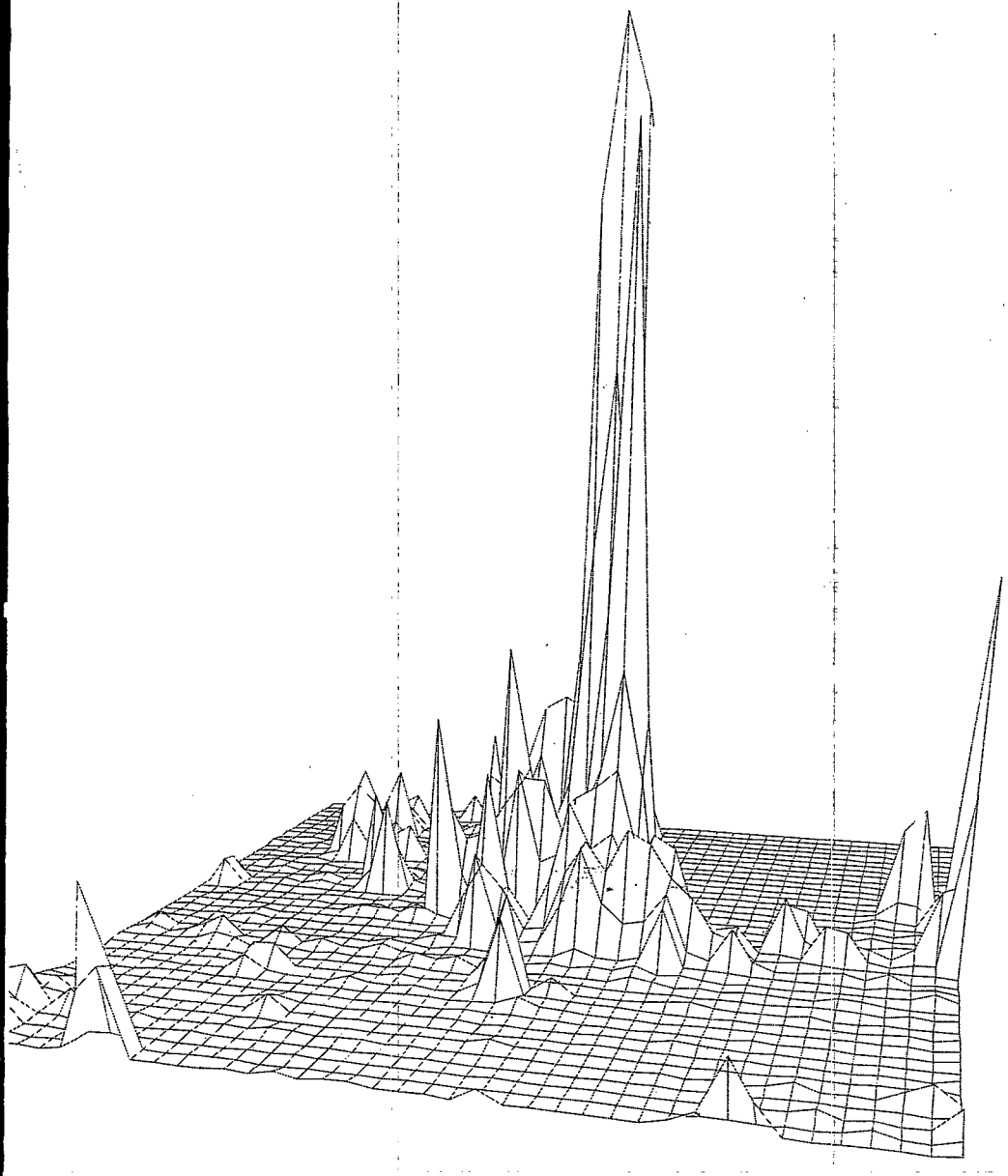
United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park, NC 27711

EPA/450/3-91-0010
February 1991

Air

EPA HEM-II User's Guide



NOTICE

The information in this document has been funded wholly or in part by the United States Environmental Protection Agency under Contract No. 68-D9-001 to Radian Corporation. Mention of trade names or commercial products does not constitute endorsements or recommendation for use.

The HEM-II system is continually being updated. This User's Guide was prepared for Version 1.3 of the HEM-II software. Versions 1.4 and 1.5 of HEM-II were completed during the preparation of this guide. Because only minor modifications have been made to the actual User Interface, the contents of this guide are still appropriate.

The use of styrene in the tutorial that is found in Chapter 2 of this document should be regarded as an illustrative example. The weight-of-evidence classification and the unit risk estimate for styrene were not approved by EPA at the time of publication of this User's Guide. Users wanting to estimate cancer risks from exposure to any potentially carcinogenic compounds should first verify the unit risk estimates with the Integrated Risk Information System (IRIS) at 202-382-2549.

Please note that this manual is a User's Guide for the HEM-II computer software. It is NOT a user's guide to the model. The HEM-II Technical Reference Guide will be produced and published at a later date.

BACKGROUND

The original Human Exposure Model (HEM or HEM-I), developed in 1979, continues to be an effective tool for screening point sources of hazardous air pollutants; and ranking individual sources and source categories in terms of their relative carcinogenic risks. The model was designed to efficiently screen a large number of sources inexpensively and quickly. HEM, on occasion, has been used in rule making decisions and supporting studies. Many opportunities for public comment on HEM have been provided through publication of proposed rulemakings in the Federal Register and summary reports of studies. Many of the comments and criticisms of HEM focus on a simplification of assumptions inherent in a model designed to be used as a screening tool.

The most important of these comments are:

1. HEM-I is not user friendly. It is not easy for people with limited HEM-I and computer experience to use. This is an important consideration for State and local air pollution control agencies and for many private parties that would like to use HEM-I.

2. The adequacy of the dispersion algorithm is questionable, because it has not been validated as a screening algorithm.

3. The use of predicted ambient concentrations at the fenceline or the residence, as the basis for exposure estimation, is also questionable. People are mobile and do not remain at "their residences" 100 percent of the time. Additionally, the exposed population does not breathe ambient (outdoor) air for the entire duration of exposure.

4. Uncertainty is not explicitly treated. This is needed because uncertainties in risk assessment and risk characterization are very large. Quantification of uncertainty will also be important for estimating the conservatism that is often associated with carcinogenic risk assessments.

The HEM is being revised and released to the public in stages defined as distinct program versions. The present version of the improved HEM (HEM-II version 1.5) addresses the first three comments listed above. It also enables users to present selected outputs graphically with bar charts, or two- or three-dimensional graphs. The HEM-II is user friendly. The user is prompted for all input data by a well-designed, logical series of screens.

The HEM-II contains an EPA-approved, validated model, the Industrial Source Complex Long-Term Model (ISCLT), that has been accepted for many industrial source modeling applications. For those situations where ISCLT is not appropriate (e.g., if the facility is sited in complex terrain), HEM-II provides the user with the means to transfer to HEM-II a concentration file that has been created by the more appropriate dispersion model. The transferred file is then used by HEM-II to estimate population exposure and risk, etc.

The HEM-II provides the user with the option of moving the exposed population "off of their front porches." This is achieved by the user defining up to ten places, or areas of unique concentrations, called microenvironments. Microenvironments may include indoors at home, indoors at work, in transit, mobility–specifically migration out of the study area, etc. The user defines an indoor-to-outdoor concentration ratio typical of the microenvironment in question, the percentage of the exposed population to be assigned to the microenvironment, and the amount of time, on an annual basis, estimated to be spent in each microenvironment.

The next version of HEM-II (2.0) will address uncertainty via a Monte Carlo analysis of the input parameters that have the potential to contribute the most uncertainty to the exposure and risk results. The parameters, under consideration at this time, include: emission rate, cancer potency estimate, microenvironment concentrations, amount of time spent in microenvironments, and the amount of time people reside at their primary residences. Version 2.0 is expected to be released during the summer of 1992.

Future versions of HEM-II may include an algorithm for moving the exposed population between home and work, and in and out of the study area. It may also contain a short-term atmospheric dispersion model, as well as other multimedia models for estimating exposure from other routes of exposure. These additional exposure routes could include ingestion and re-entrainment of deposited pollutants.

Review of Version 1.5 and a preliminary Version 2.0 (if not the completed 2.0), is expected to be conducted by the National Academy of Science as part of their review of risk assessment methodologies required by Clean Air Act Amendments of 1990.

The accompanying document is a draft user's guide. EPA/OAQPS hopes to receive comments from users on any aspect of HEM-II, e.g., unclear menu instructions/choices, unclear titles of options, software bugs, limitations on options, other features that should be added, etc. Please contact Mike Dusetzina, U. S. EPA, OAQPS, at (919) 541-5338.

CONTENTS

Figures vi
Acronyms and Abbreviations vii
User Interface Terms viii
HEM-II Model Terminology ix
1 Introduction 1-1
Purpose and Features 1-1
Anticipated Users 1-3
Manual Organization 1-3
2 First Session with HEM-II 2-1
The HEM-II User Interface 2-1
User Interaction 2-1
Keyboard 2-2
How to Access the NCC VAX 2-3
Dial-up Access 2-4
General NCC Users 2-5
Washington, DC, Users 2-6
Ethernet Access 2-6
Log-on Procedures 2-6
Log-out Procedure 2-8
Using the HEM-II User Interface 2-8
Control Menu Screens 2-9
Data Entry Screens 2-9
On-line Tutorial with Demonstration Study 2-10
Typographical Conventions 2-10
Tutorial: Part 1 2-11
Tutorial: Part 2 2-33
3 The HEM-II User Interface 3-1
Control Menu Screens 3-1
Data Entry/Review Screens 3-2
Data Entry 3-4
Screen Conventions 3-4
Screen Windows 3-4
Study Data Entry 3-5
Data Validation 3-7
User Interface Organization 3-7
4 Using HEM-II 4-1
Defining a HEM-II Study 4-1
Main Menu 4-1
Define a HEM Study 4-1
Set Output Options 4-1

Excute HEM Study 4-2
Reports and Graphics 4-2
Global Study Data Check 4-2
Software Configuration 4-3
Exit Program 4-3
Study Definition Menu 4-3
Create New Study 4-4
Create from Existing Study 4-4
Review/Modify Existing Study 4-4
Return to Main Menu 4-5
Component Data Menu 4-5
HEM Study Scenario 4-5
BAC Processing 4-6
POP Processing 4-6
EXP Processing 4-6
RISK Processing 4-6
Previous Menu 4-8
BAC Options Menu 4-6
Pollutant List 4-7
Air Dispersion Models 4-7
STAR Site Selection 4-7
Microenvironments 4-8
Previous Menu 4-8
BAC Dispersion Model Menu 4-8
HEM-II Internal Point Sources 4-9
External Point Source Model Data 4-9
HEM-II Studywide Area Sources 4-9
HEM-II Prototype Area Sources 4-9
BAC Microenvironments Pollutant Coefficients Menu 4-9
HEM-II Default Coefficients 4-10
User-defined Coefficients 4-10
Area-specific Coefficients 4-10
POP Processing Options Menu 4-11
Population Base Year 4-11
Population Cohorts 4-11
Population Growth 4-11
Microenvironments 4-12
Previous Menu 4-12
Population Growth Menu 4-12
None 4-13
By County 4-13
By Population Cohort 4-13

By Specified Area 4-13
POP Microenvironments 4-13
By Microenvironment Alone 4-14
By POP Cohort Per Microenvironment ... 4-14
Including Cohorts & Specified Areas 4-14
Checking User Data for Errors 4-14
Selecting Model Output Options 4-15
Executing a HEM-II Study 4-15
Diagnosing Problems 4-16
Session Log Files 4-17
Main Log File 4-17
Component Log Files 4-18
TSS Diagnostic Messages 4-18
GAT Diagnostic Messages 4-19
5 Reports and Graphics 5-1
Preparing Printed Reports 5-1
User-supplied HEM-II Study Definition Reports 5-2
HEM-II TSS Model Outputs 5-2
Report 1: Source-specific Maximum Concentration Report 5-3
Report 2: Source-specific Exposure/Risk Report 5-4
Report 3: Source-group Exposure/Risk Report 5-15
Report 4: Study Exposure/Risk Report 5-20
ISCLT Model Defaults 5-24
Preparing HEM-II Graphical Outputs 5-24
Creating Graphics Output Data Sets 5-28
Producing Graphics from Graphics Data Sets 5-28
6 References 6-1

