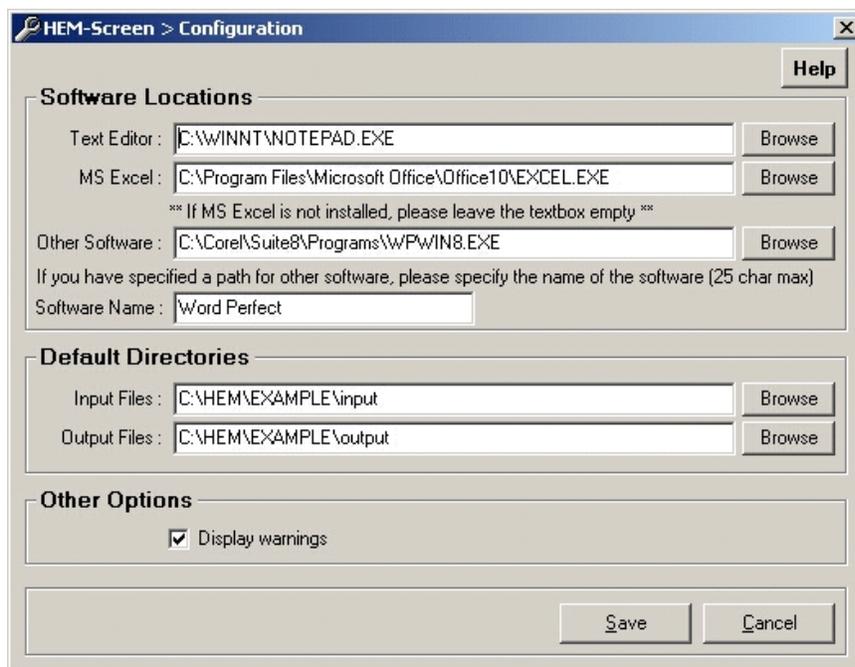
Figure 2-5. HEM-Screen Configuration Setup Screen

Within this menu, the user must enter the computer pathway (i.e., location) of the following software packages on the computer:

1. A text editor or a word-processing package, in the *Text Editor* text box, and
2. Microsoft Excel® (if applicable, otherwise leave MS Excel text box blank), or
3. The location of an alternative spreadsheet software package such as Lotus 1-2-3® in the *Other Software* text box.

If a pathway is specified for an alternative spreadsheet software, the software name or description can be entered in the *Software Name* text box. The description entered here will appear on a button that will allow the selected software to open a data input template, which is provided as a comma separated values (*.csv) file.

In addition, HEM-Screen Version 2003 (Beta) allows users to select default directories for the separate storage of HEM-Screen input and output files. This avoids possible confusion as to where HEM-Screen is storing input and output files. If HEM-Screen software is installed under the *recommended* C:\HEM directory, the default HEM-Screen input and output subdirectories would be:

1.   **C:\HEM\input**, (or C:*<user's specified install directory>*\input) and

2.   **C:\HEM\output** (or C:*<user's specified install directory>*\output) .

The HEM-Screen Version 2003 (Beta) also provides a subdirectory called:
C:\HEM\EXAMPLE. The files in this subdirectory provide examples of all HEM-Screen input and output files. A list of the available HEM-Screen examples files is provided in Appendix A.

New to HEM-Screen Version 2003 (Beta) is the option to display or not display help and warning messages. For users who become experienced with HEM-Screen Version 2003 (Beta), some of the help and warning messages may be unnecessary or distracting during repetitive use of the model. However, users should exercise caution in deciding to deactivate the messages because the option is an "all or none" choice. Appendix B provides a list of HEM-Screen instructional messages (error and informative) that are available for each menu screen in HEM-Screen.

3. Creating and Using a HEM-Screen Input File

Version 2003 (Beta) of HEM-Screen has a built-in utility that helps to simplify the creation of HEM-Screen data input files. This chapter presents a step-by-step discussion of how to create and use data input files for the air dispersion model within HEM-Screen.

To launch HEM-Screen Version 2003 (Beta) software, the user clicks on the MS Windows® **START** button, then selects **PROGRAMS**, and the **HEM-Screen Version 2003** program group. Clicking on HEM-Screen globe icon brings up the model's "Main Menu" screen (see Figure 3-1), which offers the user a choice of using two types of HEM-Screen input files:

1.   Create or use existing data input files for HEM-Screen to estimate pollutant concentration grids, human exposure, and risk; or

2.   Use pollutant concentration grid results from the ISCST3 dispersion model for HEM-Screen to estimate only the human exposure and risk.

The "Create or use HEM-Screen input file" option is discussed in this chapter, while the "Use results from ISCST3" option is discussed in Chapter 4.
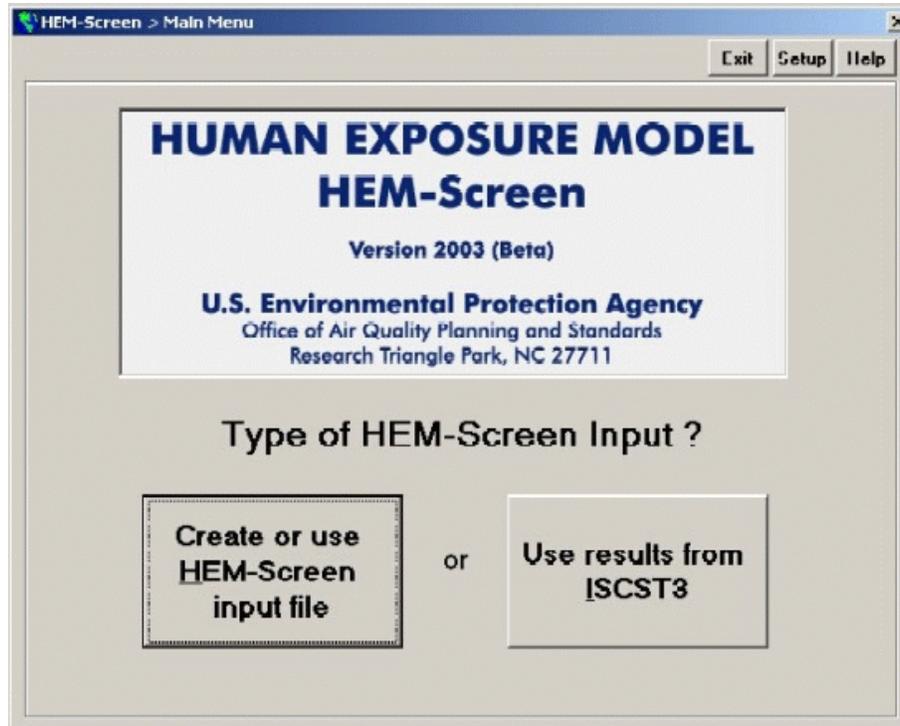
Figure 3-1. HEM-Screen Main Menu Screen

3.1. Use or Create a HEM-Screen Input File

In order to create or use a HEM-Screen input file, the user must click on **Create or use HEM-Screen input file** on the HEM-Screen main menu screen. This will bring up the screen shown in Figure 3-2. Selecting this option allows the user to create HEM-Screen input files with source information and dose response factors to estimate annual average, ground-level concentrations around the source, exposure to the population, and possible risk.

The menu on this screen offers several utilities to simplify the creation of a compatible HEM-Screen data input file. For the initial use of HEM-Screen, the user will need to create a data input file and must start with **Step -1**. However, if the user already has created a HEM-Screen compatible input file (*.hem), then Steps 1 and 2 can be skipped and the user can proceed directly to Step 3 to select HEM-Screen input file.

Figure 3-2. Use or Create HEM-Screen Input File Screen

Step-1: Need a Data Input Template?

Version 2003 of HEM-Screen offers a data entry template to simplify the process of entering data into an appropriately formatted file. The template is available as either a MS Excel® spreadsheet or as a comma separated values (*.csv) file that can be opened with any available spreadsheet software. This menu offers the choice to open the data entry template with MS Excel® or with an alternative spreadsheet software package that the user specified in the HEM-Screen configuration setup menu. The spreadsheet template can be opened by clicking on the *Open MS Excel Template?* button or the *Open <user specified software>* button. The template format is shown in Figure 3-3.

The required HEM-Screen input data include:

- *Chemical Name* (user-specified text description);
- *Inhalation Unit Risk Factor* for the modeled pollutant ($\mu g/m^3$);
- *Facility ID Number* (unique source identifier);
- *Facility Name* (user-specified text description);
- *Latitude/Longitude* coordinates of the modeled source (degrees, minutes, and seconds);
- *Urban or Rural* meteorology stability class (value of "0" or "1");
- *Number of Emission Points* within modeled source (numerical total) ;
- *Emission Point ID* (user-specified description);
- *Vent Type Description* (user-specified description);
- *Emission Rate* of the pollutant from the modeled emission point (kilograms/year);
- *Stack Height* of the modeled emission point (meters);
- *Area* meaning the vertical cross-sectional area for a point source and the horizontal cross-sectional area for a fugitive source (square meters);
- *Vent Type Orientation* (value of "0" for vertical or "1" for non-vertical);
- *Stack Diameter* of the modeled emission point (meters);
- *Gas Exit Velocity* from the modeled emission point (meters/second); and
- *Temperature* of gas exiting the modeled emission point (kelvin).

> *Be sure to use __METRIC UNITS__ for all applicable data inputs:*
>
> - *meters (m)*
> - *square meters (m^2)*
> - *meters per second (m/sec)*
> - *Kelvin (K)*
> - *kilograms per year (kg/yr)*
> - *micrograms per cubic meter ($\mu g/m^3$)*

Each of these input data parameters is described in more detail in Chapter 6. Note that the data must be entered under the correct spreadsheet column headings, and in metric units (where applicable). All defaults for all data entry fields must be entered by

Chemical Name	Unit Risk Factor (ug/m3)-1	Facility ID Number	Facility Name	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Location Urban or Rural? 0 - Urban 1 - Rural	Number of Emission Points	Emission Point ID Number	Vent Type Process Vent (P) Storage Vent (S) Fugitive Emissions(F) Stack (H)	Emission Rate (kg/year)	Stack Height (meters)	Area (square meters)	Vent Type 0 - vertical 1 - nonvert.	Stack Diameter (meters)	Gas Exit Velocity (m/sec)	Gas Exit Temperature (K)	Model Output Maps? Y - Yes N - No	Each Ring? Y - Yes N - No
Chemical X	0.0000083	1	Source A	420321	874759	0	2	1	Process Vent (P)	9.4431	4.6	10	0	0.152	7.76	308	N - No	N - No
Chemical X	0.0000083	1	Source A	420321	874759	0	2	2	Fugitive Emissions(F)	5.2462	4.6	100	1			293	N - No	N - No
Chemical X	0.0000083	2	Source B	420823	875405	0	2	1	Process Vent (P)	9.4431	4.6	10	0	0.152	7.76	308	N - No	N - No
Chemical X	0.0000083	2	Source B	420823	875405	0	2	2	Fugitive Emissions(F)	5.2462	4.6	100	1			293	N - No	N - No
Chemical X	0.0000083	3	Source C	422136	875144	0	2	1	Process Vent (P)	9.4431	4.6	10	0	0.152	7.76	308	N - No	N - No
Chemical X	0.0000083	3	Source C	422136	875144	0	2	2	Fugitive Emissions(F)	5.2462	4.6	100	1			293	N - No	N - No
Chemical X	0.0000083	4	Source D	420110	874049	0	2	1	Process Vent (P)	9.4431	4.6	10	0	0.152	7.76	308	N - No	N - No
Chemical X	0.0000083	4	Source D	420110	874049	0	2	2	Fugitive Emissions(F)	5.2462	4.6	100	1			293	N - No	N - No
Chemical X	0.0000083	5	Source E	415721	875628	0	2	1	Process Vent (P)	9.4431	4.6	10	0	0.152	7.76	308	N - No	N - No
Chemical X	0.0000083	5	Source E	415721	875628	0	2	2	Fugitive Emissions(F)	5.2462	4.6	100	1			293	N - No	N - No
Chemical X	0.0000083	6	Source F	415322	875125	0	2	1	Process Vent (P)	9.4431	4.6	10	0	0.152	7.76	308	N - No	N - No
Chemical X	0.0000083	6	Source F	415322	875125	0	2	2	Fugitive Emissions(F)	5.2462	4.6	100	1			293	N - No	N - No

A copy of this example HEM-Screen data input file is located in C:\HEM\EXAMPLE\example.xls. Note: There are five additional columns not shown that allow a user to manually select a meteorological site. The use of these five additional columns are discussed in Chapter 6, but their use is recommended only for experienced HEM-Screen users.

Figure 3-3. Example HEM-Screen Data Input Template

the user. The HEM-Screen does not select any default values for input data entries. Guidance on selecting appropriate default values for input data is also provided in Chapter 6.

Once all the required data have been entered into the spreadsheet, the user should save the data input template as a tab delimited text file (*.txt) with a name that is compatible with the filename limitations discussed in Section 1.3.2. When the template is saved as a text file, the user may receive a pop-up message box asking:

> ***"May contain features that are not compatible with text/tab delimited format. Do you want to keep the spreadsheet in this format?"***

Respond by answering "YES". Although it is not necessary for running HEM-Screen, it is recommended that the file be saved in the selected spreadsheet software with the same name. If corrections are needed to be made to the file, it will be easier to work with the spreadsheet file instead of a text file.

There are no filename restrictions for the spreadsheet file or the tab delimited text file. However, the filename resulting from the conversion process (and any pathways to that file) can have only 8 alphanumeric characters. If the user wants the spreadsheet filename, the tab delimited text file, and the converted filename to be consistent, then all these filenames should have only 8 alphanumeric characters.

Step-2: Convert to HEM-Screen Compatible Input File

> ***Numbers entered in the *.hem format must be right justified in the specified column range, otherwise HEM-Screen assumes zeros in the remaining columns. Also, decimal points count as a column. However, HEM Version 2 and HEM-Screen 2003 (Beta) automatically accounts for these formats.***

After saving the data entry spreadsheet as a tab delimited text file, this step converts the data into the complex format required to run HEM-Screen. The user must enter the name of the tab delimited file in the text box under Step 2 or select the file using the folder icon to browse. Once a file is identified, the "open" button allows the user to view the data in the file to verify that it is the correct file.

Once the filename is entered, the user should click on the "Convert" button. The program interface extracts data from the text file and reformats it into specific rows and columns required by the original HEM-Screen program. Upon completion of the format conversion, a new file is created with the same filename as the text file but with a new extension of (*.hem). Text file names longer than 8 alphanumeric characters will be truncated by the software after the eighth character. The new file name will automatically appear in the text box under Step -3 "Select HEM-Screen Input File." For example, the file name TESTRUN26.txt would be truncated to TESTRUN2.hem after the conversion. An example of the reformatted text file is shown in Figure 3-4.

```
 |123456789*123456789*123456789*123456789*123456789
1|00006     ff 0.0000083
2|Chemical X
3|1  Source A
4|420321 874759                              000002
5|P        9.4431 4.6  1000.15 7.76 308
6|F        5.2462 4.6 1001   0    0 293
7|Chemical X
8|2  Source B
9|420823 875405                              000002
*|P        9.4431 4.6  1000.15 7.76 308
1|F        5.2462 4.6 1001   0    0 293
2|Chemical X
3|3  Source C
4|422136 875144                              000002
5|P        9.4431 4.6  1000.15 7.76 308
6|F        5.2462 4.6 1001   0    0 293
7|Chemical X
8|4  Source D
9|420110 874049                              000002
*|P        9.4431 4.6  1000.15 7.76 308
1|F        5.2462 4.6 1001   0    0 293
2|Chemical X
3|5  Source E
4|415721 875628                              000002
5|P        9.4431 4.6  1000.15 7.76 308
6|F        5.2462 4.6 1001   0    0 293
7|Chemical X
8|6  Source F
9|415322 875125                              000002
*|P        9.4431 4.6  1000.15 7.76 308
1|F        5.2462 4.6 1001   0    0 293
```

A copy of this example HEM-Screen input format file is located in C:\HEM\EXAMPLE\example.hem

Figure 3-4. Example HEM-Screen Input Format

The first line indicates:

- Number of facilities modeled (00006) in columns 1 through 5,
- Whether maps are to be generated (ff = no) in columns 11 and 12, and
- The inhalation unit risk factor used for exposure (0.0000083) in columns 13 through 23.