Appendix A HEM-II Disk File Directories A-1
Appendix B HEM-II Version 1.3 Specifications B-1
Appendix C HEM-II Point Source Module C-1
Introduction C-1
Meteorological Data C-2
Model Options C-3
Appendix D HEM-II Area Source Module D-1
Appendix E Calculation of Exposure and Risk E-1
Introduction E-1
Point Sources E-2

Studywide Area Sources E-3
Point Sources and Studywide
Area Sources Combined E-4
Appendix F User-supplied Point Source
Concentration Data from External
Dispersion Models F-1
Appendix G HEM-II Permanent Support
Data Files G-1
Appendix H Study Definition Reports H-1
Appendix I ISCLT Model Defaults Reports I-1
Appendix J Microenvironments J-1

FIGURES

3-1. HEM-II Control Menus 3-3
3-2. HEM-II Control Menu Diagram for
Main Menu 3-8
3-3. HEM-II Control Menu Diagram for
BAC Options Menu 3-9
3-4. HEM-II Control Menu Diagram for
POP Options Menu 3-10
5-1. Plan View Graphic 5-26
5-2. Bar Chart Graphic 5-26
5-3. Contour Graphic 5-27
5-4. Surface Graphic 5-27
C-1. Example Schematic of Source Hierarchy
within HEM-II (1.3) C-4
D-1. 10 x 10 Grid Encompassing Most of
Morgan County, CO D-3
E-1. Interpolation of Pollutant Concentrations E-2
F-1. File Format for HEM-II External Mode Data F-3
F-2. FORTRAN Code from HEM-II for
Writing External File F-4

ACRONYMS AND ABBREVIATIONS

BGED	Block Group/Enumeration District
CGM	Computer Graphics Metafile
CONC LB	Concentration Lower Bounds
CONC UB	Concentration Upper Bounds
EOF	End of File
EPA	Environmental Protection Agency
GAT	Graphics Analysis Tools
GEMS	Graphical Exposure Modeling System
HEM	Human Exposure Model
I/O	Input/Output (of data from computer files)
IO_ERR	I/O Error Trapping Routine
ISCLT	Industrial Source Complex Long Term Model
ISO	International Standards Organization
NAAQS	National Ambient Air Quality Standards
NCC	National Computer Center
NEM	NAAQS Exposure Model
NESHAP	National Emission Standards for Hazardous Air Pollutants
NTIS	National Technical Information Service
NWS	National Weather Service
OTS	Office of Toxic Substances
PAB	Pollutant Assessment Branch
PC	Personal Computer
STAR	STability ARray
TECH_ERR	Technical Error Trapping Routine
TSSMS	Time Sharing Services Management Systems
UNAMAP	User's Network for Applied Modeling of Air Pollution
VAX	Family of Digital Equipment Corporation (DEC) Computers
VMS	VAX Operating System
WIC	Washington Information Center

USER INTERFACE TERMS

NOTE: User Interface terms are listed in a logical order of use.

TERMINAL - The hardware device used to communicate with the host VAX computer.

TERMINAL EMULATOR - A software program that allows a personal computer to imitate the characteristics of a specified computer terminal (i.e., a VAX terminal).

DISPLAY - The visible surface of the terminal monitor on which screens are presented.

SCREEN - The formatted information that appears on the terminal's display. HEM-II uses two screen types, control menu screens and data entry screens. Data entry screens may consist of multiple windows.

MENU - A predetermined list of options presented on a computer screen from which the user selects to control the program operation.

WINDOW - A collection of related information, presented on a computer screen in a framed box.

NESTED WINDOW - A window inset within a larger window. Nested windows are used to visibly present logically related information.

POP-UP WINDOW - A small window that appears superimposed over a larger window. Its purpose is to allow the user to supply additional detailed information that relates to a selection made in the larger window.

INPUT FIELD - A single item of information that the user supplies as indicated on a computer screen.

CURSOR - A blinking or highlighted indicator that shows the position of current activity on a screen.

CURSOR KEYS - The arrow keys on the terminal keyboard that are used to move the cursor around within a window or input field.

FUNCTION KEYS - Special purpose (non-display) keys on the terminal keyboard that software programs interpret for control purposes. The programmable function keys are used for HEM-II software control (PF1, PF2, PF3, and PF4).

FULL-SCREEN EDITING - A data-entry window that allows the user to move horizontally and vertically between the various input fields within a given window.

DEFAULT VALUES - A value for a user-supplied entry field that will be used unless the user provides a specific value.

REVERSE (INVERSE) VIDEO - The use on the computer screen of dark letters on a bright background. This causes the information in the reverse-shaded block to appear as a highlighted block.

LIGHT BAR - An inverse video highlighted block that appears on the screen to indicate a currently selected value.

MENU NAVIGATION - Moving vertically through a tree-structured hierarchical network of menu screens.

HEM-II MODEL TERMINOLOGY

ALGORITHM - A stepwise method for solving a problem. In computer science, an algorithm also details the way that this solution is implemented in computer code.

BAC - The HEM-II Breathing Air Component.

BATCH PROCESS - The type of process that requires no user interaction and continues unless a stop or delete command is issued by the user. A batch process will continue after the user has logged out from the VAX System. Batch processing operates in the batch mode.

BGED - Block Group Enumeration District. This is a population grouping system used by the U.S. Bureau of the Census. Block groups are generally found in urban areas; enumeration districts, in rural.

COORDINATORS - The secondary control routines that are directly invoked by the Supervisor routine. The function of these coordinators is to allow the four components of the HEM-II to execute independently.

COMPONENTS - The four chief functional segments of the HEM-II modeling software.

EXP - The HEM-II Exposure Component.

INTERACTIVE PROCESS - The user directs computer program operation by software interaction, receiving information on the terminal display and entering control information and data from the terminal keyboard. An interactive process is one that operates in the interactive mode.

MICROENVIRONMENT - A location where pollutant concentrations are characteristically different from ambient air concentrations. Most air dispersion models calculate pollutant concentrations for the ambient air. The most health-conservative estimate of human exposure to pollutants assumes that a person is exposed to the full concentration in the ambient air. To provide a more realistic estimate of exposure, HEM-II allows exposure to be partitioned between multiple microenvironments. The default microenvironments in HEM-II are indoor and outdoor, with the indoor microenvironment specified using a percentage of time spent indoors and a percentage of the indoor concentration relative to the ambient (outdoor) concentration.

MODULES - Large computer systems are divided into smaller functional units, termed modules. Each module performs a specific function.

POP - The HEM-II Population Component.

PROCESSORS - The technical modeling routines that process the user-specified study definition under the direction of the Component Coordinators.

RISK - The HEM-II Risk Component.

STUDY - A single application scenario of the HEM-II software using a given set of model inputs. User-supplied study definitions are retained in permanent storage for later reuse or modification and resubmission.

SUPERVISOR - The main software routine of the HEM-II modeling software. This routine controls the execution of the individual Component Coordinators.

TSS - The Technical Software System of HEM-II. It consists of the BAC, POP, EXP, and RISK Components combined. Runs in batch mode.

UNIT RISK ESTIMATE - Incidences of cancer per unit of pollutant concentration. The lifetime cancer probability occuring in a hypothetical population in which all individuals are exposed continuously throughout their lifetimes to 1 $\mu g/m^3$ of the potential carcinogen in the air that they breathe.

USER INTERFACE - The HEM-II User Interface is an interactive segment of the HEM-II model. It is the primary means for the user to supply input data for processing. The User Interface aids the user in defining the application data files that collectively are called a "HEM study."

USR - The HEM-II User Interface Component. Runs in interactive mode.

SECTION 1
INTRODUCTION

In 1980, the U.S. Environmental Protection Agency (EPA) developed the Human Exposure Model (HEM). This model was designed to screen point sources of air pollutant emissions efficiently, ranking the sources according to their potential cancer risks. Several years of experience with HEM indicated that additional modeling capabilities were needed to address issues related to the analysis of toxic air pollutants. The Human Exposure Model II (HEM-II), Version 1.3, is the result of the program to develop the enhanced modeling system.

PURPOSE AND FEATURES

HEM-II is intended for use in evaluating potential human exposure and risks generated by sources of air pollutants. The HEM-II modeling system incorporates current techniques in air dispersion modeling, population characterization, and health effects to provide the user with a flexible and powerful analytical tool.

Although HEM-II has been designed to allow the user to analyze a wide range of situations, the essential purpose of the original HEM has been preserved. That is, HEM-II also can be used to screen point sources for a single pollutant in order to rank sources according to cancer risks. However, technical aspects of the modeling system have been updated to be current with EPA practices. Moreover, HEM-II includes features that allow the user to conduct a more refined analysis of individual point sources, and to study entire urban areas that include multiple point sources, multiple pollutants, area sources, and dense population distributions.

Some of the technical aspects of the model are listed below. HEM-II:

- incorporates the latest version of the Industrial Source Complex Long Term model (ISCLT) regulatory mode only, which allows the user to perform a modeling analysis that is consistent with EPA modeling tools and guidance (Alternatively, the user can import the output files of any dispersion model executed outside the HEM-II modeling system.);

- contains a limited STability ARray (STAR) site data base within the model (Although STAR sites are automatically selected by HEM-II, the user can override this selection.);

- can be used to model complex emission inventories [HEM-II can accommodate area sources (e.g., mobile sources and residential heating) simultaneously with point sources.];

- offers a choice of grid systems for calculating exposures: a source polar grid similar to the original HEM, and a master Cartesian grid that will accommodate areas with high population density and numerous air pollution sources;

- allows the user to account for differences between microenvironments, e.g., indoor and outdoor concentrations;

- incorporates a population data base that covers the entire United States to the Block Group/ Enumeration District (BGED) level;

- allows for population modeling within HEM-II to account for population growth (either from the base year of the population data base to the current year or to a future year); and

- generates graphical output of results, producing bar charts, plan views, contours, and three-dimensional surfaces.

The HEM-II software has been developed in a modular, structured fashion to provide an extensible modeling system. HEM-II can be enhanced with new features to meet the needs of evolving techniques in human health risk estimation. Additional releases of HEM-II are planned and will provide increasingly sophisticated analytical capabilities.

ANTICIPATED USERS

HEM-II is a complex model that incorporates techniques from a variety of disciplines: atmospheric dispersion modeling, population data analysis, and health sciences. Users of HEM-II should be familiar with the principles of dispersion modeling (ISCLT; U.S. EPA, 1987) and with the EPA Guideline on Air Quality Models (U.S. EPA, 1986a). Additionally, users should be familiar with the uses and limitations of risk assessment techniques. It is important to apply professional judgment in the design of HEM-II modeling scenarios, and especially in the interpretation of HEM-II outputs.

Similarly, this User's Guide has been written with the assumption that the user is knowledgeable about the principles and practices of dispersion modeling and risk assessment.

MANUAL ORGANIZATION

Section 2 serves two purposes for the first-time user:

1. Describes how to access HEM-II on the National Computer Center (NCC) VAX computer, and

2. Provides an on-line tutorial to acquaint the user with the HEM-II User Interface screens.

Section 3 discusses the design philosophy and operation of the HEM-II User Interface. Section 4 describes the user menus and data entry screens

used for defining a HEM-II study scenario. Section 5 describes the types of tabular reports and computer graphics available for presenting the results of a HEM-II study after processing data input. Technical appendices provide specifics about the model's capabilities.

Appendix A lists HEM-II disk file directories. Appendix B details Version 1.3 specifications for pollutant and population processing maximum limits. Appendices C and D describe the HEM-II Area and Point Source Module, respectively. Appendix E explains calculation of exposure and risk for both point and studywide area sources. Appendix F provides information for experienced modelers to use alternative air dispersion models other than those incorporated in HEM-II. Appendix G covers HEM-II permanent support data files and lists the 392 U.S. sites for which meteorological data are available. Appendix H shows example study definition reports, Appendix I shows the default report for the ISCLT model, and Appendix J discusses microenvironments.

SECTION 2
FIRST SESSION WITH HEM-II

THE HEM-II USER INTERFACE

The HEM-II User Interface is a user-friendly, interactive program that assists the user in supplying the complex information required to exercise the advanced modeling features of HEM-II. All data file formatting is handled automatically by the User Interface. The user simply has to fill in the blanks provided within the various computer data entry screens; this information is then processed into the appropriate data file formats as required by the Technical Software System (TSS).

The HEM-II User Interface is implemented as a separate component (USR) from the TSS that performs the actual mathematical calculations. The TSS itself consists of multiple components.

User Interaction

The HEM-II User Interface requires the use of a VAX computer terminal or emulator. In this section, a description of the VAX computer keyboard is followed by detailed instructions to enable the first-time user to access the NCC VAX computer on which the HEM-II program is processed.

An extensive tutorial in two parts completes the section. Part 1 covers all features of HEM-II and will guide the first-time user through data input to describe and execute a HEM-II study. Part 2 instructs the user on producing reports and graphics and depicts the variety of HEM-II outputs available.

Keyboard

The VAX computer terminal or VAX terminal emulator keyboard contains the following five types of keys that serve specific purposes described below:

1. Alphanumeric Keys,
2. Cursor Keys,
3. Return Key (or Enter Key),
4. Backspace Key, and
5. Programmable Function Keys (PF1 - PF4).

Alphanumeric Keys include alphabetical (A - Z), special character (e.g., +, -, [,], :), and numeric keys (0 - 9) and are used to type in responses to on-screen prompts to the user.

Cursor Keys are the left, right, up, and down arrow keys.

The Return Key and in many places the cursor keys are then used to accept the keyed response and move forwards (or backwards).

The Backspace Key is used to fix an incorrect response by deleting the character to the left of the current screen cursor location.

The programmable function keys (PF1 - PF4) on the terminal keyboard are used to perform all special operations in the User Interface. The definitions of these special keys are shown in the following frame.

PF1 - HELP

PF2 - SCREEN COMMAND MENU

PF3 - CANCEL OPERATION

PF4 - (reserved for future use)

HOW TO ACCESS THE NCC VAX

To use HEM-II, users must obtain access to the NCC VAX computer. This can be done through EPA or another organization using the NCC System. Users must have a User ID and a project number to which computer time will be charged, and these should be provided to users by their supervisor. Assistance with access or use of the NCC system is available through NCC User Support at one of the following numbers:

- (919) 541-7862,
- (FTS) 629-7862, or
- (800) 334-2405 (outside NC only).

Information on access through EPA or an interagency agreement may be obtained by contacting NCC's Account User Registration at Time Sharing Services Management Systems (TSSMS) at:

- (919) 541-3629 or
- (FTS) 629-3629.

To arrange access outside of EPA, contact Cathy Metzler at the National Technical Information Service (NTIS) at:

- (703) 487-4807 or
- (FTS) 737-4807.

For questions regarding equipment compatibility, call Telecommunication Support at:

- (919) 541-4506,
- (FTS) 629-4506, or
- (800) 334-0741 (outside NC only).

After a user has arranged for a User ID and project number, you can access the NCC VAX in two different ways:

1. Via a modem connection over a dedicated telephone line or
2. Via the Ethernet network.

Dial-up Access

Video display terminals or personal computers (PCs) that are equipped with modems may be used to connect with the NCC VAX System. Consult your hardware documentation for specific instructions because of the wide variety of modems and communications packages that can be used. However, the following general guidelines apply to all communication with the NCC VAX:

1. Dial-up at either a 1200 or 2400 baud rate.
2. Use communication software that emulates a VT100, VT200, or VT300 series DEC terminal.
3. Use the following communication parameters: seven data bits, one stop bit, and even parity.

The user's location and modem speed will determine the most appropriate telephone number for connecting with the NCC VAX. Three options are available for accessing the main (Port Selector) NCC menu.

GENERAL NCC USERS

The NCC VAX may be accessed by dialing one of the following numbers:

- 1200 baud: (919) 541-4642 or (FTS) 629-4642 or
- 2400 baud: (919) 541-0700 or (FTS) 629-0700.

Users local to the NCC VAX in Research Triangle Park, North Carolina, may dial without use of an area code. Users outside of the Research Triangle Park area may also access the VAX via the TYMNET, BITNET, or other communication network. Ask your computer systems manager about how to reach the Port Selector Menu via these networks.

When connected, press the Return Key once and the following menu will appear.

```
Welcome to the Environmental Protection Agency National Computer Center
          Please enter one of the following selections:
                IBMPSI for IBM
                TCP for IBM 3270 EMULATION
                VAXA for VAX SYS A
                VAXB for VAX SYS B
                EMAIL for EMAIL
Enter selection:
```

The '**VAXA**' option is the one to select for accessing HEM-II and corresponds to the VAXTM1 mode of the EPA VAX Cluster. The message '**Connected**'

should appear after this selection is made. Press the Return Key again to begin the log-on procedure.

WASHINGTON, DC, USERS

Users in the Washington, DC, area can access the VAX through the Washington Information Center (WIC) Headquarters Data Switch by dialing (202) 488-3671. When the selection prompt appears, enter "**VAXA**" to complete the connection.

ETHERNET ACCESS

The VAX also can be accessed via direct link through a terminal server to the Ethernet network. Simply turn on the terminal server and press the Return Key. When the DECserver 200 Terminal Server Local prompt appears, connect to the VAX by entering the command:

Connect Vax

Log-on Procedures

After the user has established the NCC VAX connection, the system will ask for a user name. Pressing the Return Key may be required before the following prompt will appear:

Username:

This prompt requests the three-character User ID that the NCC issues to users who register to use the VAX Cluster. This name identifies you to the VAX each time you log on. Type in your User ID and press the Return Key.

Next the system will ask for your password with the following prompt:

Password:

Carefully enter your password and press the Return Key. Note that the cursor will not move and your password will not appear on the screen. If you enter

your password incorrectly, the following message will appear on the screen.

User Authorization Failure

If this message appears, press the Return Key once again to obtain the 'Username' prompt. Repeat entry of your user name and password.

If you are unsuccessful in entering your password three consecutive times, you will be disconnected. If you are unsuccessful in logging on five consecutive times, your User ID will become invalid, and further attempts to log on will be prohibited without contacting the NCC User Support Center.

If your password has expired (this will occur the first time you log on), you must much change it immediately. A password can be changed anytime by entering the following command:

Set Password

The following prompt will appear:

Old Password

Enter your current password and then your new password. Verify the new password by entering it again.

The following rules apply to VAX passwords:

- Length can range from 6 to 31 characters, and A-Z, 0-9, $, and _ (underline) are acceptable. Including at least one alphabetic and one numeric character is recommended. The system does not differentiate between upper- and lower-case characters.
- Passwords expire every 90 days and must be changed.
- You cannot reuse your most recent password.

- Changing your password often is recommended. This should be done immediately if password secrecy is lost.

Assistance with passwords or other questions about use of the NCC System is available through NCC User Support by calling one of the numbers at the beginning of this section.

Now a prompt will appear requesting your project code. When users register with the NCC, authorization is issued for one or more projects. Project codes enable the VAX Cluster accounting system to compute charges for computer time used. Enter your project code and press the Return Key.

Next, the VAX prompt '**$**' will appear, signifying that the user has successfully completed the log-on procedure. The VAX system will now receive and process commands. At this point, first-time users can now proceed to the HEM-II Tutorial.

Log-out Procedure

To end a session on the VAX, there are two options. Entering the command "**LOGOUT**" will provide users with full accounting information including session charges. Alternatively, entering the command "**LO**" will log the user off quickly and no accounting information will be displayed.

USING THE HEM-II USER INTERFACE

NOTE: If the user presses any key that is not correct or does not activate the desired response, two results are possible: either nothing will happen or the terminal will beep three times.

The User Interface is visually oriented and organized into two classes of computer screens: control menu screens and data entry screens. Menu screens enable the user to activate the desired data entry screens. The User Interface also records information that is dependent on the actual selection chosen from these menu screens. This information may be used by the TSS later to decide which program options to exercise or omit. The data entry screens then allow the user to enter all information for specific features. These data entry screens are compartmentalized so that each screen

shows a group of related data items that have the same level of detail.

Control Menu Screens

NOTE: The term "menu" used throughout this document is synonymous with control menu screen.

Some of the options that appear in the control menus will not be active in Version 1.3. If the user selects one of these inactive options, such as the Population Cohorts option on the POP Options Menu, the control menu will remain on the screen rather than branching to another menu or data screen. However, the terminal will beep and display a message in the user message area that the selected option is not yet implemented in the model software.

Data Entry Screens

The data entry screens in the User Interface of Version 1.3 of the HEM-II show all of the features that are available now as well as some planned for a future version. These presently inactive options are included to facilitate the screen design and to maximize the use of development funds by producing a completed working kernel of the interface in Version 1.3.

Data entry screens may consist of one or more data entry windows. Also, certain items in the data entry windows are given fixed values and currently cannot be edited. These include the Stochastic Processing options for the POP and BAC components. Specific examples of such options will be mentioned in the relevant discussions in this manual.

ON-LINE TUTORIAL WITH DEMONSTRATION STUDY

This tutorial is intended for the first-time user of the HEM-II. It will cover all of the features of the HEM-II, guide the user through the description and execution of a HEM-II study, and then produce reports and graphical outputs. The tutorial assumes that HEM-II is already installed on the VAX computer and that the directories and operating configurations have been set up by the VAX system manager for the user's account.

Typographical Conventions

To facilitate use of this tutorial as well as this user's guide, the following typographical conventions are used:

- The ☞ symbol indicates passages where specific steps that the user should perform are described. Intervening passages contain additional information important in understanding the HEM-II tutorial and actual model use.

- Computer menu titles and data entry window titles are shown in bold and all caps, e.g., **HEM-II MAIN MENU.**

- Specific selections on menu screens or items on data entry windows are shown in bold with initial caps and single quotation marks, e.g., **'Define a HEM Study.'**

- Actual commands or input to be entered by the user appear in bold and with standard (double) quotation marks when within text passages, e.g., **"HEM."**

- Left-margin notes provide important supplemental information for completing the tutorial and for using HEM-II.

NOTE: Important supplemental information for using HEM-II and completing the tutorial will appear here as a left-margin note.

Tutorial: Part 1

1. How to Begin.

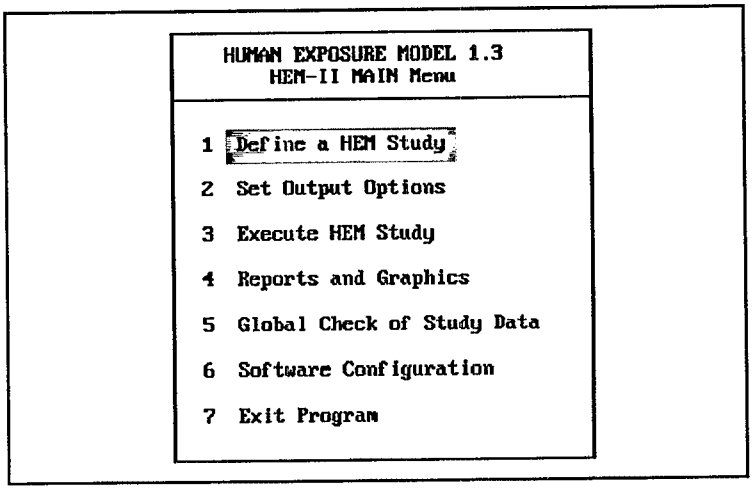
☞ To invoke the HEM-II User Interface from the VAX command level, type the command "**HEM**," or whatever symbol the system manager has designated to be used to execute the HEM-II model. The computer terminal screen will clear and the first control menu in the HEM-II User Interface (the **HEM-II MAIN MENU**) will appear.

Each control menu has up to seven options that can either be selected with a combination of the cursor keys and the Return Key or by typing the number that appears to the left of each selection. The following features apply to control menus:

- There is a title at the top of the control menu box to uniquely identify the menu.
- Each control menu will have a distinct title that will be used as a reference in this User's Guide.
- Additional information for the user will be presented in messages at the bottom of the computer screen.
- Error and warning messages also appear at the bottom of the screen in the event of inappropriate data.

Generally, in any control menu, the items will appear in the order that they should be selected to operate the model.

2. Here is the **HEM-II MAIN MENU.**



NOTE: The term 'HEM Study' is used to collectively denote all of the various data processing options and user-supplied data that create a modeling scenario.