The second line, columns 1 through 80, identifies the chemical to be modeled (Chemical X). The third line, columns 1 through 80, identifies the facility to be modeled (input order = 1 and the source name = Source A).

The fourth line provides the latitude coordinates (420321) in columns 1 through 6, and longitude coordinates (874759) in columns 7 through 13. The fourth line also lists the

meteorology stability class (0 as urban) in column 39, and the number of release points modeled for the source (00002) in columns 40 through 45.

The fifth and sixth lines contain information the two modeled release points:

- Vent type description = P for process/F for fugitive (column 1),
- Emission rate = 9.4431/5.2462 (columns 2 through 13),
- Stack height = 4.6/4.6 (columns 14 through 17),
- Area = 10/100 (columns 18 through 21),
- Vent type orientation = 0 for vertical/1 for nonvertical (column 22),
- Stack diameter = 0.15/<none> (columns 23 through 26),
- Gas exit velocity = 7.76/<none> (columns 27 through 31), and
- Gas exit temperature = 308/293 (columns 32 through 35).

Step-3: Select HEM-Screen Input File

If the user has completed the conversion of a data entry text file to a HEM-Screen compatible file under Step-2, then the name of the newly converted file will be listed automatically in the text box under Step-3.

However, at anytime, the user can use the browser button (with the folder icon) to locate and select a desired HEM-Screen compatible input file (*.hem) from the computer directory. If the user wants to review the format and content of an input file before running HEM-Screen, clicking on the **Open** button will display the contents of the input file.

Step-4: Model Run Options

The next step in preparing a HEM-Screen data input file is selecting the options for how HEM-Screen will process the data. There are three key modeling options available to users:

1. Selecting radial distances to model around the source from a menu of choices;
2. Selecting 1990 or 2000 U.S. Census population data; and
3. Accounting for chemical reactivity in the atmosphere to determine if atmospheric decay (pollutant half-life) will affect the dispersion of the estimated pollutant concentrations. Atmospheric decay can be used when a pollutant has an atmospheric half-life of less than 1 hour. A more detailed discussion of atmospheric decay is provided in Section 6.2.3.

The following options have been pre-selected as HEM-Screen default modeling parameters when the user clicks on the **Use Defaults** button:

- Radii (distance from the source, measured in km): 0.2, 0.5, 1, 2, 5, 10, 20, 30, 40, and 50;
- 2000 U.S. Census population data; and
- No atmospheric decay (i.e., low reactivity of chemical in the atmosphere).

Clicking on the *Use Defaults* button will automatically select the above modeling parameters and HEM-Screen will proceed directly to the next step in opening the "HEM-Screen Output File Options" screen, which is discussed in detail in Chapter 5.

However, if the user clicks on the *Specify Options* button, the computer will open the "Model Run Options" screen, which is discussed in detail in the next section.

3.2. HEM-Screen Modeling Options

Figure 3-5 shows the Model Run Options screen, which enables the user to exercise some control over the data used and the output generated by the HEM-Screen.
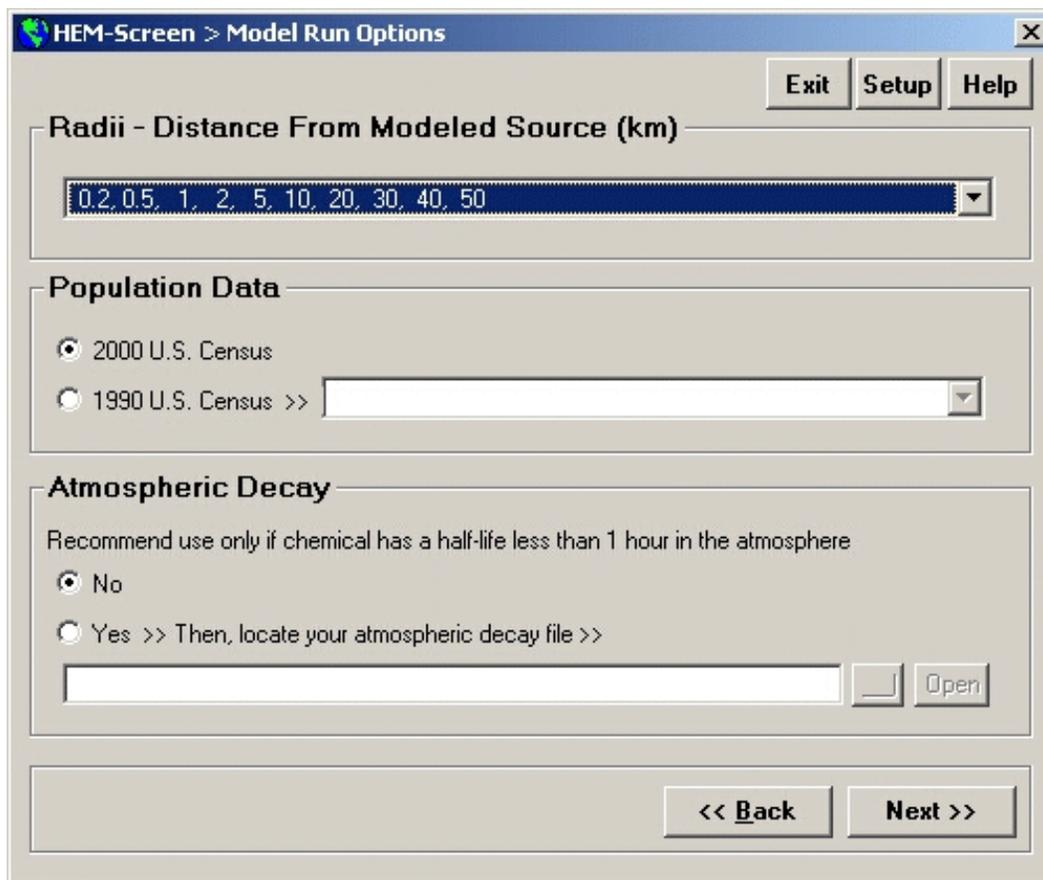
Figure 3-5. HEM-Screen Model Run Options Screen

Radii - Distance From Modeled Source (km)

To view optional sets of radial distances (i.e., alternative coverage areas around the modeled source) the user must use the drop down list arrow on the right side of the radii data field. The HEM-Screen offers 8 optional sets of 10 radii values each. Clicking on a radii set selects that choice.

Population Data

For population data, it is recommended to use the 2000 U.S. Census population data to provide the most up-to-date and valid exposure estimates. However, 1990 U.S. Census population data are available for users who wish to validate HEM-Screen runs prior to 2000. To use the 1990 U.S. Census data, the user must click on the circle button to the left of "1990 U.S. Census" and then select among the parameters presented in the data field. The 1990 Census data is available at various levels of detail. The block group option is most appropriate for comparing current run results to previous HEM-Screen runs.

Atmospheric Decay

Most chemicals have a low degree of reactivity in the atmosphere. Therefore, HEM-Screen is defaulted not to factor atmospheric decay of a chemical into its exposure calculations. It is recommended that the user select "No" atmospheric decay unless the pollutant has an atmospheric half-life of less than 1 hour. A more detailed discussion of atmospheric decay is provided in Section 6.2.3.

Clicking on the *Next >>* button will bring up the HEM-Screen Output File Options screen, which is discussed in detail in Chapter 5.

4. Using ISCST3 Results to Create a HEM-Screen Concentration Input File

The HEM-Screen (versions 2 and 2003 (Beta)) has the capability to convert pollutant concentration output files from EPA's ISCST3 dispersion model (*.out) for use as a HEM-Screen concentration input file (*.hem). This utility allows HEM-Screen to estimate population exposures using pollutant concentration results from the ISCST3 dispersion model. The results from this HEM-Screen utility are valid only if the ISCST3 model is operated with a specific group of setup parameters that generate a concentration grid compatible with HEM-Screen. The proper ISCST3 setup parameters are described below as *Step-1*. Prior to using this HEM-Screen utility, the user should be knowledgeable in the operation of the ISCST3 air dispersion model. Information on the use of ISCST3 is available in the EPA report, "User's Guide for the Industrial Source Complex (ISC3) Dispersion Models," (EPA-454/B-95-003a), September 1995.

Clicking on *Use Results from ISCST3* on the HEM-Screen Main Menu screen (refer to Figure 3-1) selects this option and brings up the menu screen shown in Figure 4-1.

Figure 4-1. Use ISCST3 Results as Input Screen

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Step-1: Select ISCST3 Concentration File

The user must type in a file name or use the browse folder button on the right side of the menu to locate and select the desired ISCST3 concentration output file (*.out). In order to use ISCST3 concentration grid results, the ISCST3 must be run with setup parameters that generate a concentration grid compatible with HEM-Screen. ***The ISCST3 concentration grid must be in a polar system with 10 radial distances and 16 wind directions. The wind directions start at the south and move clockwise.*** Setup parameters similar to those shown in Table 4-1 must be entered when running the ISCST3 to yield a concentration grid with the appropriate directions and wind directions to estimate exposure using HEM-Screen. The fourth line in Table 4-1 lists a set of HEM-Screen compatible radial distances. Note: For ISCST3 radial distances are entered in meters while for HEM-Screen the distances are listed in kilometers. Different sets of radial distances can be used with ISCST3 runs, as long as the radial distance sets are the same as one of the eight radial distance sets available in the HEM-Screen software, listed on the "HEM-Screen File Input Options" screen. The HEM-Screen software detects and reads the radial distances selected for the ISCST3 run and automatically selects the matching set of distances for the HEM-Screen exposure and risk function.

> *NOTE: The HEM-Screen conversion utility is limited to accepting ISCST3 concentration output files generated from one specific set ISCST3 input file conditions.*

Table 4-1. ISCST3 Setup Parameters for a Compatible HEM-Screen Concentration Grid

```
RE STARTING
RE GRIDPOLR POL1 STA
RE POL1 ORIG 0.0 0.0
RE POL1 DIST 200. 500. 1000. 2000. 5000. 10000. 20000. 30000. 40000. 50000.
RE POL1 GDIR  16   180   22.5
RE POL1 END
RE FINISHED
```

Appendix C provides an example of a complete (18 page) ISCST3 output file, "Hon1acu.out". The ISCST3 output file is a text-based file and the first page of the ISCST3 output file (which is not numbered) lists five blocks of model setup parameters. Each line of instructions within each block begins with a two letter code (CO, SO, RE, ME, or OU). The third block of code from the top of the page (RE) should be identical to the radial and directional code listed in Table 4-1.

The *Use Results from ISCST3* function extracts the ISCST3 estimated, annual average (8,760 hour) pollutant concentrations at 160 receptors and the radial distances selected for the ISCST3 run, and converts the data to a layout format compatible for the HEM-Screen exposure function. For example, the red-line data on pages 72 and 73 of Appendix C is extracted from the ISCST3 output text file by HEM-Screen and combined with source location information supplied by the user to create a file format shown in Figure 4-2. This is the input file used by HEM-Screen to estimate exposure.

Note that the distances shown at the top of Figure 4-2 are not labels for the columns in the figure. The columns are actually different directions from the source. Every two rows list the 16 concentrations for one radial distance from the source.

```
10FF    11.0000E+001.0000E+00
     .20     .50    1.00    2.00    5.00   10.00   20.00   30.00   40.00   50.00
PLANT A
BLA    BLA                                   129241991 CORPUS CHRISTI   0.00 000
 Concentrations are in Units of Micro-Grams per Cubic Meter
029373000950352
.26125E+02.20047E+02.15698E+02.23135E+02.32895E+02.47352E+02.82754E+02.10234E+03
.57556E+02.19910E+02.11639E+02.95606E+01.11436E+02.16199E+02.19065E+02.24588E+02
.66445E+01.51282E+01.38356E+01.60090E+01.85379E+01.11139E+02.18470E+02.12309E+02
.61541E+01.23296E+01.13359E+01.14737E+01.17443E+01.27831E+01.39566E+01.55060E+01
.22111E+01.16948E+01.12563E+01.19845E+01.28640E+01.36800E+01.56353E+01.33024E+01
.16919E+01.64192E+00.35708E+00.45593E+00.48149E+00.78074E+00.12262E+01.17422E+01
.74069E+00.55877E+00.41451E+00.65972E+00.95366E+00.12023E+01.17732E+01.97802E+00
.51721E+00.19498E+00.10608E+00.14875E+00.14048E+00.23378E+00.39249E+00.56809E+00
.19801E+00.14311E+00.10612E+00.17218E+00.23916E+00.28090E+00.41379E+00.21548E+00
.12290E+00.46640E-01.24090E-01.37020E-01.30720E-01.53100E-01.98120E-01.14507E+00
.81420E-01.56690E-01.41610E-01.69640E-01.90930E-01.97420E-01.14888E+00.74570E-01
.45840E-01.17030E-01.84800E-02.13690E-01.10550E-01.18560E-01.39140E-01.56440E-01
.35490E-01.24200E-01.17440E-01.30190E-01.36830E-01.35270E-01.57520E-01.27750E-01
.18150E-01.65700E-02.31300E-02.52500E-02.40100E-02.67300E-02.16990E-01.22780E-01
.22180E-01.15150E-01.10770E-01.18870E-01.22240E-01.19880E-01.33890E-01.15990E-01
.10740E-01.38900E-02.17400E-02.30400E-02.24000E-02.37600E-02.10620E-01.13600E-01
.15910E-01.10800E-01.76800E-02.13580E-01.15760E-01.13400E-01.23620E-01.10960E-01
.74200E-02.27200E-02.11400E-02.20900E-02.17100E-02.25200E-02.77400E-02.95800E-02
.12340E-01.83900E-02.59700E-02.10540E-01.12110E-01.99100E-02.17940E-01.82000E-02
.56400E-02.20800E-02.81000E-03.15800E-02.13300E-02.18400E-02.60500E-02.73400E-02
```

Figure 4-2. Example HEM-Screen Concentration Input File - Hon1acu.dat

Step-2: Enter Source Location

The latitude and longitude coordinates of the modeled source must be entered in units of degrees, minutes, and seconds with no commas, spaces, or symbols. By entering the coordinates of the modeled source, HEM-Screen can determine which Census population blocks will be affected by the concentration grid pattern. If the user does not enter the coordinates or enters an invalid numerical value for the modeled source, an error message will be shown.

Make sure that the coordinates entered are NOT a decimal/fractional format. For minutes and seconds, the values should span a range from 00 to less than 60.

Step-3: Add Text Descriptions

In this step, the user can provide text descriptions for up to three data fields to help describe the conditions of HEM-Screen output. These text fields can be used to present any type of descriptions–there are no restrictions on how these fields can be used. For convenience, each text field has been assigned a name for the descriptor that is commonly used. The first text field can be used for the name of the modeled source(s). The second text field can be used to describe the location of the modeled source(s) such as the city and state, but it could also be used to include a street address, or any other miscellaneous text description. The third text field is provided as a miscellaneous description which can be used to characterize the chemical or group of chemicals emitted from the modeled source. If text is not entered into at least two of the three text fields, an error message will appear prompting the user to complete all mandatory data entry fields.

Step-4: Specify HEM-Screen Input File Name

Here the user must enter a filename (*.dat) that will be applied to the HEM-Screen compatible concentration input file that will be created from the ISCST3 concentration output file. **This file name and its directory pathways are limited to 8 alpha-numeric characters. In addition, the HEM-Screen concentration input file name must have a (*.dat) extension, otherwise an error message will appear requesting that a (*.dat) extension be provided.** Once a file name has been specified, the user must click on the "Create Concentration File For HEM-Screen" button to extract data from the ISCST3 concentration output file and convert the data into a compatible HEM-Screen concentration input file.

Don't forget to add the ".dat" extension to HEM-Screen input file name.*

When the data extraction and conversion process is successfully completed, an information box will appear to confirm that a HEM-Screen concentration input file has

been created. The concentration data are arranged in an ASCII text file with the format shown in Figure 4-2.

The user is now ready to select HEM-Screen output file options and run HEM-Screen with this concentration input file. Clicking on the *Next >>* button at the bottom of the menu enables the user to proceed.

5. Output File Options and Running HEM-Screen

The HEM-Screen Output File Options menu screen offers the user several choices on HEM-Screen output file formats, as shown in Figure 5-1. In addition to a standard summary report, the user may select up to six optional data print out formats which provide more detailed information on HEM-Screen output results. Once a selection on HEM-Screen output file options has been made, a user-specific file name for the standard summary report and the optional detail report is required. Now the user is able to run HEM-Screen and the necessary data will be generated and exported to the specified file names.

Figure 5-1. HEM-Screen Output File Options Screen

5.1 Standard Summary Report

Each time HEM-Screen Version 2003 (Beta) is run, a Standard Summary Report is generated as a comma separated values file (*.csv) with the root name of HEM-Screen input file (*.hem) plus a "summary" tag (*-sum.csv). The summary report file will be saved in the output file subdirectory specified by the user. The default output subdirectory is C:\HEM\output. However, under Step-2: Name Output Files, the user can rename the file without any name restrictions and save the file to any computer pathway. This summary file contains the total number of people exposed at each facility, the maximum modeled concentration at a population centroid, and, if a unit risk estimate (URE) is applied, the maximum individual risk and annual incidence.

The (*.csv) file format is new to HEM-Screen Version 2003. The data can be imported and sorted within any spreadsheet software. The (*.csv) format replaces the ASCII text file, **summary.prn**, yet the summary text file is still available after the completion of a HEM-Screen run. The **summary.prn** file is located in the C:\HEM\SCRATCH subdirectory. Note that each time HEM-Screen is run, the files in the SCRATCH subdirectory are over-written unless the file names are changed. The original ASCII text file was designed to print on wide, 17-inch computer paper. To print on standard 8½-by-11-inch paper, each file had to be opened into a word processing software package and the font size had to be decreased manually. The new *.csv version can be opened with any spreadsheet software and formatted to suit the user's needs.

In addition, the ASCII text file format made it very difficult to extract and analyze data in another software medium such as a spreadsheet or database. In the new *.csv format, each output value is extracted into a spreadsheet cell and can easily be sorted and manipulated. Thus, the user can more easily create summary tables containing only the pertinent data without the need for extensive retyping.

There are some changes in the actual information printed to the Standard Summary Report file. Previous versions included a double counting exposure summary listed at the beginning of the summary file and a single counting exposure summary at the end. The new version includes only the single counting summary and places it at the beginning of the summary file. Double counting has been eliminated as an out-dated option for HEM-Screen. The previous version of the Standard Summary Report included three duplicate sets of source exposure and risk information, which were presented as different sorting orders. The first set of information was sorted according to the input order of sources in HEM-Screen input file. The second set of information was sorted (highest to lowest) by the maximum individual risk estimated for each modeled source. The third set of information was sorted (highest to lowest) by the annual incidence estimated for each modeled source. The HEM-Screen Version 2003 (Beta) extracts only one set of output results for all modeled sources -- listed according to the input order of the sources in the HEM-Screen input file. The user may then use the spreadsheet software to sort and analyze the source output information.

Figure 5-2 presents the format of the HEM-Screen Standard Summary Report file, which is organized into five general sections:

1.   Date, time, chemical information, and report description;
2.   Modeling options;
3.   Exposure results - cumulative distribution summary;
4.   Risk results - cumulative distribution summary; and
5.   Complete results - individual source summary.

In the first section, at the top of the Standard Summary Report, the following information is provided:

- Date and time of HEM-Screen run,
- A chemical name description,
- Unit risk factor used during the run, and
- An optional, user-specified "Report Description" text field to allow a user to customize the characterization of each summary report.

The second section, "MODELING OPTIONS," provides a summary of the modeling parameters selected for the particular run. Thus, if multiple HEM-Screen runs have been performed, the user has a reference as to which modeling options were selected for the corresponding results. Information listed in this section includes:

- HEM-Screen input file name,
- Radial distance set selected,
- Year of U.S. Census population data, and
- Whether or not atmospheric decay was considered.

The third section of the Standard Summary Report, "HEM-SCREEN EXPOSURE RESULTS," presents a cumulative distribution for the number of people exposed to each pollutant concentration level or higher. The concentrations listed begin with the maximum modeled concentration **among all sources** and end with the minimum modeled concentration **among all sources.** The range of modeled concentrations is categorized according to preset, incremental orders of magnitude. All pollutant concentration values are in units of (μg/m^3).

The fourth section, "HEM-SCREEN RISK RESULTS," presents a cumulative distribution for the number of people at each individual risk level or higher for all sources modeled. If an appropriate carcinogenic unit risk estimate has been entered, another distribution list is provided in this section (shown on the second page of Figure 5-2). The risk values listed begin with the maximum risk level **among all sources** and end with minimum risk level **among all sources**. The range of modeled risk is categorized according to preset, incremental orders of magnitude.

```
                              HUMAN EXPOSURE MODEL-SCREEN
                                STANDARD SUMMARY REPORT


Date: 9/24/2003                          Time: 16:42
Chemical Name: HCl                       Unit Risk: 1.00E+00


Report Description:      EXAMPLE HEM-SCREEN STANDARD SUMMARY REPORT FORMAT

MODELING OPTIONS
Input File Name:         c:\hem\testfiles\both3.hem
Radii Set:                0.2, 0.3, 0.4, 0.5, .75,  1,  2,  3,  4   5
Census Data:             2000
Atmospheric Decay:       No


HEM-SCREEN EXPOSURE RESULTS
                    Concentration   Population          Exposure
MAX:                4.25E-02          8                 3.40E-01
MIN:                2.51E-07         14,800             5.11E+01


         Level    Concentration      Population       Exposure
           1        4.25E-02              8           3.40E-01
           2        2.50E-02             49           1.63E+00
           3        1.00E-02          1,660           2.52E+01
           4        5.00E-03          2,490           3.12E+01
           5        2.50E-03          4,160           3.70E+01
           6        1.00E-03         12,600           5.02E+01
           7        5.00E-04         13,400           5.07E+01
           8        2.50E-04         13,900           5.10E+01
           9        1.00E-04         14,500           5.10E+01
          10        5.00E-05         14,500           5.10E+01
          11        2.50E-05         14,500           5.10E+01
          12        1.00E-05         14,500           5.10E+01
          13        5.00E-06         14,500           5.10E+01
          14        2.50E-06         14,600           5.10E+01
          15        1.00E-06         14,700           5.11E+01
          16        5.00E-07         14,800           5.11E+01
          17        2.51E-07         14,800           5.11E+01
```

Figure 5-2. Example HEM-Screen Standard Summary Report

```
HEM-SCREEN RISK RESULTS
                Risk Level      Population          Exposure * Risk
MAX:            4.25E-02                8            3.40E-01
MIN:            2.51E-07           14,800            5.11E+01

        Level  Risk Level        Population Exposure * Unit Risk
          1    4.25E-02                8            3.40E-01
          2    2.50E-02               49            1.63E+00
          3    1.00E-02            1,660            2.52E+01
          4    5.00E-03            2,490            3.12E+01
          5    2.50E-03            4,160            3.70E+01
          6    1.00E-03           12,600            5.02E+01
          7    5.00E-04           13,400            5.07E+01
          8    2.50E-04           13,900            5.10E+01
          9    1.00E-04           14,500            5.10E+01
         10    5.00E-05           14,500            5.10E+01
         11    2.50E-05           14,500            5.10E+01
         12    1.00E-05           14,500            5.10E+01
         13    5.00E-06           14,500            5.10E+01
         14    2.50E-06           14,600            5.10E+01
         15    1.00E-06           14,700            5.11E+01
         16    5.00E-07           14,800            5.11E+01
         17    2.51E-07           14,800            5.11E+01
```

HEM-SCREEN COMPLETE RESULTS

Input Order	Source Name	Max Concentration	Max People	Max Exposure	Lifetime Incidence	Max Risk	Min Concentration	Min People	Min Exposure	Annual Incidence	Repeat Interval
1	PLANT A	2.14E-02	40	8.56E-01	8.56E-01	2.14E-02	1.80E-03	1,730	2.28E+01	0.33	3.1
2	PLANT B	1.35E-03	4	5.40E-03	5.40E-03	1.35E-03	2.73E-04	742	5.24E-01	0.0075	130
3	PLANT C	4.77E-06	3	1.43E-05	1.43E-05	4.77E-06	2.51E-07	260	3.21E-04	<0.0001	220,000.00
4	PLANT D	4.90E-03	15	7.35E-02	7.35E-02	4.90E-03	2.85E-04	8,120	1.31E+01	0.19	5.3
5	PLANT E	3.68E-03	39	1.44E-01	1.44E-01	3.68E-03	1.05E-03	340	7.37E-01	0.011	95
6	PLANT F	4.25E-02	8	3.40E-01	3.40E-01	4.25E-02	3.97E-03	252	4.70E+00	0.067	15
7	PLANT G	9.81E-03	9	8.83E-02	8.83E-02	9.81E-03	4.32E-04	2,170	8.45E+00	0.12	8.3
8	PLANT H	1.11E-03	293	3.27E-01	3.27E-01	1.11E-03	1.12E-05	1,490	7.21E-01	0.01	97

```
*** END OF REPORT ***
```

Figure 5-2. Example HEM-Screen Standard Summary Report (concluded)

The fifth section of the Standard Summary Report, "HEM-SCREEN COMPLETE RESULTS," presents an overall summary of HEM-Screen results for *each modeled source*. The first two columns of the summary identify the source, with the first column indicating the order of the source in the HEM-Screen input file and the second column listing the source name, as supplied by the user. Columns 3 through 7 of the "HEM-SCREEN COMPLETE RESULTS" pertain to maximum individual risk:

- The third column shows the maximum modeled concentration to which at least one person is predicted to be exposed.
- The fourth column reports the estimated number of people exposed to that concentration.
- The fifth column reports the exposure (people x concentration) due to that concentration.
- The sixth column presents the predicted lifetime incidence (exposure x unit risk) due to the maximum concentration.
- The seventh column shows the maximum individual risk (maximum concentration to which people are thought to be exposed x unit risk), which is often used in risk management decisions.

The second half of the "HEM-Screen COMPLETE RESULTS" pertains more to overall exposure:

- The eighth column reports the minimum concentration modeled within the entire range of selected radial distances surrounding the source.
- The ninth column reports the minimum number of people exposed to any concentration of the chemical within the entire range of selected radial distances surrounding the source.
- The tenth column presents the minimum cumulative exposure, the sum of the exposure values from all modeled receptor sites.
- The eleventh column reports the annual incidence, which is calculated by multiplying the cumulative exposure by the unit risk and dividing by seventy (the estimated life span).
- The twelfth column, labeled "Repeat Interval," is the inverse of the annual incidence column and indicates how many years must elapse before an incidence of cancer is expected to occur.

5.2 Detailed Reports

In addition to the Standard Summary Report, the user has the option of printing out up to six additional reports on various details for each source under "Step-1: Selecting Optional Reports."

5.2.1 Exposure, Risk and Concentration Grid

As shown in Figure 5-1, the first detail report option is "Exposure, Risk and Concentration Grid". This option allows the user to print out a concentration grid of the 160 receptors around each source, the exposure summary and risk for each source (described under the next option) and some Census population information. The concentration grid, shown in Figure 5-3, presents the name of the source, the STAR site selected, and the modeled concentrations at the 160 receptors (16 wind directions and 10 radial distances) surrounding the source.

In previous versions of HEM, this information is saved as an ASCII text file called *detail.prn* in the C:\HEM\SCRATCH subdirectory. In addition, HEM-Screen Version 2003 (Beta) automatically renames this file with the root name of the HEM-Screen input file (*.hem) used for the run and adds a "detail" text (*-det.txt) extension. This file is saved automatically to the default output subdirectory, C:\HEM\output. The detail report file will also be saved in any output file subdirectory specified initially by the user. However, under Step-2: Name Output Files, the user can rename the file without any name restrictions and save the file to any computer pathway. Also, the user has the option to extract the concentration grid data from the ASCII text file to a spreadsheet compatible (*.csv) file. This option is discussed later under "Step 2- Name the Output files."

5.2.2 Only Exposure and Risk

The second detail report option, "Only Exposure and Risk", prints only the exposure and risk distribution summary information for each source. This report provides the same type of distribution summary for exposure and risk information listed in the Standard Summary Report (Figure 5-2). However, instead of creating a summary distribution for a cumulative group of sources, this report option creates a summary distribution based on each individual source. An example of this report printout is shown in Figure 5-4. This information is also printed to the *detail.prn* and *-det.txt* file. If the first report option is selected, information from the two reports is combined in the output file. If only the second report option is selected, the output files will include only the exposure and risk information and will exclude the concentration grid for each source. The first concentration level on this output report is the maximum concentration for all sources modeled. The last concentration level is the minimum concentration for all sources modeled. The remaining concentration levels and population figures apply to that one source only.

5.2.3 Maximum Modeled Concentration

The third detail report option, "Max Modeled Concentration," presents the maximum modeled concentration for each source and the longitude and latitude of that concentration. Note that the maximum modeled concentration in this report is the

```
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 1  PLANT A                                 - 14913Duluth/Int'l AirMN   84.33 155
  Concentrations are in Units of Micro-Grams per Cubic Meter (Annual Average)
  Input Concentrations


 Dir   D i s t a n c e
        .200       .300       .400       .500       .750      1.000      2.000      3.000      4.000      5.000
  S   3.9160E-03 5.5118E-03 8.9485E-03 1.3038E-02 1.9549E-02 2.1386E-02 1.6021E-02 1.1868E-02 9.2064E-03 7.4386E-03
 SSW  1.0432E-03 1.7122E-03 2.9037E-03 4.2208E-03 6.2193E-03 6.8463E-03 5.3499E-03 4.0942E-03 3.2391E-03 2.6513E-03
  SW  6.6461E-04 9.8510E-04 1.5904E-03 2.2648E-03 3.3300E-03 3.7316E-03 3.0159E-03 2.3257E-03 1.8375E-03 1.4976E-03
 WSW  2.0630E-03 2.1704E-03 3.0704E-03 4.3378E-03 6.6251E-03 7.3883E-03 5.6412E-03 4.1618E-03 3.2026E-03 2.5635E-03
  W   1.4754E-02 1.4289E-02 1.8670E-02 2.4681E-02 3.4002E-02 3.5479E-02 2.3675E-02 1.6039E-02 1.1673E-02 8.9673E-03
 WNW  5.8145E-03 8.0932E-03 1.3047E-02 1.8995E-02 2.8600E-02 3.1226E-02 2.2364E-02 1.5778E-02 1.1784E-02 9.2239E-03
  NW  3.7092E-03 5.9971E-03 9.8005E-03 1.3747E-02 1.9261E-02 2.0692E-02 1.5388E-02 1.1384E-02 8.8032E-03 7.0804E-03
 NNW  2.3284E-03 3.6189E-03 5.7675E-03 7.9138E-03 1.0679E-02 1.1324E-02 8.4924E-03 6.3940E-03 5.0065E-03 4.0647E-03
  N   3.3226E-03 4.8837E-03 7.8725E-03 1.1143E-02 1.5784E-02 1.6845E-02 1.2143E-02 8.7990E-03 6.7235E-03 5.3642E-03
 NNE  2.5749E-03 3.5673E-03 5.6104E-03 7.8855E-03 1.1119E-02 1.1740E-02 8.1111E-03 5.6742E-03 4.2277E-03 3.3063E-03
  NE  5.5299E-03 6.6271E-03 9.8988E-03 1.3775E-02 1.9452E-02 2.0494E-02 1.4106E-02 9.8593E-03 7.3551E-03 5.7653E-03
 ENE  6.4008E-03 7.7265E-03 1.1445E-02 1.5816E-02 2.2253E-02 2.3553E-02 1.6836E-02 1.2229E-02 9.3982E-03 7.5468E-03
  E   6.4273E-03 7.9529E-03 1.2034E-02 1.6899E-02 2.4294E-02 2.6102E-02 1.9695E-02 1.4861E-02 1.1699E-02 9.5497E-03
 ESE  6.4314E-03 7.8628E-03 1.2079E-02 1.7331E-02 2.5617E-02 2.7615E-02 2.0108E-02 1.4663E-02 1.1271E-02 9.0407E-03
  SE  6.6810E-03 8.3774E-03 1.2999E-02 1.8812E-02 2.8406E-02 3.1102E-02 2.3166E-02 1.6971E-02 1.3046E-02 1.0448E-02
 SSE  5.0137E-03 6.3045E-03 9.8207E-03 1.4258E-02 2.1519E-02 2.3439E-02 1.7164E-02 1.2470E-02 9.5408E-03 7.6184E-03


 Source Location
   00 Deg, 00' 00" N Lat.  (  00.0000 Degrees)
   00 Deg, 00' 00" W Long. ( -00.0000 Degrees)
```

Note: Plant locations are masked by inserting zeros (0) for all source location coordinates.