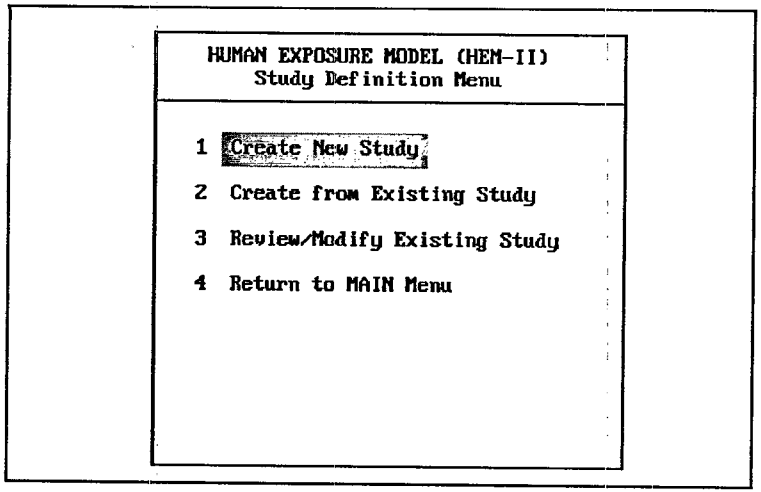
The first selection is '**Define a HEM Study.**' This will be the first step in creating the input files required to specify a HEM-II scenario. When HEM-II is started, the light bar first appears on selection 1 of the control menu, '**Define a HEM Study.**'

☞ At this time, either press the number **1** on the computer keyboard or press the Return Key to activate the subsystem of the HEM-II User Interface used to define a HEM-II study by keying in all user data.

3. Next, the **HEM-II STUDY DEFINITION MENU** appears.

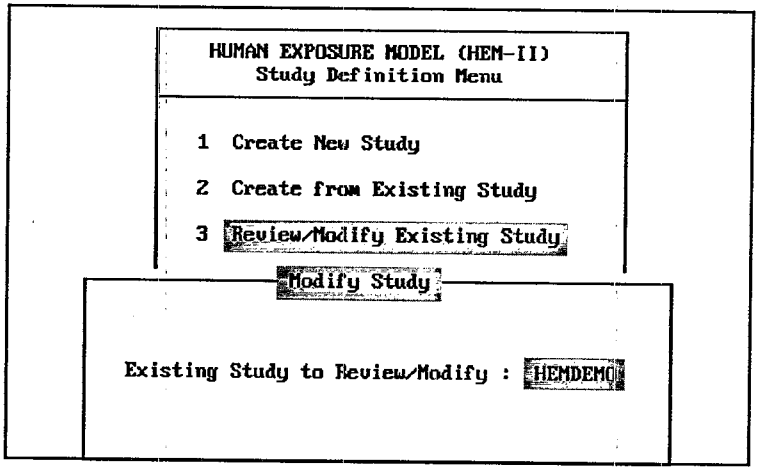
Three study definition options are given in this menu:

1. Create a new study,
2. Copy an existing study to one under a new name, and
3. Review or modify an existing study.



☞ Press either the number **3** or use the down arrow key to move the light bar to '**Review/Modify Existing Study**,' and press the Return Key.

A smaller window entitled **MODIFY STUDY** appears. The user is requested to enter the name of the HEM-II study to be used.

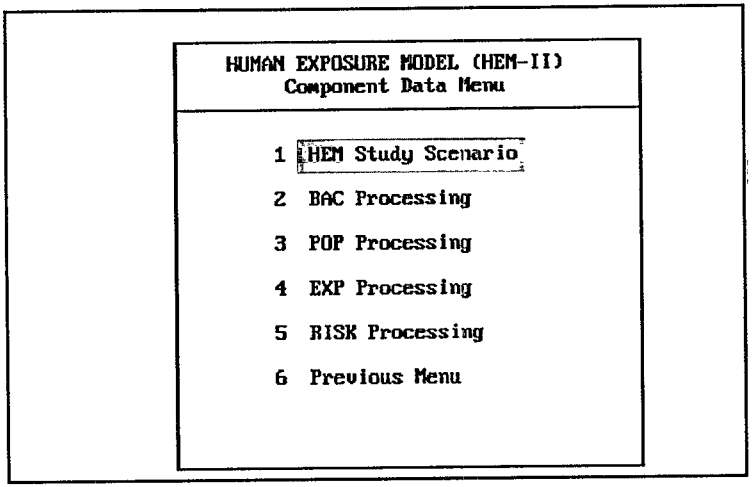


NOTE: Any combination of upper- and lower-case letters is acceptable for study names.

☞ Type in "**HEMDEMO**" and press the Return Key.

☞ Answer the confirmation prompt at the bottom of the screen by pressing the letter **Y** on the computer keyboard.

4. A control menu entitled **COMPONENT DATA MENU** will now appear on the screen.

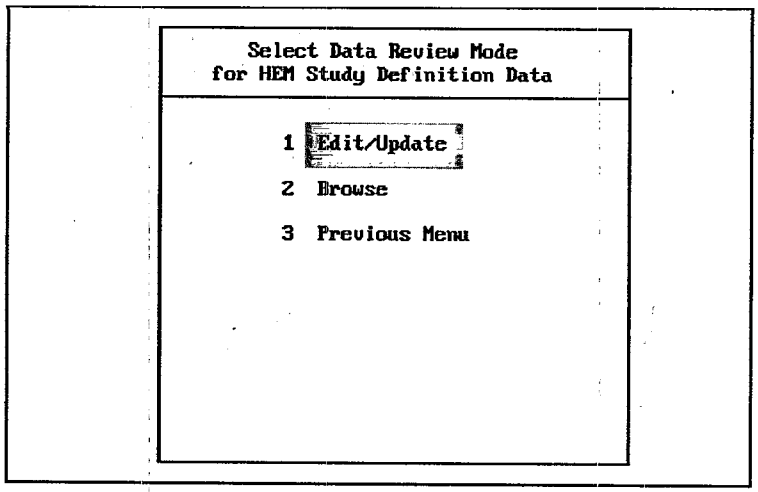


This is a central control menu that allows the user to navigate between the different data entry screens of the HEM-II User Interface corresponding to the various HEM-II components.

The first selection on this screen is '**HEM Study Scenario,**' and involves the universal processing options affecting all features of the HEM-II model.

☞ To review these, either press the number **1** or press the Return Key.

Another control menu, **SELECT DATA REVIEW MODE FOR HEM-II STUDY DEFINITION DATA,** will appear, allowing the user to enter the option to browse or edit/update for this session.

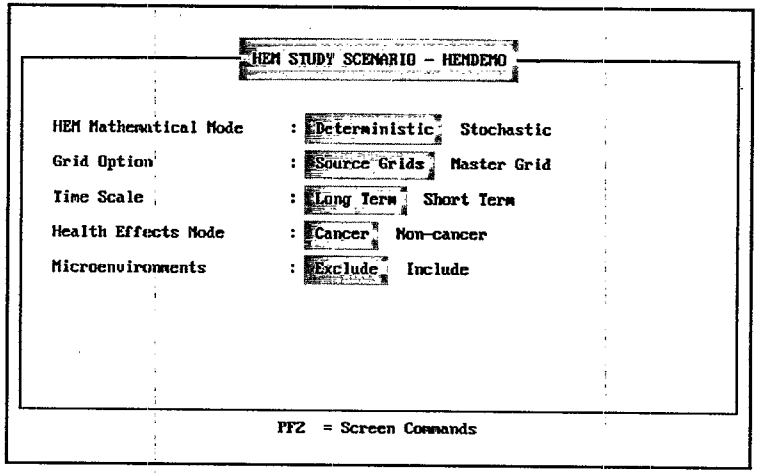


The browse mode allows the user to review the existing study without having to worry about inadvertently changing the data values in that study.

☞ For this tutorial, select **1** or use the cursor key to move the light bar down to '**Edit/Update**' and press the Return Key.

A data entry screen, framed in a rectangular box, appears. This is called a "window." The window title appears at the top of the screen.

5. The window **HEM STUDY SCENARIO-HEMDEMO** will appear.



NOTE: Certain options in some data entry screens have not yet been implemented in Version 1.3 of the model. In such cases, the user will not supply data for these items, and the User Interface will automatically skip these items.

NOTE: TSS = Technical Software System.

The cursor appears on the option **'Source Grids'** of item 2, **'Grid Option,'** because the first item, **'HEM Mathematical Mode,'** may not be selected until a later release of the model.

The grid option setting of source grids tells the HEM-II TSS to use the individual polar receptor grids of the various point sources to perform all calculations.

The master grid option allows the processing of very densely populated areas, which may exceed the memory limitations of the VAX computer.

☞ Leave the grid option setting at **'Source Grids'** for this tutorial.

☞ Now press the down arrow key once.

NOTE: The actual apprearance of bright or highlighted text may differ on some terminals.

6. The item selected is indicated by the bright or highlighted prompt title on the left of the screen that is now **'Microenvironments.'**

The option selected is **'Exclude'** for the HEMDEMO study, which is the default setting.

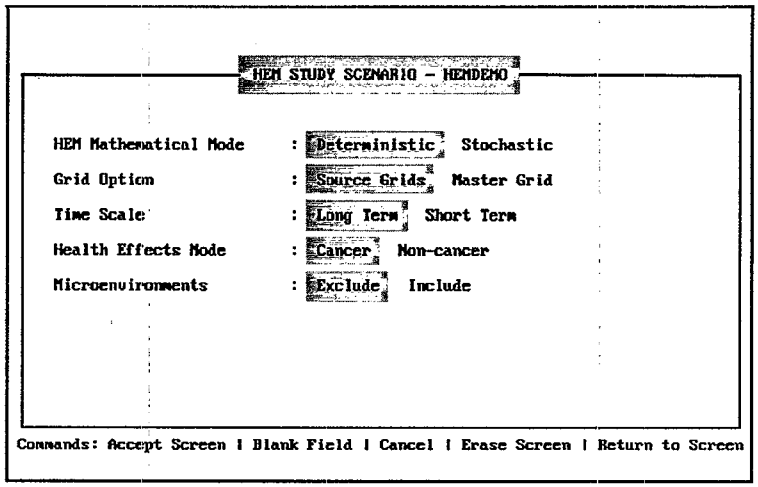
NOTE: Other details about microenvironments appear on pages 4-8 and 4-12.

'Microenvironments' offers a way to represent the day-to-day activity patterns of a population.

A message at the bottom of the screen indicates that the programmable function key PF2 should be used to perform screen commands (see the screen entitled **HEM STUDY SCENARIO-HEMDEMO** on the previous page).

*NOTE: For the rest of this tutorial, the phrase **'Accept this screen'** shall mean to use the PF2 and A key combination to accept the displayed screen information as it appears and then continue.*

☞ Press the Screen Command Key PF2. A line of options now appears at the bottom of the screen.



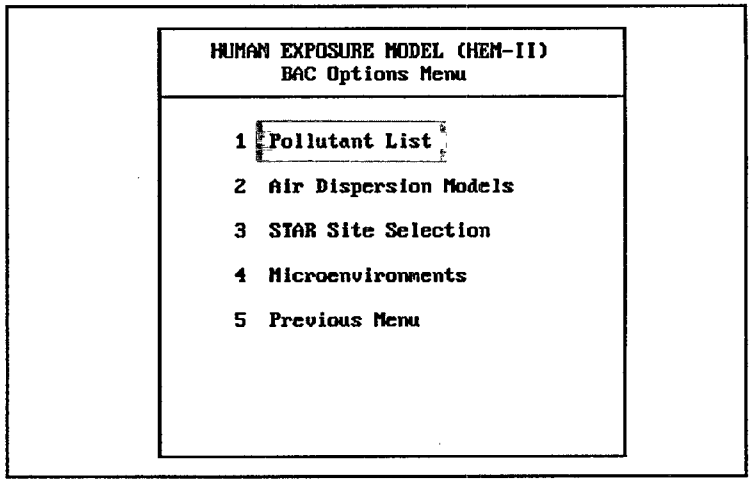
☞ To indicate that these data are complete and will be accepted, press the **A** key.

Data from that screen are now stored, and the **COMPONENT DATA MENU** now reappears on the screen.

7. Next the user will supply data for the Breathing Air Component (BAC).

☞ Do this by either pressing the number 2 or moving the cursor down one position to '**BAC Processing**' and press the Return Key.

A new control menu, **BAC OPTIONS MENU**, appears on the screen at this time.



The cursor highlights the first selection, '**Pollutant List**.'

The complete list of pollutants for any HEM-II study must be specified before any other data because all other data entry screens refer back to this pollutant list.