Figure 5-3. Optional Report - Detailed Exposure, Risk, and Concentration Grid

```
1  PLANT A                       12916New Orleans/Int'LA   94.64 316
   Concentrations are in Units of Micro-Grams per Cubic Meter (Annual Average)

 Level  Concentration  Population     Exposure
  1      7.69E-05                    0.00E+00
  7      1.00E-06            11       1.29E-05
  8      5.00E-07            11       1.29E-05
  9      2.50E-07           116       4.85E-05
 10      1.00E-07           191       5.91E-05
 11      5.00E-08           385       7.45E-05
 12      2.50E-08           464       7.80E-05
 13      1.00E-08           765       8.33E-05
 14      5.00E-09         1,600       8.94E-05
 15      2.50E-09         2,590       9.28E-05
 16      1.00E-09         5,320       9.73E-05
 17      5.00E-10         7,840       9.91E-05
 18      2.50E-10        11,300       1.00E-04
 19      1.00E-10        15,000       1.01E-04
 20      5.10E-11        15,000       1.01E-04


Maximum Concentration to which any People are Actually Exposed
         1.17E-06            11       1.29E-05
Minimum Concentration to which any People are Actually Exposed
         1.18E-10        15,000       1.01E-04


 Using a Risk Factor of  1.00E+00

 Level   Risk Level     Population     Exposure
  1      7.69E-05                    0.00E+00
  7      1.00E-06            11       1.29E-05
  8      5.00E-07            11       1.29E-05
  9      2.50E-07           116       4.85E-05
 10      1.00E-07           191       5.91E-05
 11      5.00E-08           385       7.45E-05
 12      2.50E-08           464       7.80E-05
 13      1.00E-08           765       8.33E-05
 14      5.00E-09         1,600       8.94E-05
 15      2.50E-09         2,590       9.28E-05
 16      1.00E-09         5,320       9.73E-05
 17      5.00E-10         7,840       9.91E-05
 18      2.50E-10        11,300       1.00E-04
 19      1.00E-10        15,000       1.01E-04
 20      5.10E-11        15,000       1.01E-04
Maximum Risk Level to which any People are Actually Exposed
         1.17E-06            11       1.29E-05
```

Figure 5-4. Optional Report - Only Exposure and Risk Summary for Each Source

maximum concentration at one of the 160 receptors in the concentration grid for that source. This is different from the maximum concentration reported for each source in the Standard Summary Report, which is the maximum concentration to which a person is expected to be exposed. For the HEM-Screen model, this means the maximum modeled concentration estimated at a population centroid. The report file displays one line for each source, as shown in Figure 5-5. Unlike the other report options, this file is not written to the detail report subdirectory. Instead, it is written to C:\HEM\SCRATCH and is named "max-conc.dat". Unless this file is saved with a new name, it will be overwritten the next time the model is run with this option.

5.2.4 List Latitude and Longitude for Each Census Block

The fourth detail report option prints the latitude and longitude for each Census block used by the model to estimate risk for each source. An example of this type of output is shown in Figure 5-6. Because some sources have thousands of Census blocks in the modeled area, this report can be extensive. Select this option only if detailed population information is necessary.

5.2.5 File Echoing Input

Two other report options are available when running HEM-Screen from an HEM-Screen input file (i.e., not from a concentration file). The first option allows the user to print a file that echos the input data. This can be an important tool to verify that the correct information was run through the model. The information is not sent to the detail file, but instead is sent to a scratch file named "shed-sup.lis" in C:\HEM\SCRATCH. This file will be overwritten in subsequent runs if it is not saved with a new filename.

5.2.6 ISCLT Format Concentration File

The final output option puts the concentration grid in a file with the same format as the ISC concentration grid. This option would be used only if the user is comparing HEM-Screen results with ISC results or using software designed to use ISC output. Again, this output is not saved in the detail file; it is named "ISCLT.lis" in the C:\HEM\SCRATCH subdirectory. It also is subject to being overwritten if it is not saved with another filename.

5.3 Name Output Files (Step-2)

The HEM-Screen requires the user to define the output summary file name before it will run. If the user has selected a detailed output, the user must also input a detail filename before HEM-Screen will run. If these filenames are not entered, the user will be given an error message and will be asked to enter them. Since these filenames are not limited to 8 characters by HEM-Screen software (as the input files are), any filename accepted by the user's spreadsheet software may be used to name the files.

```
Max       Location      Max Risk                                           Emissions
Conc.     Distance Dir  10**6  Plant Name    Latitude  Longitude  Kg/yr        Pollutant            -Surface  Air   Station  Used -
------    ------------  ------ ------------- --------- ---------- ----   --------------------   ----------------------------------
0.0647  at (.2,   .0) 0.0647  1  PLANT A    N00 00 00  W000 00 00  100.   Subcat 3 - Uncontrolled  14719 Suffolk County/ANY   14.73  17
0.0504  at (.2,   .0) 0.0504  2  PLANT B    N00 00 00  W000 00 00  100.   Subcat 3 - Uncontrolled  13894 Mobile/WSO AirpoAL   20.60 260
0.0429  at (.2,180.0) 0.0429  3  PLANT C    N00 00 00  W000 00 00  100.   Subcat 3 - Uncontrolled  12916 New Orleans/Int'LA  130.40 313
0.0429  at (.2,180.0) 0.0429  4  PLANT D    N00 00 00  W000 00 00  100.   Subcat 3 - Uncontrolled  12916 New Orleans/Int'LA   94.64 316
0.0429  at (.2,180.0) 0.0429  5  PLANT E    N00 00 00  W000 00 00  100.   Subcat 3 - Uncontrolled  12916 New Orleans/Int'LA   28.50 289
0.0429  at (.2,180.0) 0.0429  6  PLANT F    N00 00 00  W000 00 00  100.   Subcat 3 - Uncontrolled  12916 New Orleans/Int'LA   30.77 282
0.0429  at (.2,180.0) 0.0429  7  PLANT G    N00 00 00  W000 00 00  100.   Subcat 3 - Uncontrolled  12916 New Orleans/Int'LA   26.66 283
0.0429  at (.2,180.0) 0.0429  8  PLANT H    N00 00 00  W000 00 00  100.   Subcat 3 - Uncontrolled  12916 New Orleans/Int'LA   26.66 283
0.0429  at (.2,180.0) 0.0429  9  PLANT I    N00 00 00  W000 00 00  100.   Subcat 3 - Uncontrolled  12916 New Orleans/Int'LA   17.34 298
0.0429  at (.2,180.0) 0.0429  10 PLANT J    N00 00 00  W000 00 00  100.   Subcat 3 - Uncontrolled  12916 New Orleans/Int'LA   13.48  89
```

Note: Plant locations are masked by inserting zeros (0) for all source location coordinates.

Figure 5-5. Optional Report - Maximum Modeled Concentration Option

```
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 County A                         Being Accessed at the BG/ED Level with  12033 BG/ED's    Growth Rate = 1.00000

 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF       0  AT DIST**2 =  9234.1010
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      20  AT DIST**2 =  7489.7790
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      52  AT DIST**2 =  7382.9600
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF       0  AT DIST**2 =  7412.1760
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      32  AT DIST**2 =  7583.1050
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF       0  AT DIST**2 =  7394.0200
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      23  AT DIST**2 =  7389.6170
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      86  AT DIST**2 =  7320.8910
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      38  AT DIST**2 =  7280.6990
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      46  AT DIST**2 =  7173.5300
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      24  AT DIST**2 =  7351.6500
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      27  AT DIST**2 =  7393.7120
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      55  AT DIST**2 =  7343.3090
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      50  AT DIST**2 =  7416.6280
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF     199  AT DIST**2 =  7569.4790
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      15  AT DIST**2 =  7647.0830
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF       1  AT DIST**2 =  7685.1450
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      30  AT DIST**2 =  7732.2990
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF       0  AT DIST**2 =  7592.2390
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF       5  AT DIST**2 =  7685.3710
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF     192  AT DIST**2 =  7273.3960
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF       2  AT DIST**2 =  7293.2080
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      20  AT DIST**2 =  7291.7510
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      46  AT DIST**2 =  7274.9210
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      35  AT DIST**2 =  7245.0200
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      34  AT DIST**2 =  7291.7690
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      26  AT DIST**2 =  7311.3820
 LAT =  00.0000  LONG =  -00.0000   WITH POPULATION OF      34  AT DIST**2 =  7327.8930
```

Note: Plant locations are masked by inserting zeros (0) for all source location coordinates.

Figure 5-6. Optional Report - Detail Population Output

Under this section, there is a box that requests a (*.csv) file for the concentration grid. When this box is checked, the program extracts the values in the concentration grid for further analysis and presentation. This file is assigned the same filename the user specifies for the optional detail report, but the file will have a (*.csv) extension.

5.4 Run HEM-Screen (Step-3)

Once the user has selected all of the output reports needed for this HEM-Screen run and named the files, clicking on the ***Run HEM-Screen and Export Results*** button shown under "Step-3" in Figure 5-1 will execute the model run. While HEM-Screen is running, the screen will display some information. The user can minimize the display screen and use the computer for other activities. When HEM-Screen is finished running, the display screen will state, ***"HEM-Screen is finished running, press any key to continue***." After pressing any key, the user may access any of the requested model output files.

6. HEM-Screen Input Data Details

Chapter 3 provides a list of the data required to run HEM-Screen and produce pollutant concentration, exposure, and risk values. This chapter describes each type of data input in more detail, including sources for locating information, suggested default values, and corresponding units of measure.

6.1 Required HEM-Screen Input

Chemical Name

> This field must be the same for all entries in one run. Although labeled "chemical name," this field can be any textual description that helps the user identify or characterize the run. No chemical database is accessed by this field to look up the unit risk or any other chemical characteristics. When modeling several different chemicals, one at a time, from the same sources, chemical name is a good identifier. When modeling emissions of one chemical at several different emission exit velocities, this field could be used to identify which velocity was used for the run. When modeling several types of sources for one chemical, this field could be used to identify which source type was used for the run. **Whatever identifier is chosen, it must be the same for all sources within a data file.**

Unit Risk Factor

> Enter the chemical inhalation dose-response value in units of $(\mu g/m^3)^{-1}$. These units are consistent with the Unit Risk Estimate (URE) for chemicals known or suspected of causing cancer. When modeling chemicals with non-cancer health effects, the *inverse* of the Reference Concentration (RfC) can be used, but the units must be converted to $(\mu g/m^3)^{-1}$. All risk results are directly proportional to the value entered as the Unit Risk Factor. Thus, if the unit risk is unknown or is incorrect when HEM-Screen is first run, the results may be multiplied by the "new" unit risk and divided by the one used in the HEM-Screen run to produce the results using the "new" unit risk. **Note that only one unit risk factor is entered per HEM-Screen run.** Chapter 7 (section 7.5) explains how to enter data for multiple pollutants for a single, aggregate HEM-Screen run.

Facility ID Number

> All stacks or emission sources within one facility must be given the same facility ID number. The HEM-Screen input file creation program uses this column to identify which emission points are associated with one facility and allows the program to count the number of facilities. The HEM-Screen output file will not

display this number, but the facility name is included in HEM-Screen output file to identify the source.

Facility Name

This field must be the same for all emission points associated with that source. It must be unique among other facilities within the same database. The HEM-Screen output will display this name with the summary results. **Due to field size limitations within HEM-Screen, this name must be kept to 25 characters or less**.

Latitude/Longitude

The geographic location (latitude and longitude) of the source being modeled must be identified in order to run HEM-Screen. The user should enter the latitude and longitude coordinates for the source. The coordinates must be entered in degrees, minutes, and seconds, with no spaces or symbols (e.g., 784451 for 78 degrees, 44 minutes, 51 seconds). Note that only one set of coordinates can be entered for a single source. If the source has multiple release points, the user should enter the coordinates of the geographic center of the emission release points.

The source location can have a significant impact on the exposure and risk estimated for a source. The coordinates are used to select the meteorological station used for dispersion and to identify the Census blocks representing exposed populations. Specific point source locations may be acquired from a variety of published references. If the street address, city, state, and ZIP code are known, commercially available software can be used to convert this information into latitude and longitude coordinates. Some sources may provide locations in UTM or decimal coordinates. Free software is available over the Internet that converts UTM or decimal coordinates into degrees, minutes, and seconds.

Urban or Rural

The selection of urban (0) or rural (1) determines what stability classes are used from the meteorology. Urban areas generally have a significant amount of cement and asphalt, which heat up more quickly than unpaved land, thereby causing unstable air conditions. A source may actually be located in a remote, rural location (e.g., surrounded by farmland) and still be categorized as urban if it includes a large paved parking lot and/or consists of a large brick/metal building. Urban (0) is the default setting.

Number of Emission Points

This value is the number of emission points to be modeled for the facility in the current HEM-Screen run.

Emission Point ID Number

This field simply helps the user identify the emission point. It is not used by the model and may be left blank.

Vent Type Description

This does not affect any dispersion modeling of the source. It is a one-letter identifier to help the user identify the type of emission point. It is common convention to use "P" for process vent, "S" for storage vent, "F" for fugitive emissions, and "H" for stack emissions.

Emission Rate

For the pollutant of concern, enter the total quantity emitted (kilograms/year) from the selected emission point. Total emissions resulting from the production of a chemical or the intermediate use of a specific chemical are, in general, a summation of process, storage, and fugitive emissions. Process emissions are discrete losses that occur at stacks or process vents from reactors, columns, boilers, and other types of plant equipment. Storage emissions include losses from the raw material feed, in-process and final process storage tanks, as well as from loading and handling losses. Fugitive emissions are losses that result from plant equipment leaks, evaporation from waste products, and other non-discrete sources. Once the emissions data for each emission source and each pollutant are obtained, they must be converted into units of kilograms/year before being input into HEM-Screen.

If it is necessary to model multiple pollutants, Chapter 7 describes how to determine the appropriate value to enter as the emission rate.

Stack Height

This parameter is the height above the ground, measured in meters, where emissions are released into the atmosphere. For fugitive emissions, a height of 1.0 meter is a common default.

Area

The HEM-Screen air dispersion function uses one algorithm to estimate pollutant concentrations from both point and fugitive sources. At emission release velocities greater than 0.1 meters/second, the HEM-Screen air dispersion function approximates pollutant concentrations as if released from a point source. However, at emission release velocities less than 0.1 meters/second, HEM-Screen air dispersion function approximates pollutant concentrations as if released from a fugitive source.

For point sources, this parameter corresponds to the building wake effect or downwash factor. In general, as the wind blows across a building and reaches the opposite side, it dips down proportionally to the cross-sectional area of the building. If the building is located near a stack, this downward motion can increase pollutant concentrations at ground-level near the stack. To estimate the building wake effect, the user must use the building's ***vertical*** cross-sectional area that faces the stack -- building height and width, measured in meters. The building wake effect has an insignificant impact on ground-level concentrations at points further downwind from the source than 1.0 km. In general, sources with greater building effects create greater ground-level concentrations near the source. For most screening level assessments, the cross-sectional area is not known. Since downwash may increase concentrations close to the source, a default of 100 square meters is used to insure downwash is not underestimated.

For fugitive sources, this parameter corresponds to the ***horizontal*** cross-sectional area (measured in meters) of the fugitive source. As emission release velocities decrease to 0.1 m/sec or less, HEM-Screen mimics the dispersion from a fugitive source. Thus, in cases where the emission release velocity is equal to or less than 0.1 m/sec, the ***horizontal*** cross-sectional area of the release is entered in this field. For example, the width and length of a lagoon may be entered. Again, if the area is unknown, a default value of 100 square meters should be entered. The user must be careful not to enter an area of release value that conflicts with the first radial distance being modeled. For example, an area of release greater than 2,000 square meters would exceed a radial distance of 0.2 kilometers.

Vent Type Orientation

This input value specifies whether the release point is vertical or non-vertical. Emissions from a stack are normally vertical (0). Emissions from fugitive sources or vents on the sides of buildings are non-vertical (1).