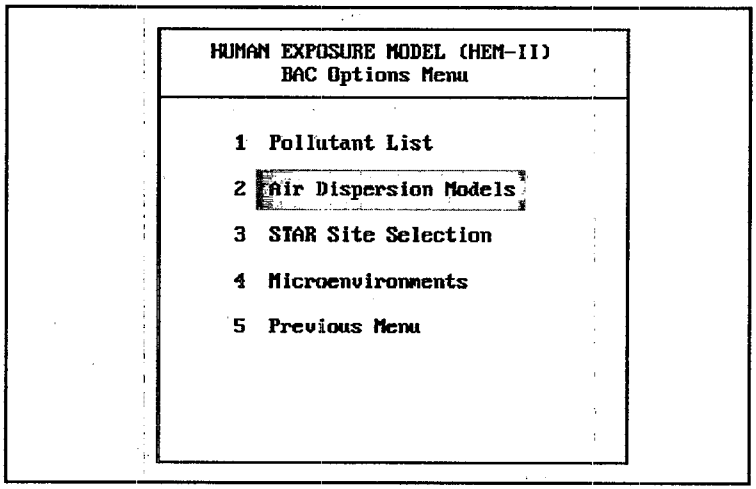
☞ With the light bar highlighting the first section '**Pollutant List**,' either press the number **1** or the Return Key to access the pollutant list data entry screen at this time.

NOTE: This and other simple screens are not depicted in this tutorial.

8. The window **HEM STUDY POLLUTANT LIST-HEMDEMO** now appears and contains two columns: '**Pollutant Name**' and the '**Atmospheric Decay Rate**.' Three pollutants have been defined for this study: chloroform, benzene, and styrene. The atmospheric decay rates are negligible and therefore have been left equal to zero.

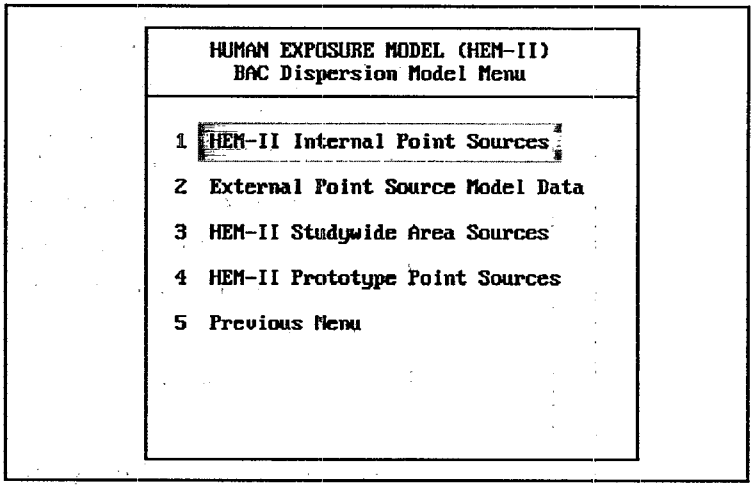
☞ Press the down arrow key three times. With the light bar in this position, the user could add additional pollutants to the list at this time. For purposes of this tutorial, do not add another pollutant. Press the PF2 key and then the **A** key to accept this screen.

9. The **BAC OPTIONS MENU** now reappears on the screen.



☞ To select the air dispersion model data portion of the User Interface, press the down arrow once and Return Key, or press the number **2**.

A new control menu, **BAC DISPERSION MODEL MENU**, which has four selections with an additional selection allowing the user to return to the previous menu when complete, will appear.



The first selection, '**HEM-II Internal Point Sources**,' is highlighted. Currently, this is performed by the

Industrial Source Complex Long Term (ISCLT) version of the model of the U.S. EPA's User's Network for Applied Modeling of Air Pollution (UNAMAP).

The second selection, '**External Point Source Model Data**,' allows the user to provide point source model data from other models external to the HEM-II modeling system.

Selections 1 and 2 are mutually exclusive.

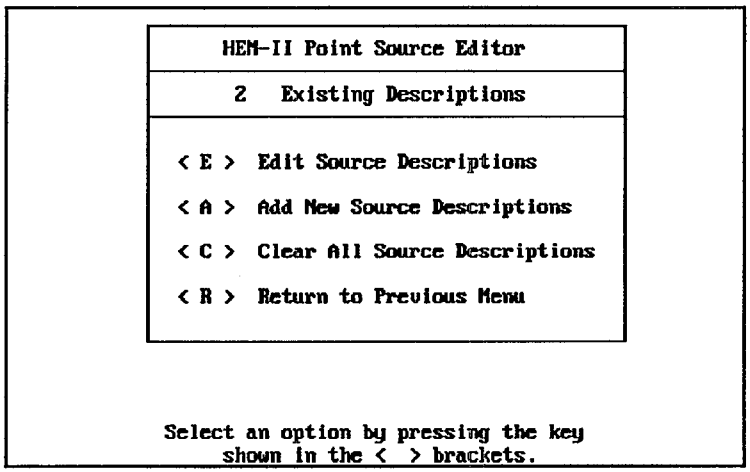
Selection 3, '**HEM-II Studywide Area Sources**,' allows use of the TOXBOX and Hanna-Gifford Area Source models that are built into the HEM-II model.

Selection 4, '**HEM-II Prototype Point Sources**,' will be implemented in a later version of the HEM-II model.

☞ To proceed to describe the HEM-II internal point sources, either press the number **1** or the Return Key.

10. The **HEM-II POINT SOURCE EDITOR** screen now appears. The second heading box on the Editor Screen indicates that there are two existing emissions point source descriptions.

NOTE: In the HEM-II User Interface, the point source description corresponds to a plant or facility, and the emissions point descriptions provide the detailed information about each stack, or other emission unit type, within that facility.



☞ Press the **E** key for '**Edit Source Descriptions.**'

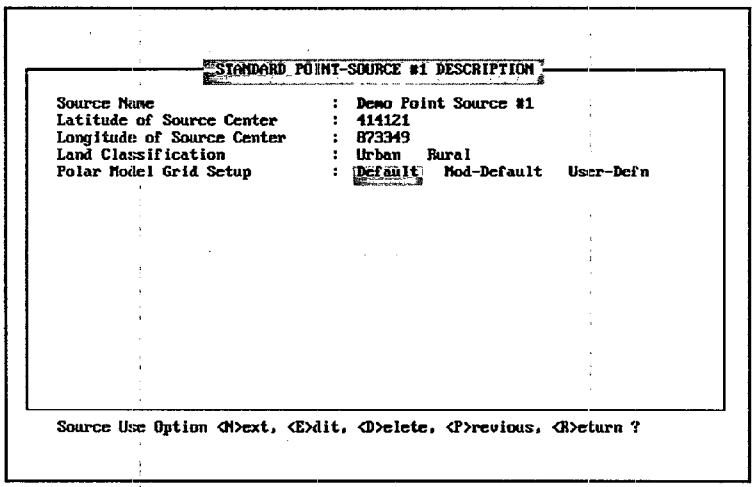
☞ A small window now appears allowing the user to specify the initial source to edit. Press the Return Key to accept the default: Source #1.

11. The data entry screens, which are used to supply data for the dispersion models, are organized as a series of nested windows and appear on the computer screen as a set of inset cards.

    Each of these windows has a title, and will be inset from the borders of the previous window that it occludes.

12. The first window that appears is entitled **STANDARD POINT-SOURCE #1 DESCRIPTION.** The name of the source is given along with its latitude and longitude, the land classification, and option for the specification of the polar receptor grids.

    With Demo Point Source #1, the Polar Model Grid Setup has the default option selected. This will tell HEM-II to run the ISCLT model with the standard set of rings and direction of radials typically used at the Pollutant Assessment Branch (PAB) of the U.S. EPA.



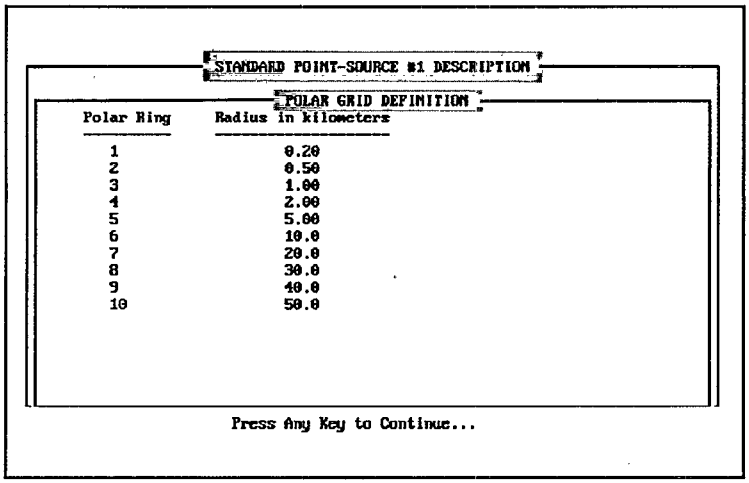
The **'Source Use Option'** at the bottom of the screen allows the user to either move to the next source, edit or delete the current source, or move to the next or previous screens. Single keystroke responses are used.

☞ Press **E** to edit point source #1.

☞ Press the down arrow key four times until the selection **'Polar Model Grid Setup'** is highlighted, with the cursor on the option **'Default.'** Press the Return Key.

NOTE: A nested window appears inset within a larger window.

Now a nested window appears on the screen called **POLAR GRID DEFINITION.**



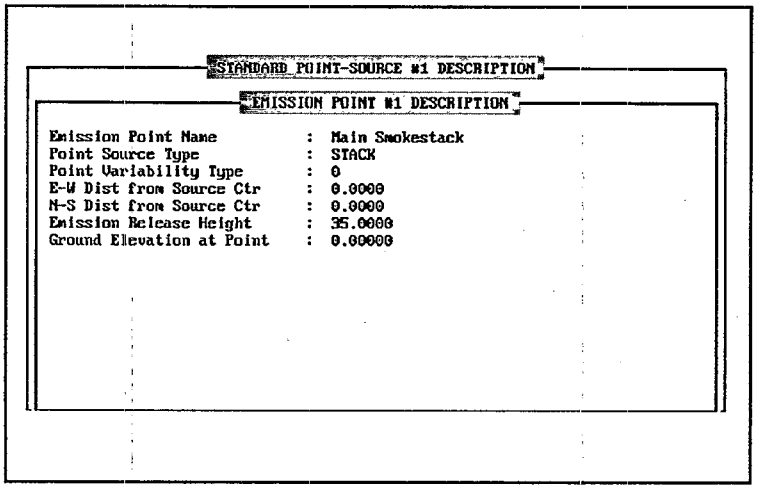
Because the default option has been selected, the user cannot alter these values; they now are displayed on the screen only for review.

☞ At the bottom of the screen is a message that says **'Press any key to continue...'** Press the space bar or any other key on the keyboard now to return to the source description window.

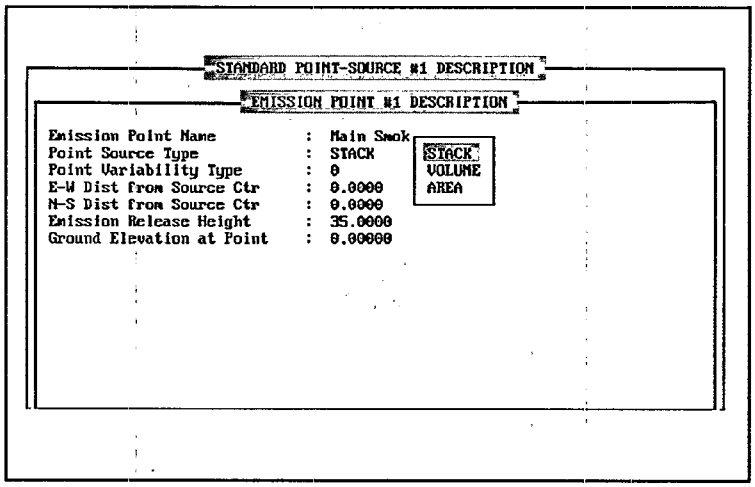
☞ Press the PF2 key and the **A** key to accept the **STANDARD POINT-SOURCE #1 DESCRIPTION** screen. Now, a new nested window appears on the

screen for the first emission point within point source #1.

☞ Select **E** to edit this emission point. The name of this emission point is '**Main Smokestack.**'

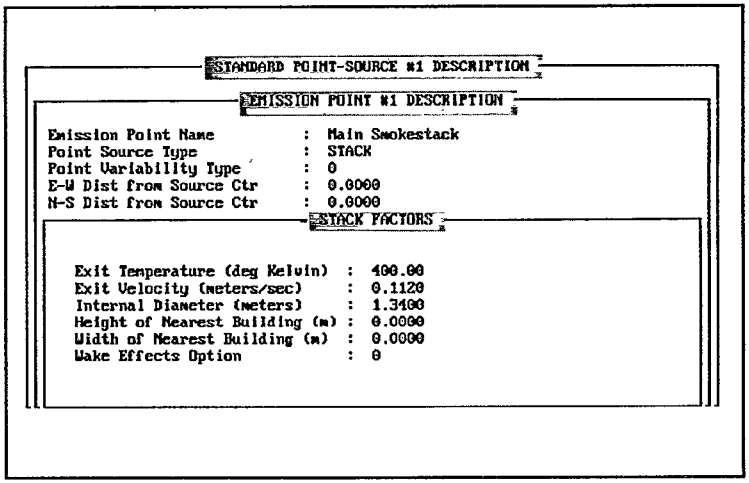


☞ Press the down arrow key one time to activate the item '**Point Source Type.**' You will now see a pop-up selector box on the **EMISSION POINT #1 DESCRIPTION** screen, which allows you to select either stack, volume, or area source processing within ISCLT.



☞ Leave the selection on **'Stack'** and press the Return Key.

13. A third-level nested data entry screen appears entitled **STACK FACTORS** and is specific to those values needed by the model for stack type emission points.



☞ Accept the values that are given by pressing the PF2 and **A** key combination.

NOTE: Emission point coordinates south and/or west of the source center are indicated with negative distances.

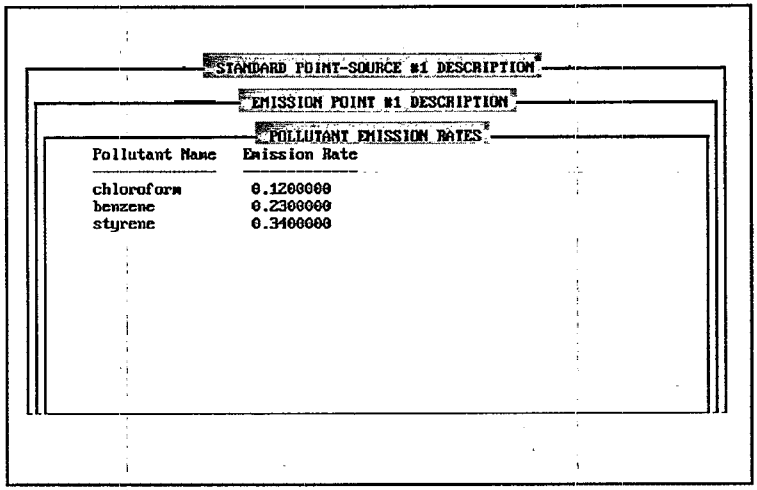
The user would next specify the location of each emission point in terms of positive and negative meters in the east-west direction or north-south direction relative to the latitude and longitude coordinates given for the center of this source.

The user can also give an emission release height, that corresponds to the stack height in this case.

☞ Press the PF2 and **A** key combination to accept emission point #1.

14. At this time, another nested window, **POLLUTANT EMISSION RATES**, will appear.

NOTE: Users should refer to the notice on p. ii of this guide for information on the use of styrene in this tutorial.



☞ Press **E** to edit these emission rates. Now the user can supply an emission rate in units of grams per second for each pollutant that is emitted from this stack. All three pollutants that the user listed appear in the **HEM STUDY POLLUTANT LIST**.

To designate that a pollutant is not emitted from this source, an emission rate value of zero would be used.

☞ All three pollutants are provided emission rates for emission point #1 of point source 1. Accept this screen to continue.

☞ The User Interface now provides the user the option of adding more emission points to this source description. Press **N** or the Return Key to continue.

☞ The User Interface now progresses to point source #2. Press **E** to edit this source.

☞ Press the down arrow key four times to the '**Polar Model Grid Setup**' selection.

☞ The light bar will be positioned on the selection '**User defn.**' Press the Return Key to review these user-defined options for polar grid definitions.

☞ In this option, the user is allowed to modify the values for the rings of the polar grid. After reviewing these values, accept this screen and continue.

☞ Upon return to the **STANDARD POINT SOURCE #2** window, press the PF2 and **A** keys again to accept that screen and move to **EMISSION POINT #1 DESCRIPTION.**

☞ Select **E** to edit the emission point, **'Big Stack.'**

☞ Move the light bar down to item 2, **'Point Source Type,'** and select **'Stack,'** by pressing the Return Key to review the values given for this emission point.

☞ Accept this screen to continue.

15. The **EMISSION POINT #1 DESCRIPTION** window will now reappear.

NOTE: Chloroform, the first pollutant on the list has the emission rate value 0.00. This indicates that chloroform is not emitted from this emission point.

☞ Press PF2 and **A** again to continue.

The user will now see the list of three pollutant emission rates.

☞ Press **N** to advance to the next screen.

The User Interface will now progress to emission point #2 of point source #2 named **'Little Stack.'**

NOTE: These emission points are located by using a positive or negative east-west distance or north-south distance in meters relative to the latitude and longitude coordinates, which were specified for the center of the point source #2.

☞ Press **E** to edit this emission point. Move the light bar down to item 2, **'Point Source Type'** and press the Return Key with the bar on **'Stack'** to review the **STACK FACTORS** window as done previously.

☞ Accept this screen and the **EMISSION POINT #2** screen will reappear.

Stack height is entered in meters in the '**Emission Release Height**' field.

☞ Accept this screen to continue.

16. The **POLLUTANT EMISSION RATES** window now appears for emission point #2 of point source #2. Note that only chloroform is emitted from this emission point, and the other two pollutants have a value of 0.00 as their emission rates.

NOTE: Because the default, N, is provided, the user should only press the Return Key.

☞ Press **N** or the Return Key to advance to the next screen.

☞ Enter **N** to add additional emission units to point source #2.

☞ The **HEM-II POINT SOURCE EDITOR** screen now reappears. Press **R** to exit point source editing and return to the **BAC DISPERSION MODEL MENU**.

17. You will now review the description of a different type of emissions source under the option '**HEM-II Studywide Area Sources.**' This selection is intended for modeling large-scale area sources, which are distributed throughout an entire geographic area. If point sources are included in the HEM-II study, they are assumed to be located within the geographic area defined by the studywide area source.

☞ To review a predefined area source in this demonstration, either press the number **3** or move the cursor down to move the highlight to '**HEM-II Studywide Area Sources**' and then press the Return Key.

The **HEM-II AREA SOURCE EDITOR** screen now appears. The second heading box on the editor menu indicates there is one existing area source description.

☞ Press **E** for '**Edit Source Descriptions**' and then press the Return Key to start with area source #1, the default.

A window entitled **AREA SOURCE #1 DESCRIPTION** now appears.

☞ Press the **E** key to edit this description.

The HEM-II uses two distinct internal area source models, the Hanna-Gifford and the TOXBOX.

An area source is described by giving the latitude and longitude of its center, the number of rectangular cells in the east-west and north-south directions, and the cell size to create a grid for the area source.

The source name of this studywide area source is '**Gasoline Stations As H-G Area Source**' and is modeled as a Hanna-Gifford area source.

☞ Move the cursor down until '**Area Source Model**' is highlighted and the light bar is now on the option '**Hanna-Gifford.**' Then press the Return Key or the down arrow an extra time.

NOTE: Only one pollutant, benzene is included for this area source.

A smaller nested window will appear on the screen entitled **AREA SOURCE POLLUTANT SELECTION LIST.** This smaller window will overlay the **AREA SOURCE #1 DESCRIPTION** window.

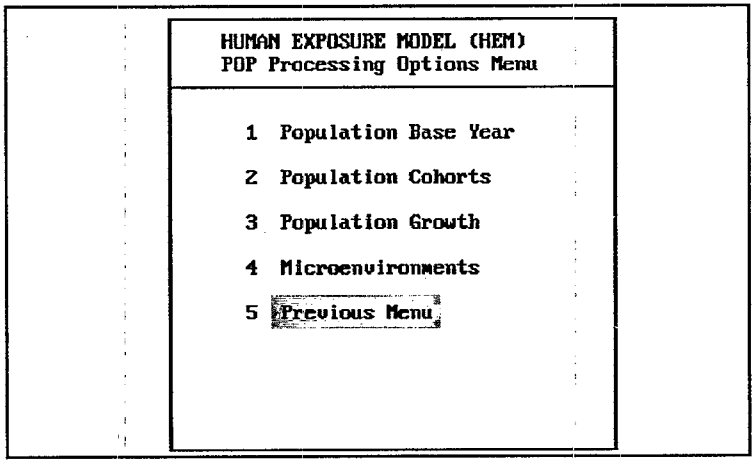
Again, this is to represent that this window, used for indicating the pollutant list, is related to the larger window entitled **AREA SOURCE #1 DESCRIPTION.**

☞ Accept this screen to continue.

Another nested window appears on the screen requesting information specific to the Hanna-Gifford pollutant description for benzene.

NOTE: The area-size-driven option is not available at this time.

- Currently all area source emissions are population driven and the pollutant emission factor is in units of grams per second per person in the study area. Accept this screen to continue.
- The User Interface returns back to the main **AREA SOURCE #1 DESCRIPTION** screen. Accept this screen.
- Press the Return Key to accept the default to answer **'No'** to the prompt to add more sources.
- The **HEM-II AREA SOURCE EDITOR** screen reappears. Press **R** to return to the **BAC DISPERSION MODEL MENU**.
- Now either press the number **5** or move the light bar down to the **'Previous Menu,'** then press the Return Key to exit the **BAC DISPERSION MODEL MENU** and return to the **BAC OPTIONS MENU**.
- Do this again to return to the previous menu, the **COMPONENT DATA MENU**.
- Move the cursor key down to **'POP Processing'** and press the Return Key. The **POP PROCESSING OPTIONS MENU** appears on the screen at this time.

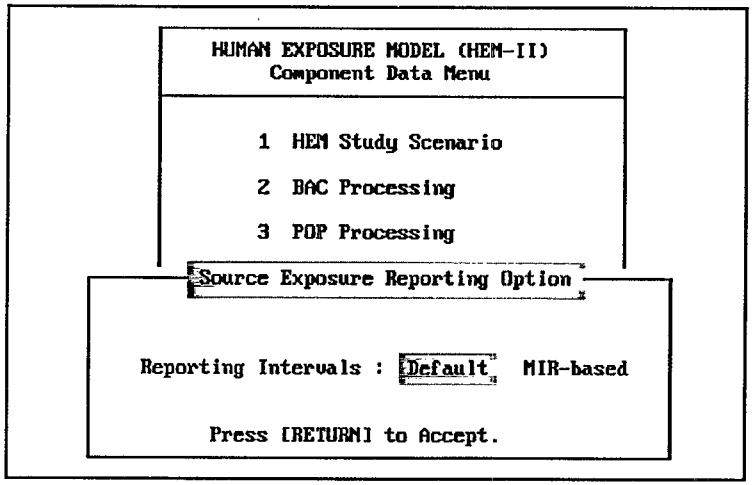


Observe the selections on this screen. No changes will be made because this tutorial uses all the population processing defaults.

☞ At this time, return to the previous menu, the **COMPONENT DATA MENU**.

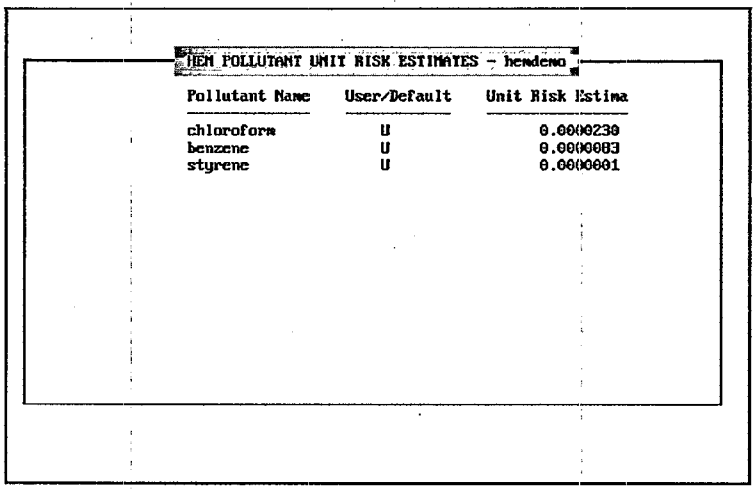
☞ Move down to selection 4, **'EXP Processing.'** Either press number **4** or move the light bar and press the Return Key.

☞ Two options appear in the **SOURCE EXPOSURE REPORTING OPTION** window, **'Default'** and **'MIR-based.'** Accept the default by pressing the Return Key.