Stack Diameter

> This parameter represents the inner diameter of the stack or vent (meters). For a square or rectangular stack, the diagonal distance from corner to opposite corner is entered. For fugitive emissions, this field may be left blank.

Gas Exit Velocity

> This is the velocity, measured in meters/second, at which the emissions are leaving the stack or process vent. For fugitive emissions, this field may be left blank or a minimal velocity of 0.1 m/sec may be entered.

Temperature

> This is the temperature in Kelvin of the gases exiting the stack or vent. For fugitive emissions, the ambient temperature (293 K) is often entered as a default. The following equation can be used to convert temperature values from Fahrenheit (^{o}F) to Kelvin:

$$K = (^\circ F - 32)\left(\frac{5}{9}\right) + 273.15$$

> This equation can be use to convert temperature values from Celsius (^{o}C) to Kelvin:

$$K = {}^\circ C + 273.15$$

Model Output

> In this case, "model output" refers to the output of maps of population data and separate risk distributions. In general, it is recommended that the user select "N" for both columns. Other HEM-Screen output provides the population information more commonly used in risk assessments. If "Y" is entered in the first column, HEM-Screen will generate 4 maps of Census blocks around each source. Each map specifies the number of Census blocks and total number of people in each grid surrounding the source. Although the grid is based on the polar grid system developed to estimate concentration, each of the 4 maps defines the grid or patch of area slightly differently. These maps are included in the "detail.prn" file located in the SCRATCH subdirectory. If "Y" is entered in the second column, the exposure assessment is performed for each radial distance. Thus, 10 risk distributions are created for each source. For example, the first page will give exposure and risk from the source to the first radial distance (e.g., 0.2 km). The second will give exposure and risk from the source to the second radial distance

(e.g., 0.5 km). If both maps and each radial distance are requested (i.e., "Y" entered in each column) the detail printout will provide 10 risk distributions and 4 maps for each radial distance, or 40 maps for each source.

6.2   Optional HEM-Screen Input

6.2.1 Choosing Meteorological Sites (STAR)

Stability array (STAR) summaries provide the principal meteorological input data to HEM-Screen dispersion model. The STAR data are standard climatological frequency-of-occurrence summaries formulated for use in EPA models and are available for U.S. meteorological monitoring sites from the National Climatic Center in Asheville, North Carolina. A STAR summary is a joint frequency-of-occurrence of wind speed, atmospheric stability, and wind direction, classified according to Pasquill's stability categories. The STAR summaries used in HEM-Screen reflect 5 years of meteorological data for each of 348 sites nationwide.

> *Note: It is recommended that only advanced users of HEM-Screen enter data in the following two fields:*
>
> • *Manually selecting a meteorological site, and*
>
> • *Manually selecting stability classes.*

If these fields are left blank, HEM-Screen automatically selects the STAR site closest to the longitude and latitude entered for the source. If it is known that this STAR site is not representative of the area and there exists a STAR site more representative of the area, the user may enter the five digit code for the appropriate STAR site.

6.2.2 Choosing Stability Classes

The user may enter stability classes for the meteorology data here. If these columns are left blank, the program will automatically choose standard values for these fields.

6.2.3 Chemical Reactivity

Atmospheric degradation in HEM-Screen is limited to a first order reaction. In a user-specified (text) file, enter the pollutant's daytime decay rate constant in (1/minutes) on the first row one, in columns 1 to 10. Next, enter the pollutant's nighttime decay rate constant in (1/minutes) also on the first row one, but in columns 11 to 20.

> *Note: When a data entry value is too large or too small for the specified HEM-Screen column width, the user can use scientific notation.*

To derive a pollutant's atmospheric decay rate constant, use the following formula:

$$\text{Decay Rate Constant} = 0.693/T_{1/2}$$

where,

   0.693 =   First order reaction constant.
   $T_{1/2}$ =   Pollutant half-life in the atmosphere (minutes).

The HEM-Screen is generally limited to a study area within a 50-Km radius of the source. In most instances, the reactivity of a chemical is not sufficiently high to cause significant removal before the material is dispersed to this distance. Therefore, in many cases this input to HEM-Screen can be left blank to assume no atmospheric decay without causing a loss in accuracy. Some chemicals, however, do have high reactivity (e.g., chloroprene, formaldehyde, and 1,3-butadiene) and should be analyzed for this behavior.

A variety of studies have reported the lifetime or atmospheric residence time of many potentially hazardous air pollutants. Often, however, the basis for the decay rates is not given and reconciliation between studies is difficult. Thus, since these values tend to be uncertain, we recommend examining all available data and using engineering judgment to select the appropriate value.

Chloroprene is used as an example to illustrate the effect of chemical reactivity on ambient concentrations. Chloroprene is an organic compound that is decidedly photoreactive in the atmosphere. Based on preliminary calculations conducted with the estimated chloroprene atmospheric decay rate, approximately 90 percent of the chloroprene emitted into the sunlit urban atmosphere would be removed within an hour through reaction with hydroxyl radicals and ozone. However, the chemical decay rates are much lower in the nighttime or under overcast conditions. Because the atmospheric reactions change atmospheric concentrations over time, the reactivity of a compound has less impact on the concentrations near the emissions source than on concentrations farther downwind. The difference in concentration at 20 meters from the source is about 3 percent; at 20 km from the source the difference is about 30 percent.

7. HEM-Screen Technical Details

This chapter includes miscellaneous details about HEM-Screen that may help the user to understand what factors impact the results of the model, how HEM-Screen estimates exposure, and how an experienced user can adjust the emission rate to estimate risk from non-carcinogens or multiple pollutants.

7.1 Relative Effect of Input Data

In general, the greatest source of uncertainty in risk analysis is the dose-response estimate. In many cases, the pollutant is identified as a "probable" human carcinogen. It is possible that the pollutant is not a human carcinogen and the risk is overestimated. It is also possible that pollutants being emitted are human carcinogens but do not have a dose-response estimate. The estimated risk from these pollutants would be assumed to be zero, greatly underestimating the risk.

The second most important components of HEM-Screen input data are (1) source location, and (2) quantity of emissions. The location that is entered for a source determines the meteorological STAR used in the dispersion modeling and the U.S. Census blocks used to estimate exposure. Small changes in location can increase or decrease the risk estimate by an order of magnitude or more. Section 7.4 explains how the concentrations and population are combined to estimate exposure and risk. Small movements in the source location can place U.S. Census blocks at different radial distances from the source, significantly impacting the estimated risk. The emission rate of each emission point is directly proportional to the concentration estimated for that emission point. If a source has only one emission point, the risk is directly proportional to the emission rate of that emission point. Any change in the emission rate directly impacts the risk.

Vent release parameters also affect the exposure and risk results, but less significantly. However, to determine the actual parameter impact, sensitivity analyses should be performed for each HEM-Screen analysis. However, vent parameters rarely impact the risk results by an order of magnitude. As long as vent release parameters used in HEM-Screen are within a reasonable range of known values or sound engineering judgement, the risk results should not be greatly affected. If the user is unsure of the vent parameters, it is recommended to run HEM-Screen for each of the extremes of the vent parameters and report a range.

7.2 Dose-Response Values

To estimate cancer risks and hazard quotients from the computed exposure estimates, the cancer potency estimate or unit risk estimate (URE) and inhalation reference concentration (RfC) must also be included for the pollutant being modeled.

The URE is presented in units of $(ug/m^3)^{-1}$ and is the estimated probability of a person contracting cancer as a result of constant exposure to an ambient concentration of 1 ug/m^3 over a lifetime. These values are generally the 95% upper confidence limits on risk; the actual cancer risks are not likely to be higher and may be lower, including zero risk.

The RfC is presented in units of (mg/m^3) and is defined as an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) to an annual average concentration of a compound that is likely to be without an appreciable risk of deleterious effects during a lifetime. Note that HEM-Screen was originally designed to estimate chronic cancer risk and not chronic noncancer risk. So HEM-Screen estimates risk by <u>multiplying</u> the exposure by the unit risk factor. For chronic noncancer analyses, risk should be calculated by <u>dividing</u> the exposure by the RfC. Thus, the HEM-Screen user must enter the inverse value of the RfC (i.e., 1/RfC) to accomplish the dividing calculation through a multiplication calculation.

7.3   Additional Uncertainties

In addition to model uncertainty and uncertainties associated with emissions, emission point locations, and release characteristics, the following sections address uncertainties related to exposure models such as HEM-Screen. In order for HEM-Screen to run quickly and require minimal input data, certain assumptions were made. For example, the model uses Census data to the Census block level. Although this is the smallest defined population unit, it still places, on average, about 40 people at one point, the centroid of the Census block. In reality, some people may reside closer to the emission source and may be more highly exposed than the model estimates, while others, who live farther away, may be subject to lower exposures than the model estimates.

The concentration patterns used in the exposure computations are obtained through atmospheric dispersion modeling based on known source characteristics and weather patterns at nearby weather stations. Naturally, any deviations in weather pattern estimates from the true pattern can directly affect the exposure results. Thus, if the nearest weather station is 50 to 100 miles away, the weather patterns may not be representative of the weather patterns in the area around the source. Also, the model assumes that the annual average weather conditions continually persist and that the source emits constantly at the annual average amount. These averages may not be representative over shorter time periods. It also assumes that each recorded wind persists in a given direction long enough to yield dispersion out to 50 km.

The program also assumes flat terrain. In most cases, this assumption does not result in erroneous results. However this factor may be more critical when dealing with tall release sources in a valley or mountainous area. In these situations, the weather station data may not give adequate information to model the wind patterns accurately,

and the model may underestimate actual impacts and risks for populations living nearby on elevated terrain.

In addition, HEM-Screen uses a Gaussian dispersion model that is based on how gases will act when dispersed from a stack. Thus, if the pollutant is fibrous or particulate, such as asbestos, the assumption that the pollutant behaves as a gas may misrepresent the actual dispersion pattern.

There are also time-dependent aspects of the exposure problem. The exposure program uses a time-averaged concentration pattern for each source, so that the time dimension is ignored in the computations. If the population distribution were essentially constant over the averaging time period, the resulting estimates would be true averages. However, population distributions are constantly changing as people commute to work, go shopping, and take longer trips. Particularly in urban industrial centers, the shifts in populations and concentrations throughout the day may be highly correlated; thus, the actual exposure may differ considerably from the value obtained by matching time-averaged concentrations with population distributions based on Census addresses. Whether the exposure is overestimated or underestimated depends on whether populations in the vicinity of a source are drained (e.g., because people leave residences near the source for work in an urban center) or are augmented (e.g., because of employment near the source).

Although several simplifications and assumptions are made in HEM-Screen, the model can provide rather accurate representations of maximum individual impacts and population exposures given correct input data. Developing more refined estimates is often more resource intensive (in terms of gathering necessary data) than the resulting increases in accuracy would justify.

7.4   Population Exposure Estimation

Population exposure is estimated as the product of the population and the concentration to which that population is exposed. To obtain this product, the concentration and the population must be known at the same location. The HEM-Screen calculates population exposure by estimating the pollutant concentration at each population centroid.

The Census Bureau collects population data in Census blocks. A population centroid is the area-weighted center of a Census block. On average, a Census block contains about forty people, although the range can be rather large (ranging from one person to several thousand). From the Census data, HEM-Screen obtains the latitude and longitude of the population centroid and the number of people for each Census block in the United States. The HEM-Screen does not include the area of the Census block or information needed to disperse the population. Thus, HEM-Screen assumes that all of the people in the Census block are at the coordinates of the population centroid. The

HEM-Screen estimates one concentration for that location and assumes everyone in that Census block is exposed to that concentration. This assumption ignores individual mobility, exposure duration, breathing rates, and other factors that are important in quantifying individual exposure. Thus, the HEM-Screen calculated population exposure is best thought of as a surrogate for exposure or a simple approximation of exposure which can be subsequently refined if more detailed information is available.

To estimate the concentration at a population centroid, HEM-Screen first uses its dispersion program to estimate pollutant concentrations at 160 receptors located at the intersections of the 10 distance rings and 16 wind directions for each source. As shown in Figure 7-1, to retrieve pertinent pollutant concentration data for a particular population centroid, HEM-Screen selects the 4 points of intersection that surround the centroid. The concentrations at these four receptor locations are labeled C_1, C_2, C_3, and C_4 in Figure 7-1. The HEM-Screen then uses these 4 concentrations to estimate, or interpolate, the pollutant concentration at the population centroid.

To be specific, HEM-Screen uses a log-log linear interpolation. There is generally a linear relationship between the logarithm of concentrations and the logarithm of distances. This relationship is used to estimate the concentrations at points CW_N and CW_S, which are the concentrations along the two closest wind directions at the same distance from the source as the population centroid (see Figure 7-1). The concentrations CW_N and CW_S are then linearly interpolated with the polar angle (wind direction) to estimate the pollutant concentration at the centroid. This process is repeated for each centroid within the maximum selected radial distance from each source.

7.5 Multiple Pollutants

The HEM-Screen was developed to model only one pollutant at a time for cancer risk. By design, emission values of one pollutant from each source were entered, the pollutant's unit risk estimate was entered once for the run, and the model estimated the cancer risk for that one pollutant for all of the sources. However, by mathematically manipulating or "normalizing" the emissions input data, HEM-Screen can be used to estimate the cumulative cancer risk from several pollutants, the non-cancer risk associated with a single pollutant, or the cumulative non-cancer risk from several pollutants.

7.5.1 Cancer Risk

The cancer risk estimated by HEM-Screen for each source is directly proportional to the emissions and cancer unit risk estimate (URE) of the pollutant. For example, HEM-Screen could generate a maximum concentration with an emission rate of 1 kg/year, then that concentration could be multiplied by the actual emission rate and URE to yield
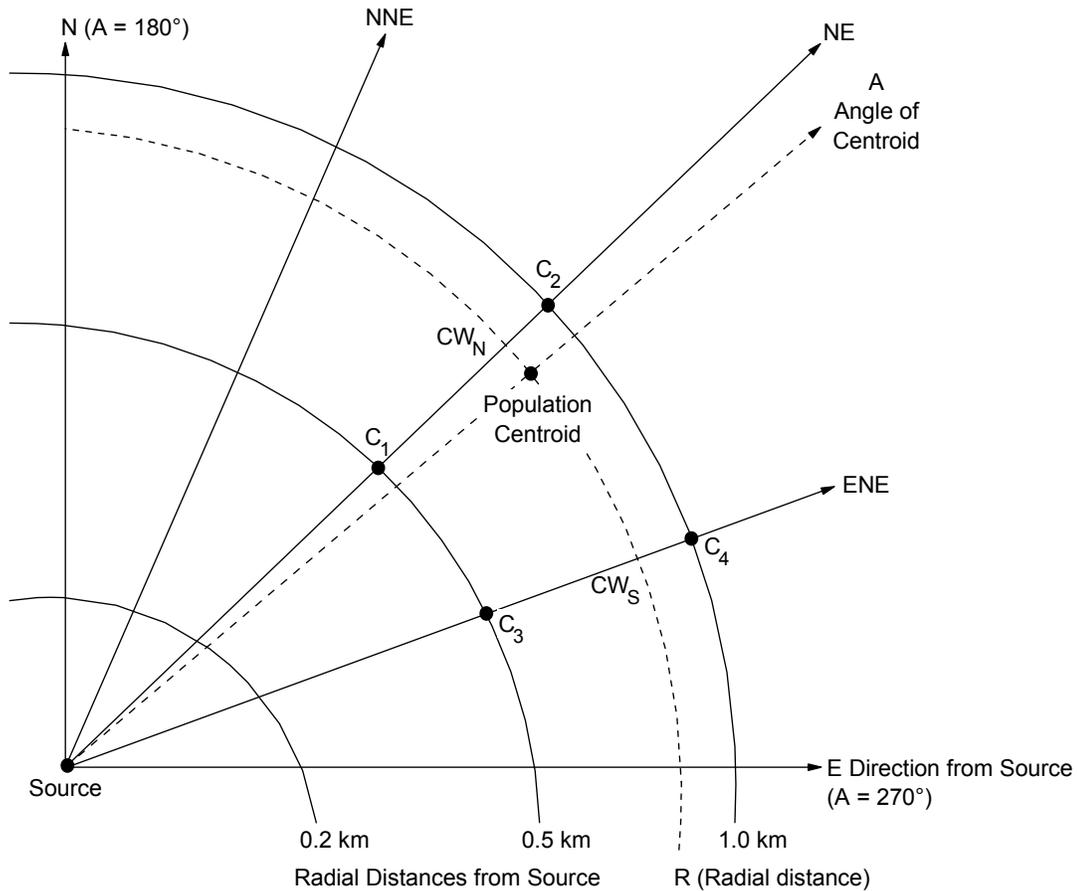
Figure 7-1. Calculation of Population Exposure

Where,

C_1, C_2, C_3, C_4 = the pollutant concentrations HEM-Screen estimates at the intersections of wind directions and source-centered radial rings surrounding the population centroid.

CW_N = the concentration at R distance on the wind direction north of the population centroid.

CW_S = the concentration at r distance on the wind direction south of the population centroid.

A = the angle of the population centroid (measured in degrees clockwise, starting from South).

R = the radial distance from the source to the population centroid.

the maximum individual risk. Notice the concentration is multiplied by both the emission rate and the URE. To manipulate the model for multiple pollutants, a "normalized" emission rate is developed that combines the emissions of each pollutant with the health risk associate with that pollutant. For cancer, the normalized emission rate is the product of the URE and the emission rate of a pollutant. The formula to calculate the toxic emission rate for each pollutant is shown below:

$$\text{Normalized Cancer Emissions}_{HAP1} = \text{Cancer Unit Risk}_{HAP1} \times \text{Emissions}_{HAP1}$$

(where emissions are in kilograms per year and the unit risk is in units of $(ug/m^3)^{-1}$)

This product is determined for each pollutant emitted from a source and the values are summed to determine the total normalized cancer emissions for the source. The formula to determine the normalized cancer emission rate for an entire source simply sums the individual pollutant normalized emission rates, as follows:

$$\text{Normalized Cancer Emissions}_{Source} = \sum_{all\ HAP} \left(\text{Cancer Unit Risk}_{HAP} \times \text{Emissions}_{HAP} \right)$$

Using the example in Table 7-1, the emission rates of the pollutants in column (c) are multiplied by the unit risk estimates in column (d) to yield the normalized cancer emission rates in column (e). The sum of column (e) is then entered as the total normalized cancer emission rate for that source. This allows HEM-Screen to estimate cancer risks from all pollutants for one subcategory in one HEM-Screen run.

7.5.2 Non-cancer Risk

Similarly, normalized emissions may be developed for non-cancer risk. However, non-cancer health risk is not in the form of an actual risk. The EPA has developed concentration thresholds or reference concentrations (RfC) for certain air pollutants, which are estimates (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Currently, non-cancer risk is expressed as a ratio of the modeled concentration and the RfC. Thus, the normalized non-cancer emissions for each pollutant is the ratio of the

emission rate and the reference concentration (RfC) for that pollutant. In general, RfC's are reported in units of mg/m^3. The pollutant concentration values developed by HEM-Screen are in units of ug/m^3. Thus, the RfC must be converted to ug/m^3 (by multiplying by 1,000) prior to dividing it into the emission rate.

The formula for calculating the normalized chronic non-cancer emission rate for each pollutant is shown below:

$$\text{Normalized Non\&Cancer Emissions}_{HAP1} = \frac{\text{Emissions}_{HAP1}}{\text{RfC}_{HAP1} \times 1,000}$$

(where emissions are in kilograms per year and the RfC is in milligrams per cubic meter).

To calculate the normalized non-cancer emissions for all pollutants for the entire source simply add the normalized non-cancer emissions for each pollutant emitted from the source, as follows:

$$\text{Normalized Non\&Cancer Emissions}_{Source} = \sum_{\text{all HAP}} \left(\frac{\text{Emissions}_{HAP}}{\text{RfC}_{HAP} \times 1,000} \right)$$

Using the example in Table 7-1, the emission rate of each pollutant in column (c) is divided by the RfC in column (f) to yield the normalized non-cancer emission rate in column (g). This value is then divided by 1,000 because the RfC must be converted from mg/m^3 to ug/m^3. Summing column (g) yields the total non-cancer equivalent emission rate. The total non-cancer risk expressed as a HI can then be estimated for all of the pollutants for all of the sources in one HEM-Screen run.

Table 7-1. Sample Calculation for Normalized Emission Rates

(a) Source	(b) Pollutant	(c) Emissions (kg/yr)	(d) Unit Risk Estimate (URE) $(ug/m^3)^{-1}$	(e) **Cancer Normalized Emissions**	(f) Reference Concentration (RfC) (mg/m^3)	(g) **Non-Cancer Normalized Emissions***
1	benzene	1,000	7.8×10^{-6}	7.8×10^{-3}	0.06	16.67
	n-hexane	2,000	0	0	0.2	10.00
	toluene	100	0	0	0.4	0.25
	trichloroethylene	250	2.0×10^{-6}	5.0×10^{-4}	0.6	0.42
	xylene	500	0	0	0.43	1.16
Normalized emissions from Source 1				**8.3×10^{-3}**		**28.50**

* RfCs are in units of mg/m^3. The HEM-Screen concentration units are $\mu g/m^3$. Thus, the user must multiply the RfC by 1,000 to obtain the correct units for the normalized non-cancer emission rate.

7.6 Back-calculating Risk

Back-calculating risk is possible ***ONLY*** when HEM-Screen output calculates risk for individual emission release points (i.e., not the risk for a combined group of emission release points). Results from an initial HEM-Screen risk assessment can be used to "back-calculate" risk for alternate assessments using different pollutants, emission rates, and emission control efficiencies for the same emission release points. Back calculation is possible because the product of the pollutant emission rate and pollutant URE for a release point (i.e., normalized cancer emissions, refer to Section 7.5.1) is directly proportional to the maximum individual risk (MIR) for the release point. Thus, for each emission release point, the MIR for an alternate risk scenario is the ratio of the alternate normalized cancer emissions to the initial normalized cancer emissions multiplied by the initial MIR value. An example equation is shown below:

$$MIR_{Alternate} ' MIR_{Initial} \left(\frac{\left(Pollutant\ Emissions_{Alternate}\ (\ Pollutant\ URE_{Alternate}\right)}{\left(Pollutant\ Emissions_{Initial}\ (\ Pollutant\ URE_{Initial}\right)} \right.$$

which is equal to:

$$MIR_{Alternate} ' MIR_{Initial} \left(\frac{\left(Normalized\ Cancer\ Emissions_{Alternate}\right)}{\left(Normalized\ Cancer\ Emissions_{Initial}\right)} \right.$$

An example benefit of this procedure is that a cancer risk assessment for benzene emissions from a release point can be used to back-calculate the cancer risk for formaldehyde emissions from the same release point. Another useful application of the procedure is determining the change in risk for a release point when the emission rate for a selected pollutant changes. Benefits also apply to risk assessments based on "normalized" emissions. In these cases, the risk contribution of a single pollutant from an individual release point can be back-calculated from the risk corresponding to the combined value of normalized emissions from the same release point.

Similarly, the HI for a pollutant may be back-calculated from an analysis of HI for another pollutant or group of pollutants from a single emission release point. Doing so requires knowing the HI and non-cancer normalized emission rate for each release point in the initial analysis, and the emissions and RfC of the pollutant of concern. An example equation is shown below:

$$HI_{Alternate} ' HI_{Initial} \left(\frac{\left(Pollutant\ Emissions_{Alternate} \div \left(Pollutant\ RfC_{Alternate}\ (\ 1,000\right)\right)}{\left(Pollutant\ Emissions_{Initial} \div \left(Pollutant\ RfC_{Initial}\ (\ 1,000\right)\right)} \right.$$

which is equal to:

$$HI_{Alternate} = HI_{Initial} \left(\frac{\left(Normalized\ Non\&cancer\ Emissions_{Alternate}\right)}{\left(Normalized\ Non\&cancer\ Emissions_{Initial}\right)} \right)$$

APPENDIX A

LIST OF EXAMPLE
HEM-SCREEN FILES

Provided with HEM-Screen is a subdirectory called "Example." The files in this subdirectory provide examples of all the files needed to run HEM-Screen. Reading through this manual, it may be helpful to run HEM-Screen with the example inputs to become familiar with the workings of the model. The files shown below are in the "Example" directory.

Files in HEM-Screen "Example" Directory

File Name	Description
C:\HEM\Example\example.xls	HEM-Screen input in the Excel template format
C:\HEM\Example\example.txt	HEM-Screen input saved as a text delimited file
C:\HEM\Example\example.hem	HEM-Screen input formatted to run in HEM-Screen
C:\HEM\Example\example.sum	HEM-Screen summary output
C:\HEM\Example\exampledetail.txt	HEM-Screen detail output
C:\HEM\Example\iscinput.txt	Input file to run ISCST3
C:\HEM\Example\iscout.txt	ISCST3 output when run according to instructions in Table 4-1 in Chapter 3
C:\HEM\Example\hemconc.txt	ISCST3 concentration output formatted to run in HEM-Screen
C:\HEM\Example\isc.sum	HEM-Screen summary exposure output for ISC concentrations
C:\HEM\Example\iscdetail.txt	HEM-Screen detail output for ISC run

APPENDIX B

LIST OF HEM-SCREEN INSTRUCTIONAL MESSAGES

Screen	Type	Message
Use/Create HEM-Screen Input File Screen	Error	Invalid HEM-Screen input file.
	Error	Invalid input file.
	Error	Invalid HEM-Screen input file. Please make sure that you select a valid HEM-Screen input file.
	Error	Invalid input file. Please select a valid input file.
	Error	Error in source file
	Informative	Source file created
	Informative	Make sure that after entering information you save the template file as 'tab delimited text' with the name of your choice.
Model Run Options Screen	Error	Invalid decay file. Please select valid decay file.
	Error	No dataset is selected.
	Error	No radii is selected.
ISCST3 Screen	Error	Invalid concentration file name. Please provide valid file name with extension *.dat
	Error	Invalid HEM-Screen output file. Please provide valid HEM-Screen output file name.
	Error	All the fields including source name, city, chemical name, latitude and longitude are mandatory. Please enter all mandatory fields and make sure that Latitude and Longitude are valid numerical values.
	Error	Invalid concentration file name. Please provide valid file name with extension *.dat
	Error	Invalid ISCST3 file.
	Informative	File has been created.
	Informative/question	File with the name xyz already exist. Do you want to over write it?

Screen	Type	Message
Run HEM-Screen Screen	Error	Concentration file not found! + File Name
	Error	Invalid summary report name. Please specify valid report name with *.csv extension.
	Error	Invalid detail report name. Please specify valid report name with *.csv extension.
	Informative/ question	Directory xyz does not exist. Do you want to create the directory?
Configuration Screen	Error	Invalid text editor path. Please provide valid path.
	Error	Invalid MS Excel path. Please provide valid path.
	Error	Invalid software path. Please provide valid path.
	Error	Please enter the name of optional software.
	Error	Invalid input directory. Please select a valid directory.
	Error	Invalid output directory. Please select a valid directory.
	Informative	All the configuration changes have been saved. You have to restart HEM-Screen application to apply configuration changes.
System wide on clicking Exit	Informative/ question	Any unsaved data will be lost. Are you sure you want to exit the program?
Run HEM-Screen Software	Informative	You are running HEM-Screen application for the first time on this computer.