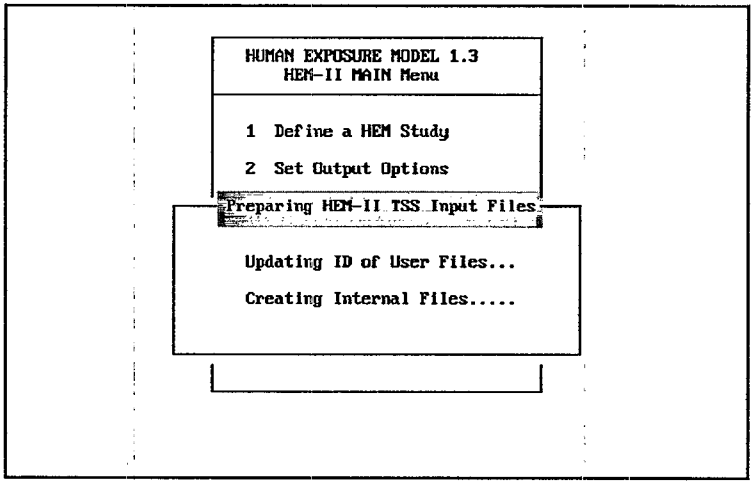
☞ Now move the light bar down to **'RISK Processing'** and press the Return Key.

☞ Another window appears on the screen entitled **HEM POLLUTANT UNIT RISK ESTIMATES — hemdemo**. Review the unit risk estimates and then accept the screen.



☞ This now completes the description of the demonstration study. Now move the cursor until **'Previous Menu'** is highlighted on the **COMPONENT DATA MENU** and press the Return Key.

18. Now the User Interface returns to the **HEM-II MAIN MENU**. However, it performs an additional step indicated by the small window in the center of the screen that is entitled **PREPARING HEM-II TSS INPUT FILES**. These are the actual files that the technical model system will use for input.

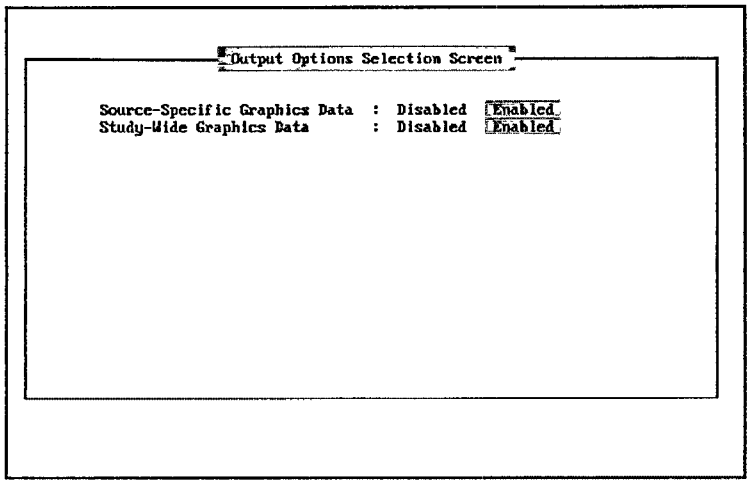


19. With the **HEM-II MAIN MENU** on the screen. The next step is to specify ouput options.

☞ Move the cursor down to selection 2 called '**Set Output Options**' and press the Return Key.

☞ A small window indicating the study name '**HEMDEMO**' now appears. Press the Return Key to accept this screen.

The **OUTPUT OPTIONS SELECTION SCREEN** now appears.



☞ Verify that both options are '**Enabled**' and accept this screen. These will be used at a later time to demonstrate the HEM-II graphics capability.

20. The **HEM-II MAIN MENU** now reappears.

☞ Now move the cursor down to '**Execute HEM Study**' and press the Return Key.

☞ Another small window appears to enable verification that the name of the study is retained, so just press the Return Key to execute the study HEMDEMO at this time.

The HEM-II study will be executed in the batch mode as a separate process from the User Interface and model execution will continue even after the user exits the HEM-II User Interface.

The message, **'WARNING: DO NOT RE-EDIT until execution has completed!!!'** will appear, accompanied by three audible beeps.

NOTE: The message 'FORTRAN STOP&' with the cursor now appear outside the HEM-II MAIN MENU.

☞ Move the cursor to **'Exit Program'** or press **7** at this time to leave the User Interface.

The user should now wait until the HEM-II study has completed execution before changing any values in this particular study. The user can monitor the progress of the execution of the study either by observing the VAX system batch queue using VMS commands or by observing a log file that is created as the study is executed. These log files are informative for additional purposes. They will indicate any warning messages or error conditions that would indicate either an incorrectly specified modeling parameter or some other VAX system problem that may influence successful completion of the model execution.

☞ Use the VAX VMS command **"SHOW QUEUE SYS$BATCH"** and press the Return Key to observe the VAX system execution queue. The job name HEMDEMO is the study that was just submitted for execution. When this disappears from the batch queue, the execution is complete, and HEM-II reports and graphics may be created from the completed tutorial demonstration study.

Tutorial: Part 2

NOTE: Version 1.5 of HEM-II has added a convenient means for checking the log files directly from the HEM-II MAIN MENU.

1. Now the user can verify that the study was successfully processed by checking the log files produced as the Technical Software System (TSS) is executed.

☞ The main log file, HEM_HEMDEMO.LOG, may be observed by entering the following command:

TYPE HEM_HEMDEMO.LOG

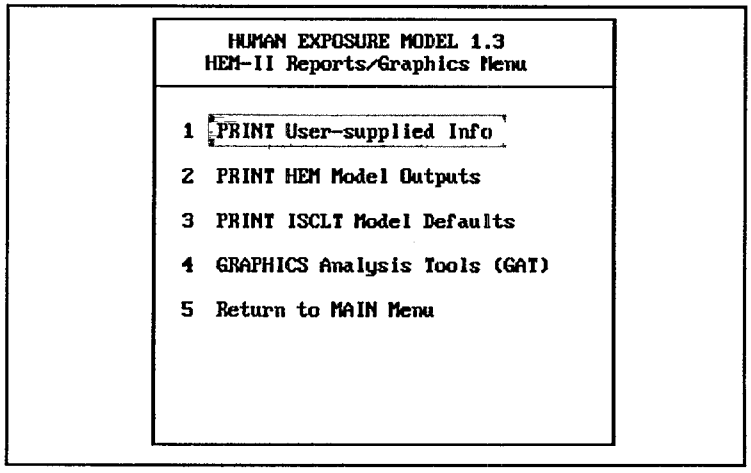
If the run was successful, the following message appears in the log file: **'HEM-II Study Processing Now Complete.'**

If errors occurred during the execution of the TSS, corresponding diagnostic messages will appear in either the main log file or one of the component log files. The main log file will direct the user to the appropriate component log file where the error occurred.

☞ If the software is correctly installed, the HEMDEMO study should be processed without any error conditions. Verify this by issuing the above VAX command to display the main log file on the terminal. If errors occurred, contact your VAX system manager; otherwise continue.

☞ The TSS has now processed the study scenario and produced measures of human exposure and risk. Restart the User Interface with the command, **"HEM."** Now select option **4** from the **HEM-II MAIN MENU, 'Reports and Graphics,'** to observe the results of the TSS execution.

The **HEM-II REPORTS/GRAPHICS MENU** will now appear on the screen.



NOTE: The NCC system configuration for plotting metafiles is being evaluated. Users should contact Mike Dusetzina before generating hard-copy plots on the system. This does not affect generating on-screen graphics or metafiles. HEM-II graphics metafiles also may be downloaded from the NCC system to generate hard-copy plots if desired.

☞ Option 1, **'Print User-supplied Info'** prepares printed reports of all of the data provided by the user in the data entry screens. Select option **2** at this time to prepare printed reports of the TSS results.

☞ A nested window, **REPORT HEM MODEL OUTPUTS**, appears requesting the user to input the study name. Type in the name, **"HEMDEMO."** Press the Return Key to accept the study name. A message will appear that reports are being sent to the system printer.

Four reports will be printed, identified as follows:

- Source-specific Maximum Concentration Report,
- Source-specific Exposure/Risk Report,
- Source-group Exposure/Risk Report, and
- Study Exposure/Risk Report.

2. Now you can see the **GRAPHICS Analysis Tools (GAT)** option of HEM-II. Choose selection **4** from the **HEM-II REPORTS/GRAPHICS MENU** to chain to the separate GAT system.

The **GAT MAIN MENU** should appear on the screen. If GAT is not correctly installed on the VAX computer or the GRAFkit® software is not enabled the following message will appear:

Cannot Proceed.
Logical Value GK_TRN not set!
ERROR: GRAFkit not properly installed.
FORTRAN STOP.

If this error occurs, first verify that the GRAFkit® procedure file GK_SETUP.COM has been executed with the following command:

@GK_SETUP

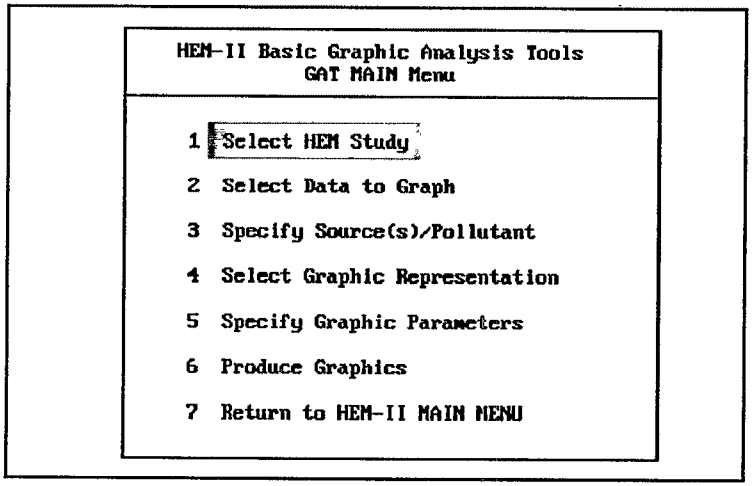
(Preferably this should be executed from your LOGIN.COM procedure file.) If GK_SETUP has

been run and this error persists, contact your VAX system manager.

☞ If this procedure was successful, the message **'GRAFkit 3.1 is now setup for VAX/VMS'** will appear. Now input **"HEM"** after the '$' prompt.

☞ The **HEM-II MAIN MENU** will reappear. Choose selection 4, **'Reports and Graphics,'** to obtain the **HEM-II REPORTS/GRAPHICS MENU**, and then select option **4, 'GRAPHICS Analysis Tools (GAT)'** to chain to the GAT Menu.

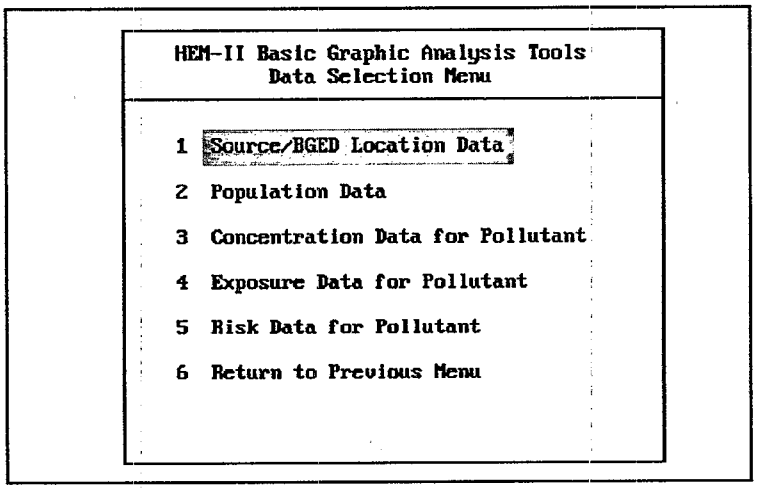
The **GAT MAIN MENU** is now on the computer screen. As in other HEM-II menu screens, the options should be selected to specify the information to present graphically and to indicate what graphical representation is desired.



☞ Choose selection **1** and enter the name of the study, **HEMDEMO.**

Another small window, **READING STUDY DESCRIPTION** appears briefly with four items.