APPENDIX C

EXAMPLE ISCST3
CONCENTRATION OUTPUT FILE:
"Hon1acu.out"

```
CO STARTING
CO TITLEONE  PLANT A
CO MODELOPT  DFAULT  URBAN  CONC
CO AVERTIME 1 PERIOD
CO POLLUTID  OTHER
CO RUNORNOT  RUN
CO FINISHED

SO STARTING
SO LOCATION  STACK1  POINT  0.0  0.0  0.0
SO SRCPARAM  STACK1  2.98E+00  21.3  394.3  6.1  1.2
SO LOCATION  AREA1  AREA  .0000  .0000  .0000
SO SRCPARAM  AREA1  7.76E-04  0.3  50.  100.
SO SRCGROUP  ALL
SO FINISHED

RE STARTING
RE GRIDPOLR POL1 STA
RE GRIDPOLR POL1 ORIG  0.0 0.0
RE GRIDPOLR POL1 DIST  200. 500. 1000. 2000. 5000. 10000. 20000. 30000. 40000. 50000.
RE GRIDPOLR POL1 GDIR  16    180.   22.5
RE GRIDPOLR POL1 END
RE FINISHED

ME STARTING
   INPUTFIL  c:\Projects\NCEE\ISC\metfile\12924-91.met
   ANEMHGHT  20 FEET
   SURFDATA  12924 1991 CORPUS CHRISTI
   UAIRDATA  12924 1991 CORPUS CHRISTI
ME FINISHED

OU STARTING
OU RECTABLE  ALLAVE FIRST-SECOND
OU MAXTABLE  ALLAVE 50
OU FINISHED

**********************************
*** SETUP Finishes Successfully ***
**********************************
```

```
  *** ISCST3 - VERSION 02035 ***    ***       PLANT A                                                        ***      09/19/02
                                    ***                                                                      ***      10:57:36
**MODELOPTs:                                                                                                          PAGE   1
CONC                    URBAN FLAT         DFAULT
                                               ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

   -- SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**NO GAS DRY DEPOSITION Data Provided.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses URBAN Dispersion.

**Model Uses Regulatory DEFAULT Options:
        1. Final Plume Rise.
        2. Stack-tip Downwash.
        3. Buoyancy-induced Dispersion.
        4. Use Calms Processing Routine.
        5. Not Use Missing Data Processing Routine.
        6. Default Wind Profile Exponents.
        7. Default Vertical Potential Temperature Gradients.
        8. "Upper Bound" Values for Supersquat Buildings.
        9. No Exponential Decay for URBAN/Non-SO2

**Model Assumes Receptors on FLAT Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates  1 Short Term Average(s) of:   1-HR
   and Calculates PERIOD Averages

**This Run Includes:    2 Source(s);     1 Source Group(s); and    160 Receptor(s)

**The Model Assumes A Pollutant Type of:  OTHER

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of PERIOD Averages by Receptor
        Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                               m for Missing Hours
                                                               b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    6.10 ;   Decay Coef. =   0.000    ;   Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                           ;   Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3
```

```
**Approximate Storage Requirements of Model =     1.2 MB of RAM.

**Input Runstream File:         Hon1acu.INP
**Output Print File:            Hon1acu.OUT
 *** ISCST3 - VERSION 02035 ***   *** PLANT A                                              ***        09/19/02
                                    ***                                                    ***        10:57:36
**MODELOPTs:                                                                                          PAGE   2
CONC                    URBAN FLAT          DFAULT
```

```
                                          *** POINT SOURCE DATA ***


              NUMBER EMISSION RATE                     BASE    STACK    STACK    STACK    STACK   BUILDING EMISSION RATE
   SOURCE     PART.  (GRAMS/SEC)      X        Y        ELEV.   HEIGHT   TEMP.    EXIT VEL. DIAMETER EXISTS   SCALAR VARY
     ID       CATS.               (METERS) (METERS) (METERS) (METERS) (DEG.K)  (M/SEC)  (METERS)                BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   STACK1       0   0.29800E+01     0.0      0.0      0.0     21.30   394.30    6.10     1.20      NO
```

```
*** ISCST3 - VERSION 02035 ***    ***  PLANT A                                          ***         09/19/02
                                  ***                                                  ***         10:57:36
**MODELOPTs:                                                                                       PAGE   3
CONC                    URBAN FLAT          DFAULT


                                        *** AREA SOURCE DATA ***

              NUMBER EMISSION RATE  COORD (SW CORNER)  BASE    RELEASE  X-DIM    Y-DIM    ORIENT.   INIT.  EMISSION RATE
   SOURCE     PART.  (GRAMS/SEC        X        Y      ELEV.   HEIGHT  OF AREA  OF AREA  OF AREA    SZ    SCALAR VARY
     ID       CATS.  /METER**2)    (METERS) (METERS) (METERS) (METERS) (METERS) (METERS) (DEG.)  (METERS)     BY
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   AREA1          0  0.77600E-03      0.0      0.0      0.0     0.30    50.00   100.00     0.00     0.00
```

```
 *** ISCST3 - VERSION 02035 ***    ***  PLANT A                                              ***       09/19/02
                                    ***                                                      ***       10:57:36
**MODELOPTs:                                                                                           PAGE   4
CONC                  URBAN FLAT          DFAULT


                                    *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                                   SOURCE IDs


 ALL        STACK1  , AREA1   ,
```

```
 *** ISCST3 - VERSION 02035 ***     ***   PLANT A                                                       ***        09/19/02
                                    ***                                                                 ***        10:57:36
**MODELOPTs:                                                                                                       PAGE   5
CONC                    URBAN FLAT         DFAULT


                                      *** GRIDDED RECEPTOR NETWORK SUMMARY ***

                              *** NETWORK ID: POL1      ;   NETWORK TYPE: GRIDPOLR ***

                                     *** ORIGIN FOR POLAR NETWORK ***
                            X-ORIG =       0.00 ;    Y-ORIG =        0.00  (METERS)

                                    *** DISTANCE RANGES OF NETWORK ***
                                             (METERS)

          200.0,      500.0,     1000.0,     2000.0,     5000.0,    10000.0,    20000.0,    30000.0,    40000.0,    50000.0,


                                    *** DIRECTION RADIALS OF NETWORK ***
                                             (DEGREES)

          180.0,      202.5,      225.0,      247.5,      270.0,      292.5,      315.0,      337.5,      360.0,       22.5,
           45.0,       67.5,       90.0,      112.5,      135.0,      157.5,
```

```
 *** ISCST3 - VERSION 02035 ***    ***   PLANT A                                                  ***       09/19/02
                                   ***                                                            ***       10:57:36
**MODELOPTs:                                                                                                 PAGE   6
CONC                    URBAN FLAT         DFAULT


                              *** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
                                              (1=YES; 0=NO)

        1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1
        1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1
        1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1
        1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1
        1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1
        1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1
        1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1
        1 1 1 1 1 1 1 1 1 1    1 1 1 1 1 1

            NOTE:  METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.


                           *** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
                                              (METERS/SEC)

                         1.54,    3.09,    5.14,    8.23,   10.80,


                                       *** WIND PROFILE EXPONENTS ***


          STABILITY                          WIND SPEED CATEGORY
          CATEGORY          1               2               3               4               5               6
             A         .15000E+00      .15000E+00      .15000E+00      .15000E+00      .15000E+00      .15000E+00
             B         .15000E+00      .15000E+00      .15000E+00      .15000E+00      .15000E+00      .15000E+00
             C         .20000E+00      .20000E+00      .20000E+00      .20000E+00      .20000E+00      .20000E+00
             D         .25000E+00      .25000E+00      .25000E+00      .25000E+00      .25000E+00      .25000E+00
             E         .30000E+00      .30000E+00      .30000E+00      .30000E+00      .30000E+00      .30000E+00
             F         .30000E+00      .30000E+00      .30000E+00      .30000E+00      .30000E+00      .30000E+00


                              *** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
                                        (DEGREES KELVIN PER METER)


          STABILITY                          WIND SPEED CATEGORY
          CATEGORY          1               2               3               4               5               6
             A         .00000E+00      .00000E+00      .00000E+00      .00000E+00      .00000E+00      .00000E+00
             B         .00000E+00      .00000E+00      .00000E+00      .00000E+00      .00000E+00      .00000E+00
             C         .00000E+00      .00000E+00      .00000E+00      .00000E+00      .00000E+00      .00000E+00
             D         .00000E+00      .00000E+00      .00000E+00      .00000E+00      .00000E+00      .00000E+00
             E         .20000E-01      .20000E-01      .20000E-01      .20000E-01      .20000E-01      .20000E-01
             F         .35000E-01      .35000E-01      .35000E-01      .35000E-01      .35000E-01      .35000E-01
```

```
 *** ISCST3 - VERSION 02035 ***    ***  PLANT A                                                      ***         09/19/02
                                    ***                                                              ***         10:57:36
**MODELOPTs:                                                                                                     PAGE   7
CONC                    URBAN FLAT        DFAULT


                    *** THE FIRST  24 HOURS OF METEOROLOGICAL DATA ***

       FILE:   c:\Projects\NCEE\ISC\metfile\12924-91.met
       FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,i4,f7.2)
       SURFACE STATION NO.: 12924                        UPPER AIR STATION NO.:  12924
                    NAME: CORPUS                                     NAME: CORPUS
                    YEAR:  1991                                      YEAR:  1991

                FLOW    SPEED   TEMP   STAB  MIXING HEIGHT (M)   USTAR   M-O LENGTH    Z-0  IPCODE  PRATE
YR MN DY HR  VECTOR    (M/S)    (K)   CLASS   RURAL    URBAN    (M/S)      (M)        (M)          (mm/HR)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

91 01 01 01   191.0    3.60   278.7    4     438.2    438.2    0.0000      0.0     0.0000    0     0.00
91 01 01 02   198.0    4.12   278.7    4     428.1    428.1    0.0000      0.0     0.0000    0     0.00
91 01 01 03   184.0    4.63   278.7    4     418.0    418.0    0.0000      0.0     0.0000    0     0.00
91 01 01 04   183.0    4.12   278.7    4     407.9    407.9    0.0000      0.0     0.0000    0     0.00
91 01 01 05   183.0    3.60   279.3    4     397.9    397.9    0.0000      0.0     0.0000    0     0.00
91 01 01 06   182.0    4.12   279.3    4     387.8    387.8    0.0000      0.0     0.0000    0     0.00
91 01 01 07   185.0    4.12   279.3    4     377.7    377.7    0.0000      0.0     0.0000    0     0.00
91 01 01 08   193.0    4.12   279.3    4     367.6    367.6    0.0000      0.0     0.0000    0     0.00
91 01 01 09   197.0    5.14   279.3    4     357.5    357.5    0.0000      0.0     0.0000    0     0.00
91 01 01 10   201.0    4.63   279.3    4     347.4    347.4    0.0000      0.0     0.0000    0     0.00
91 01 01 11   194.0    5.14   279.8    4     337.3    337.3    0.0000      0.0     0.0000    0     0.00
91 01 01 12   166.0    5.14   280.4    4     327.2    327.2    0.0000      0.0     0.0000    0     0.00
91 01 01 13   183.0    4.63   282.0    4     317.1    317.1    0.0000      0.0     0.0000    0     0.00
91 01 01 14   199.0    5.14   282.0    4     307.0    307.0    0.0000      0.0     0.0000    0     0.00
91 01 01 15   202.0    5.14   283.2    4     307.0    307.0    0.0000      0.0     0.0000    0     0.00
91 01 01 16   224.0    5.14   283.2    4     307.0    307.0    0.0000      0.0     0.0000    0     0.00
91 01 01 17   211.0    4.12   283.2    4     307.0    307.0    0.0000      0.0     0.0000    0     0.00
91 01 01 18   207.0    4.63   282.6    4     306.4    306.4    0.0000      0.0     0.0000    0     0.00
91 01 01 19   214.0    4.63   282.6    4     304.5    304.5    0.0000      0.0     0.0000    0     0.00
91 01 01 20   187.0    3.60   283.2    4     302.6    302.6    0.0000      0.0     0.0000    0     0.00
91 01 01 21   190.0    6.17   283.2    4     300.6    300.6    0.0000      0.0     0.0000    0     0.00
91 01 01 22   202.0    5.66   282.6    4     298.7    298.7    0.0000      0.0     0.0000    0     0.00
91 01 01 23   210.0    6.17   282.6    4     296.8    296.8    0.0000      0.0     0.0000    0     0.00
91 01 01 24   200.0    5.14   282.6    4     294.9    294.9    0.0000      0.0     0.0000    0     0.00


*** NOTES:  STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
            FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.
```

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*** ISCST3 - VERSION 02035 ***    ***   PLANT A                                        ***        09/19/02
                                   ***                                                 ***        10:57:36
**MODELOPTs:                                                                                      PAGE   8
CONC               URBAN FLAT         DFAULT

                    *** THE PERIOD (  8760 HRS) AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP: ALL       ***
                        INCLUDING SOURCE(S):       STACK1  , AREA1   ,

                    *** NETWORK ID: POL1    ;  NETWORK TYPE: GRIDPOLR ***

                       ** CONC OF OTHER    IN MICROGRAMS/M**3                            **

      DIRECTION |                                         DISTANCE (METERS)
      (DEGREES) |   200.00      500.00      1000.00    2000.00     5000.00    10000.00    20000.00    30000.00    40000.00
    - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

        180.00 |   26.12458     6.64452     2.21109    0.74069     0.19801     0.08142     0.03549     0.02218     0.01591
        202.50 |   20.04729     5.12819     1.69477    0.55877     0.14311     0.05669     0.02420     0.01515     0.01080
        225.00 |   15.69800     3.83559     1.25626    0.41451     0.10612     0.04161     0.01744     0.01077     0.00768
        247.50 |   23.13488     6.00898     1.98453    0.65972     0.17218     0.06964     0.03019     0.01887     0.01358
        270.00 |   32.89541     8.53788     2.86401    0.95366     0.23916     0.09093     0.03683     0.02224     0.01576
        292.50 |   47.35186    11.13908     3.68003    1.20231     0.28090     0.09742     0.03527     0.01988     0.01340
        315.00 |   82.75445    18.47047     5.63529    1.77323     0.41379     0.14888     0.05752     0.03389     0.02362
        337.50 |  102.33672    12.30926     3.30243    0.97802     0.21548     0.07457     0.02775     0.01599     0.01096
        360.00 |   57.55556     6.15408     1.69192    0.51721     0.12290     0.04584     0.01815     0.01074     0.00742
         22.50 |   19.91024     2.32959     0.64192    0.19498     0.04664     0.01703     0.00657     0.00389     0.00272
         45.00 |   11.63903     1.33586     0.35708    0.10608     0.02409     0.00848     0.00313     0.00174     0.00114
         67.50 |    9.56062     1.47368     0.45593    0.14875     0.03702     0.01369     0.00525     0.00304     0.00209
         90.00 |   11.43550     1.74428     0.48149    0.14048     0.03072     0.01055     0.00401     0.00240     0.00171
        112.50 |   16.19879     2.78310     0.78074    0.23378     0.05310     0.01856     0.00673     0.00376     0.00252
        135.00 |   19.06488     3.95658     1.22623    0.39249     0.09812     0.03914     0.01699     0.01062     0.00774
        157.50 |   24.58819     5.50599     1.74224    0.56809     0.14507     0.05644     0.02278     0.01360     0.00958
```

```
 *** ISCST3 - VERSION 02035 ***    ***   PLANT A                                                      ***          09/19/02
                                    ***                                                               ***          10:57:36
 **MODELOPTs:                                                                                                      PAGE   9
 CONC                     URBAN FLAT            DFAULT

                              *** THE PERIOD (  8760 HRS) AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP: ALL       ***
                                  INCLUDING SOURCE(S):       STACK1 , AREA1   ,

                               *** NETWORK ID: POL1     ;  NETWORK TYPE: GRIDPOLR ***

                                   ** CONC OF OTHER    IN MICROGRAMS/M**3                           **

        DIRECTION |                                            DISTANCE (METERS)
        (DEGREES) |      50000.00
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

          180.00 |       0.01234
          202.50 |       0.00839
          225.00 |       0.00597
          247.50 |       0.01054
          270.00 |       0.01211
          292.50 |       0.00991
          315.00 |       0.01794
          337.50 |       0.00820
          360.00 |       0.00564
           22.50 |       0.00208
           45.00 |       0.00081
           67.50 |       0.00158
           90.00 |       0.00133
          112.50 |       0.00184
          135.00 |       0.00605
          157.50 |       0.00734
```

```
*** ISCST3 - VERSION 02035 ***    ***  PLANT A                                                        ***      09/19/02
                                   ***                                                                ***      10:57:36
**MODELOPTs:                                                                                                   PAGE  10
CONC                  URBAN FLAT         DFAULT

                         ***  THE   1ST HIGHEST  1-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL      ***
                              INCLUDING SOURCE(S):       STACK1  , AREA1   ,

                       ***  NETWORK ID: POL1     ;  NETWORK TYPE: GRIDPOLR ***

                       ** CONC OF OTHER    IN MICROGRAMS/M**3                                       **

DIRECTION |                                                DISTANCE (METERS)
(DEGREES) |          200.00                 500.00                 1000.00                2000.00                5000.00
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

      180.0 |  1501.55603 (91092405)    484.61984 (91020723)    199.95938 (91110314)    114.69185 (91110314)    51.65492 (91110314)
      202.5 |  1455.31445 (91021107)    480.02853 (91021107)    203.31728 (91021107)     83.31702 (91021107)    26.78938 (91021107)
      225.0 |  1136.70996 (91040705)    361.34790 (91031723)    160.73401 (91031723)     65.09146 (91031723)    20.28281 (91012602)
      247.5 |  1257.27295 (91021401)    457.73276 (91040704)    188.08006 (91040704)     70.24591 (91040704)    20.27097 (91072304)
      270.0 |  1238.72424 (91050505)    457.49582 (91082504)    199.25746 (91082806)     80.48198 (91061920)    24.99545 (91032004)
      292.5 |  1340.20654 (91031222)    481.37009 (91091805)    202.76378 (91082803)     84.12709 (91082803)    26.00556 (91082803)
      315.0 |  1645.81958 (91100302)    522.26605 (91030921)    212.13699 (91091605)     85.57477 (91062104)    27.07774 (91061722)
      337.5 |  2387.18750 (91061723)    583.61292 (91082904)    221.97876 (91071604)     86.27188 (91071604)    26.02669 (91071604)
      360.0 |  3324.92773 (91080703)    624.96387 (91100305)    230.50153 (91100305)     87.65869 (91100305)    26.82338 (91100305)
       22.5 |  3424.63770 (91090202)    627.63135 (91090202)    212.88162 (91090202)     77.76836 (91090202)    21.91127 (91090202)
       45.0 |  2338.47729 (91021206)    605.10608 (91092407)    217.60117 (91092407)     81.67418 (91092407)    23.98470 (91092407)
       67.5 |  1747.01892 (91030119)    546.25061 (91080104)    218.48918 (91080104)     81.37032 (91080104)    22.80527 (91080104)
       90.0 |  1600.79211 (91091904)    517.33002 (91012720)    212.90433 (91082406)     83.95705 (91082406)    24.74858 (91082406)
      112.5 |  1651.16931 (91020623)    501.53741 (91060702)    207.06186 (91020702)     83.87395 (91111721)    27.13421 (91111721)
      135.0 |  1694.47180 (91031007)    489.73767 (91020705)    182.70006 (91051721)     82.17277 (91112107)    43.67725 (91112107)
      157.5 |  1663.41040 (91072306)    491.68097 (91092402)    190.40242 (91110316)    113.22594 (91110316)    50.29743 (91110316)
```

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*** ISCST3 - VERSION 02035 ***    ***   PLANT A                                                          ***      09/19/02
                                  ***                                                                    ***      10:57:36
**MODELOPTs:                                                                                                      PAGE  11
CONC                    URBAN FLAT          DFAULT

                          ***  THE   1ST HIGHEST  1-HR AVERAGE CONCENTRATION    VALUES FOR SOURCE GROUP:  ALL      ***
                               INCLUDING SOURCE(S):      STACK1  , AREA1    ,

                          ***  NETWORK ID: POL1     ;   NETWORK TYPE: GRIDPOLR ***

                          **  CONC OF OTHER    IN MICROGRAMS/M**3                                 **

DIRECTION |                                                     DISTANCE (METERS)
(DEGREES) |       10000.00                  20000.00              30000.00               40000.00                50000.00
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    180.0 |    25.36606 (91110314)      9.49738 (91110314)      4.30654 (91110314)      3.05345 (91010608)      2.55450 (91010608)
    202.5 |    12.02963 (91021107)      5.58296 (91021107)      3.61076 (91021107)      2.89626 (91100518)      2.56930 (91100518)
    225.0 |     9.15342 (91012602)      4.61272 (91010618)      3.69711 (91010618)      3.17136 (91010618)      2.82024 (91010618)
    247.5 |     9.09379 (91072304)      5.02260 (91021519)      3.82953 (91021519)      3.09570 (91021519)      2.68359 (91060820)
    270.0 |    11.74112 (91031618)      7.71208 (91031618)      6.05825 (91031612)      5.19630 (91031612)      4.62050 (91031612)
    292.5 |    14.74498 (91121915)      9.34974 (91121915)      7.11859 (91121915)      5.73123 (91121915)      4.81794 (91121915)
    315.0 |    12.22723 (91061722)      5.75321 (91061722)      4.11215 (91031615)      3.41679 (91031615)      2.99781 (91031615)
    337.5 |    10.97392 (91071604)      4.59130 (91071604)      2.67972 (91083003)      1.97551 (91083003)      1.54261 (91083003)
    360.0 |    11.68591 (91100305)      5.19301 (91100305)      3.22220 (91100305)      2.40951 (91012008)      2.00358 (91030607)
     22.5 |     8.36909 (91090202)      2.88283 (91090202)      1.86239 (91090211)      1.57136 (91090211)      1.34856 (91090211)
     45.0 |     9.68587 (91092407)      3.72344 (91092407)      1.97605 (91092407)      1.20803 (91092407)      0.77555 (91092407)
     67.5 |     8.98803 (91080105)      4.17044 (91080105)      2.68916 (91080105)      2.10911 (91112408)      1.87099 (91112408)
     90.0 |     9.98259 (91082406)      3.81598 (91082406)      2.46400 (91112108)      2.07585 (91112108)      1.78627 (91112108)
    112.5 |    12.16292 (91111721)      5.65606 (91111721)      3.64126 (91111721)      2.66866 (91111721)      2.09238 (91111721)
    135.0 |    28.12067 (91112107)     18.58513 (91112107)     14.36807 (91112107)     12.22339 (91112107)     10.43482 (91112107)
    157.5 |    23.06341 (91110316)      7.49917 (91110316)      3.11837 (91010612)      2.55506 (91010612)      2.18700 (91010612)
```

```
*** ISCST3 - VERSION 02035 ***    ***   PLANT A                                                                   ***        09/19/02
                                  ***                                                                             ***        10:57:36
**MODELOPTs:                                                                                                                 PAGE  12
CONC                   URBAN FLAT        DFAULT

                           ***  THE   2ND HIGHEST  1-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL       ***
                                INCLUDING SOURCE(S):       STACK1  , AREA1   ,

                           ***  NETWORK ID: POL1     ;  NETWORK TYPE: GRIDPOLR ***

                           **  CONC OF OTHER    IN MICROGRAMS/M**3                                  **

DIRECTION |                                                  DISTANCE (METERS)
(DEGREES) |        200.00                    500.00                   1000.00                  2000.00                  5000.00
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     180.0 |  1501.25830 (91011608)    376.39426 (91030903)    191.37912 (91020723)     72.84218 (91030903)     22.58328 (91030903)
     202.5 |  1441.12122 (91072307)    438.67038 (91072307)    180.27579 (91072307)     72.13591 (91072307)     21.31820 (91072307)
     225.0 |  1001.44092 (91031723)    360.76990 (91111224)    160.53403 (91111224)     65.05059 (91111224)     20.16645 (91032302)
     247.5 |  1254.02002 (91043005)    370.41241 (91021401)    150.81964 (91072304)     63.00666 (91072304)     19.73399 (91022503)
     270.0 |  1234.66443 (91031207)    445.51147 (91082806)    198.22604 (91112419)     76.62392 (91082806)     24.36553 (91061920)
     292.5 |  1338.02795 (91082503)    473.89322 (91092324)    202.18793 (91082403)     74.71960 (91082403)     23.48088 (91121915)
     315.0 |  1645.80725 (91040102)    483.61069 (91091605)    206.44470 (91062104)     83.45536 (91061722)     27.07774 (91091001)
     337.5 |  2379.44653 (91072805)    583.51575 (91070603)    214.91817 (91082904)     74.91078 (91082904)     20.08162 (91083003)
     360.0 |  3320.81616 (91081703)    528.46881 (91070502)    171.95099 (91021102)     66.88387 (91021102)     20.64260 (91091405)
      22.5 |  2956.87549 (91101605)    492.83246 (91101605)    161.83588 (91101605)     55.65389 (91101605)     15.19258 (91033124)
      45.0 |  2333.47461 (91030923)    517.65393 (91072906)    145.38011 (91072906)     45.83125 (91013122)     12.19385 (91013122)
      67.5 |  1740.02527 (91030924)    386.50674 (91080808)    163.37320 (91080808)     63.96153 (91080808)     20.14064 (91080105)
      90.0 |  1594.74280 (91020602)    511.69098 (91071605)    203.13364 (91071605)     70.75286 (91071605)     16.82014 (91071605)
     112.5 |  1643.04248 (91032303)    449.04300 (91020702)    195.61198 (91111721)     83.74547 (91013124)     27.11848 (91013124)
     135.0 |  1656.66882 (91092306)    479.05563 (91012508)    172.54233 (91011106)     80.66273 (91051721)     26.73210 (91051721)
     157.5 |  1663.37402 (91101904)    417.15240 (91020722)    181.39984 (91092402)     75.47617 (91110317)     25.47861 (91110317)
```

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*** ISCST3 - VERSION 02035 ***    ***   PLANT A                                                          ***        09/19/02
                                  ***                                                                    ***        10:57:36
**MODELOPTs:                                                                                                        PAGE  13
CONC                    URBAN FLAT        DFAULT

                          ***  THE    2ND HIGHEST  1-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL       ***
                               INCLUDING SOURCE(S):       STACK1  , AREA1   ,

                        ***  NETWORK ID: POL1     ;  NETWORK TYPE: GRIDPOLR ***

                        **  CONC OF OTHER    IN MICROGRAMS/M**3                              **

DIRECTION |                                                  DISTANCE (METERS)
(DEGREES) |       10000.00                20000.00                30000.00                40000.00                50000.00
- - - - - | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    180.0 |     9.26069 (91030903)      4.94550 (91010608)      3.77376 (91010608)      2.58248 (91100514)      2.29642 (91100514)
    202.5 |     9.03376 (91122424)      4.29220 (91100518)      3.41654 (91100518)      2.63358 (91021107)      2.08072 (91021107)
    225.0 |     9.12794 (91032302)      4.31066 (91012602)      2.81225 (91012602)      2.08583 (91012602)      1.65746 (91012602)
    247.5 |     8.90212 (91022503)      4.82563 (91010614)      3.64703 (91010601)      3.02469 (91060820)      2.58696 (91021519)
    270.0 |    11.24852 (91031612)      7.55995 (91031612)      6.01109 (91031618)      5.06457 (91031618)      4.35847 (91031618)
    292.5 |    11.03199 (91082803)      4.62498 (91082803)      2.68861 (91082803)      1.96026 (91031904)      1.53444 (91031904)
    315.0 |    12.22723 (91091001)      5.75321 (91091001)      3.75405 (91061722)      2.78385 (91061722)      2.21156 (91061722)
    337.5 |     8.97074 (91083003)      4.16779 (91083003)      2.65707 (91071604)      1.75837 (91071604)      1.25887 (91071604)
    360.0 |     9.23162 (91091405)      4.32736 (91091405)      3.05912 (91012008)      2.25355 (91030607)      1.95393 (91012008)
     22.5 |     6.41002 (91033124)      2.80729 (91101502)      1.81223 (91101502)      1.32041 (91101502)      1.04258 (91101502)
     45.0 |     4.72238 (91101601)      2.15497 (91012009)      1.21787 (91012009)      0.75760 (91012009)      0.59487 (91101208)
     67.5 |     8.68036 (91080104)      3.41789 (91080808)      2.47040 (91112408)      1.97306 (91080105)      1.54463 (91080105)
     90.0 |     6.01652 (91041507)      3.25586 (91041507)      2.09485 (91041507)      1.44522 (91041507)      1.06975 (91041507)
    112.5 |    12.15950 (91013124)      5.65527 (91013124)      3.64093 (91013124)      2.66848 (91013124)      2.09227 (91013124)
    135.0 |    12.15215 (91051721)      5.73611 (91051721)      3.74660 (91051721)      2.92213 (91110907)      2.56450 (91110907)
    157.5 |     8.42292 (91031308)      4.12533 (91010612)      3.03904 (91110316)      2.25465 (91120408)      2.00052 (91120408)
```

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*** ISCST3 - VERSION 02035 ***     ***   PLANT A                                                                              ***      09/19/02
                                   ***                                                                                        ***      10:57:36
**MODELOPTs:                                                                                                                          PAGE  14
CONC                    URBAN FLAT          DFAULT

                          ***  THE MAXIMUM   50   1-HR AVERAGE CONCENTRATION    VALUES FOR SOURCE GROUP:  ALL        ***
                               INCLUDING SOURCE(S):     STACK1 , AREA1   ,

                               ** CONC OF OTHER    IN MICROGRAMS/M**3                            **

RANK       CONC    (YYMMDDHH)  AT      RECEPTOR (XR,YR) OF TYPE     RANK        CONC    (YYMMDDHH)  AT      RECEPTOR (XR,YR) OF TYPE
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   1.    3424.63770 (91090202) AT (      76.54,     184.78) GP       26.    2344.56860 (91072905) AT (      76.54,     184.78) GP
   2.    3324.92773 (91080703) AT (       0.00,     200.00) GP       27.    2338.47729 (91021206) AT (     141.42,     141.42) GP
   3.    3320.81616 (91081703) AT (       0.00,     200.00) GP       28.    2333.47461 (91030923) AT (     141.42,     141.42) GP
   4.    3320.72510 (91042101) AT (       0.00,     200.00) GP       29.    2328.57324 (91101924) AT (      76.54,     184.78) GP
   5.    3292.86523 (91061201) AT (       0.00,     200.00) GP       30.    2315.69751 (91072906) AT (     141.42,     141.42) GP
   6.    3282.74561 (91021205) AT (       0.00,     200.00) GP       31.    2310.21680 (91011302) AT (     141.42,     141.42) GP
   7.    3223.36450 (91070502) AT (       0.00,     200.00) GP       32.    2268.86206 (91061821) AT (     -76.54,     184.78) GP
   8.    3211.59033 (91061303) AT (       0.00,     200.00) GP       33.    2262.72314 (91032003) AT (       0.00,     200.00) GP
   9.    2980.31152 (91070506) AT (       0.00,     200.00) GP       34.    2262.72192 (91020522) AT (       0.00,     200.00) GP
  10.    2956.87549 (91101605) AT (      76.54,     184.78) GP       35.    2262.69507 (91081807) AT (       0.00,     200.00) GP
  11.    2794.42676 (91020601) AT (      76.54,     184.78) GP       36.    2235.29102 (91080724) AT (       0.00,     200.00) GP
  12.    2653.74683 (91061504) AT (       0.00,     200.00) GP       37.    2234.92871 (91070804) AT (       0.00,     200.00) GP
  13.    2653.65625 (91062401) AT (       0.00,     200.00) GP       38.    2219.49292 (91020903) AT (      76.54,     184.78) GP
  14.    2548.52319 (91091501) AT (      76.54,     184.78) GP       39.    2199.22778 (91061807) AT (     -76.54,     184.78) GP
  15.    2494.23730 (91082104) AT (       0.00,     200.00) GP       40.    2185.53589 (91082004) AT (     -76.54,     184.78) GP
  16.    2492.62402 (91021204) AT (       0.00,     200.00) GP       41.    2185.53442 (91012801) AT (     -76.54,     184.78) GP
  17.    2470.40674 (91081924) AT (       0.00,     200.00) GP       42.    2182.49561 (91013121) AT (     141.42,     141.42) GP
  18.    2470.26392 (91092622) AT (       0.00,     200.00) GP       43.    2158.75342 (91100305) AT (       0.00,     200.00) GP
  19.    2462.28906 (91020901) AT (       0.00,     200.00) GP       44.    2128.02075 (91092407) AT (     141.42,     141.42) GP
  20.    2442.69507 (91100308) AT (      76.54,     184.78) GP       45.    2097.81152 (91070505) AT (     -76.54,     184.78) GP
  21.    2435.89600 (91022203) AT (      76.54,     184.78) GP       46.    2097.18481 (91052603) AT (      76.54,     184.78) GP
  22.    2416.05005 (91040701) AT (       0.00,     200.00) GP       47.    2056.04932 (91011224) AT (      76.54,     184.78) GP
  23.    2387.18750 (91061723) AT (     -76.54,     184.78) GP       48.    2052.75269 (91031224) AT (      76.54,     184.78) GP
  24.    2379.44653 (91072805) AT (     -76.54,     184.78) GP       49.    1999.44092 (91033124) AT (      76.54,     184.78) GP
  25.    2345.56055 (91070503) AT (     -76.54,     184.78) GP       50.    1995.99414 (91070701) AT (      76.54,     184.78) GP

  *** RECEPTOR TYPES:   GC = GRIDCART
                        GP = GRIDPOLR
                        DC = DISCCART
                        DP = DISCPOLR
                        BD = BOUNDARY
```

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 *** ISCST3 - VERSION 02035 ***    ***   PLANT A                                                          ***    09/19/02
                                    ***                                                                   ***    10:57:36
**MODELOPTs:                                                                                                     PAGE  15
CONC               URBAN FLAT        DFAULT

                                 *** THE SUMMARY OF MAXIMUM PERIOD (  8760 HRS) RESULTS ***


                         ** CONC OF OTHER    IN MICROGRAMS/M**3                            **

                                                                                              NETWORK
GROUP ID                     AVERAGE CONC             RECEPTOR  (XR, YR, ZELEV, ZFLAG)   OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      1ST HIGHEST VALUE IS     102.33672 AT (     -76.54,      184.78,      0.00,      0.00) GP  POL1
         2ND HIGHEST VALUE IS      82.75445 AT (    -141.42,      141.42,      0.00,      0.00) GP  POL1
         3RD HIGHEST VALUE IS      57.55556 AT (       0.00,      200.00,      0.00,      0.00) GP  POL1
         4TH HIGHEST VALUE IS      47.35186 AT (    -184.78,       76.54,      0.00,      0.00) GP  POL1
         5TH HIGHEST VALUE IS      32.89541 AT (    -200.00,        0.00,      0.00,      0.00) GP  POL1
         6TH HIGHEST VALUE IS      26.12458 AT (       0.00,     -200.00,      0.00,      0.00) GP  POL1
         7TH HIGHEST VALUE IS      24.58819 AT (      76.54,     -184.78,      0.00,      0.00) GP  POL1
         8TH HIGHEST VALUE IS      23.13488 AT (    -184.78,      -76.54,      0.00,      0.00) GP  POL1
         9TH HIGHEST VALUE IS      20.04729 AT (     -76.54,     -184.78,      0.00,      0.00) GP  POL1
        10TH HIGHEST VALUE IS      19.91024 AT (      76.54,      184.78,      0.00,      0.00) GP  POL1


  *** RECEPTOR TYPES:  GC = GRIDCART
                       GP = GRIDPOLR
                       DC = DISCCART
                       DP = DISCPOLR
                       BD = BOUNDARY
```

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 *** ISCST3 - VERSION 02035 ***    ***   PLANT A                                          ***        09/19/02
                                   ***                                                    ***        10:57:36
**MODELOPTs:                                                                                          PAGE  16
CONC                    URBAN FLAT         DFAULT

                                   *** THE SUMMARY OF HIGHEST  1-HR RESULTS ***


                          ** CONC OF OTHER    IN MICROGRAMS/M**3                          **

                                              DATE                                                    NETWORK
GROUP ID                       AVERAGE CONC   (YYMMDDHH)       RECEPTOR  (XR, YR, ZELEV, ZFLAG)   OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      HIGH  1ST HIGH VALUE IS   3424.63770  ON 91090202: AT (     76.54,    184.78,    0.00,    0.00)  GP   POL1
         HIGH  2ND HIGH VALUE IS   3320.81616  ON 91081703: AT (      0.00,    200.00,    0.00,    0.00)  GP   POL1


 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
                      BD = BOUNDARY
```

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 *** ISCST3 - VERSION 02035 ***    ***  PLANT A                                            ***      09/19/02
                                   ***                                                     ***      10:57:36
**MODELOPTs:                                                                                        PAGE  17
CONC                  URBAN FLAT           DFAULT


*** Message Summary : ISCST3 Model Execution ***

 --------- Summary of Total Messages --------

A Total of          0 Fatal Error Message(s)
A Total of          0 Warning Message(s)
A Total of        371 Informational Message(s)

A Total of        371 Calm Hours Identified


    ******** FATAL ERROR MESSAGES ********
            ***  NONE  ***


    ********   WARNING MESSAGES   ********
            ***  NONE  ***


    ************************************
    *** ISCST3 Finishes Successfully ***
    ************************************
```