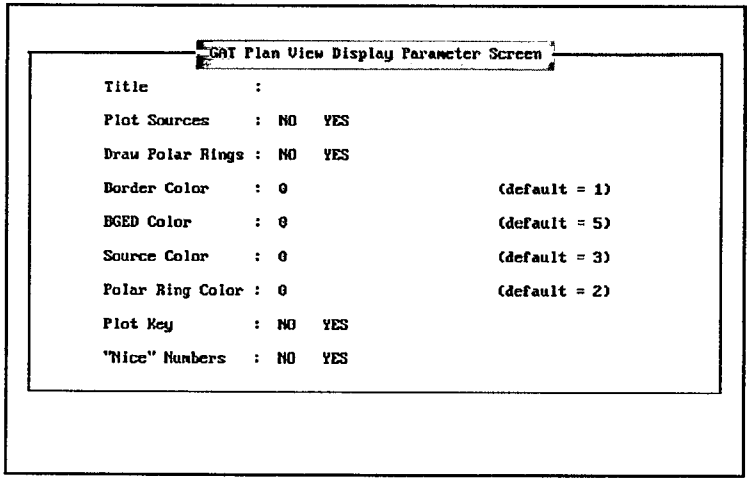
☞ Now choose selection **2, 'Select Data to Graph.'** Then select **'Source/BGED Location Data'** from the **DATA SELECTION MENU.**



Another small window stating what will be presented appears briefly and then the **GAT MAIN MENU** will return to the screen.

☞ Selections 3 and 4 do not pertain to location data; therefore, select option **5, 'Specify Graphic Parameters.'** GAT will now load the studywide graphics data set to determine the geographic extent covered by the demo study.

The **GAT PLAN VIEW DISPLAY PARAMETER SCREEN** will now appear with various options to control the appearance of the Source/BGED Location Data plot.



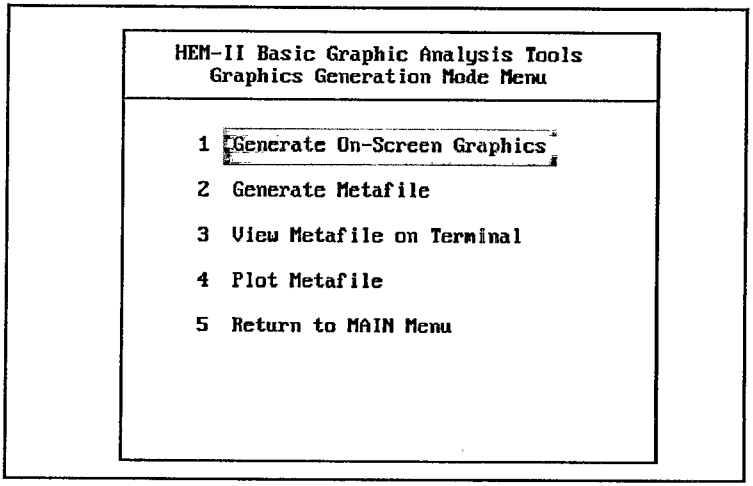
☞ Supply a title for the plot type by typing in:

BGED/SOURCE LOCATIONS FOR HEMDEMO

☞ Then accept this screen.

3. The **GAT MAIN MENU** will reappear.

☞ Now select option **6, 'Produce Graphics.'** The **GRAPHICS GENERATION MODE MENU** will now appear on the screen. Select option **1, 'Generate On-Screen Graphics.'**



A message window appears stating that the GRAFkit® Interactive Mode is being invoked.

NOTE: Both graphics data file options are enabled.

A cartesian plot over latitude and longitude will now be generated on the terminal. Each BGED will be indicated as a point. Area source and point source centers are represented by a plus sign, '+', and an asterisk, '*', respectively. Point source polar grid radii are shown as well.

NOTE: This is depicted in Figure 5-1 on p. 5-26 of this guide.

☞ When graphics generation has completed, the prompt **'<READY>'** is displayed in the top left-hand corner of the screen. When you are finished viewing this graphic, press the Return Key to go back to the **GRAPHICS GENERATION MODE MENU.**

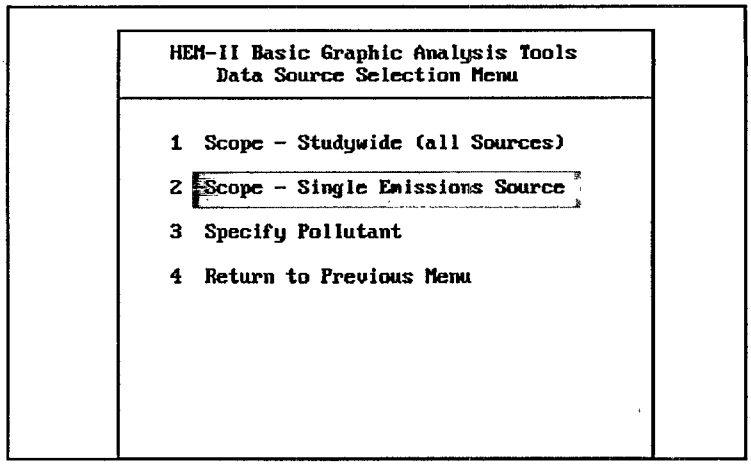
☞ Now select option **2, 'Generate Metafile,'** and provide a name to use for storing the graphical image. Once the metafile is generated, it may be redisplayed with option 3, plotted on a hard-copy plotter using option 4, or downloaded from the VAX computer into a PC-based desktop publishing system by use of Kermit file transfer software. The graphics in this manual were prepared in this manner.

☞ Return to the **GAT MAIN MENU** by selecting option **5.**

4. The **GAT MAIN MENU** should reappear.

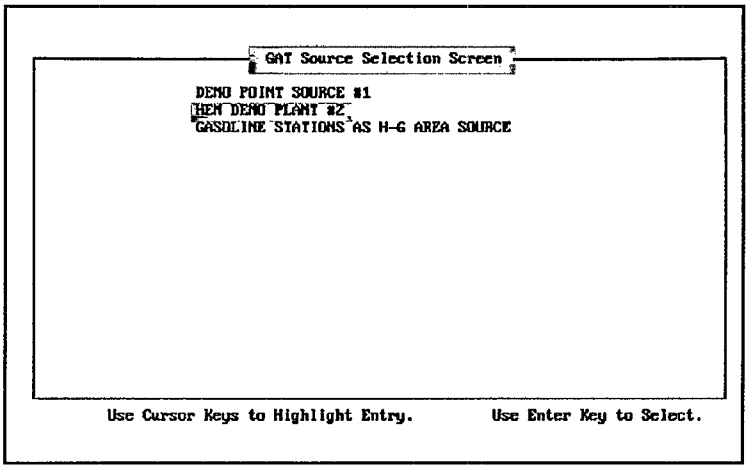
☞ Choose option **2, 'Select Data to Graph,'** and then option **3, 'Concentration Data for Pollutant'** from the **DATA SELECTION MENU.** A small window appears briefly stating that pollutant concentration data are selected for graphics and then the **GAT MAIN MENU** reappears. Now pick option **3, 'Specify Sources(s)/Pollutant.'**

The **DATA SOURCE SELECTION MENU** now appears.



☞ Pick option **2**, '**Scope - Single Emissions Source**' to display concentration data for a single user-selected source.

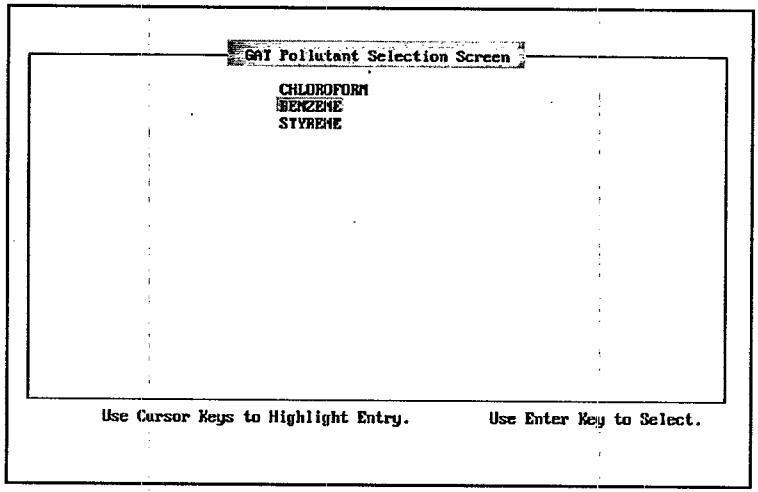
The **GAT SOURCE SELECTION SCREEN** now appears.



☞ Use the cursor and return keys to select '**HEM Demo Plant #2.**'

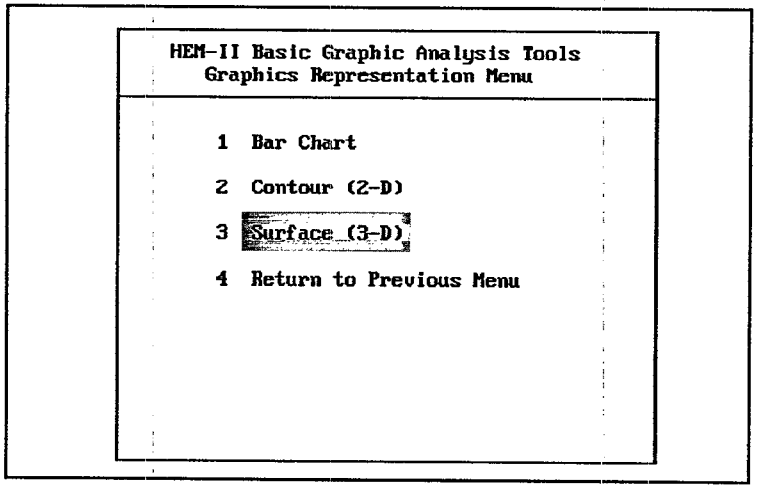
☞ The **DATA SOURCE SELECTION MENU** reappears. Now select option **3**, '**Specify Pollutant.**'

The **GAT POLLUTANT SELECTION SCREEN** will appear on the screen.



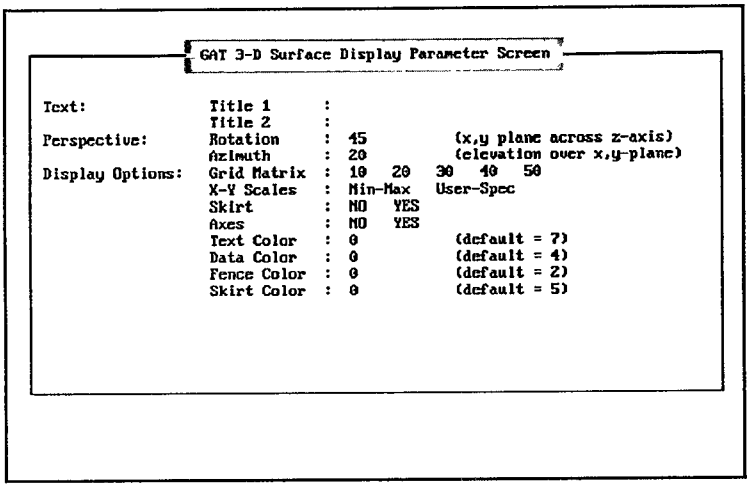
☞ Select '**Benzene**' as the pollutant to display concentration data for with the HEM Demo Plant #2. After the **DATA SOURCE SELECTION MENU** reappears, select option **4** to return to the **GAT MAIN MENU**.

☞ Choose option **4**, '**Select Graphic Representation**,' from the **GAT MAIN MENU**. Next, choose '**Surface (3-D)**' from the **GRAPHICS REPRESENTATION MENU**.



A small window will appear briefly verifying this selection.

☞ When the **GAT MAIN MENU** reappears, choose option **5**, **'Specify Graphic Parameters'** to load the source-level graphics data set. Review the display options for the 3-D surface representation. Supply a title for the graphic and then accept the screen.



NOTE: This is depicted in Figure 5-4 on p. 5-27 of this guide.

☞ Now select **'Produce Graphics'** from the **GAT MAIN MENU. The GRAPHICS GENERATION MODE MENU** will appear again. Select option **1**, **'Generate On-Screen Graphics,'** to invoke the GRAFkit® Interactive Mode and display the concentration isopleth.

☞ When graphics generation has completed, the prompt **'<READY>'** appears in the top left-hand corner of the screen. When you are finished viewing this graphic, press the Return Key and the **GRAPHICS GENERATION MODE MENU** reappears.

5. Try other combinations of graphics data, graphical representations, and display options to familiarize yourself with the capabilities of the GAT system. This is done by returning to step 4 in Part 2 of this

tutorial and selecting different options, some of which may not yet be enabled.

☞ When you are finished, select option **7**, '**Return to HEM-II Main Menu**' from the **GAT MAIN MENU**. From the **HEM-II MAIN MENU**, exit this HEM-II session by selecting option **7**, '**Exit Program.**'

This concludes the HEM-II Tutorial.

SECTION 3
THE HEM-II USER INTERFACE

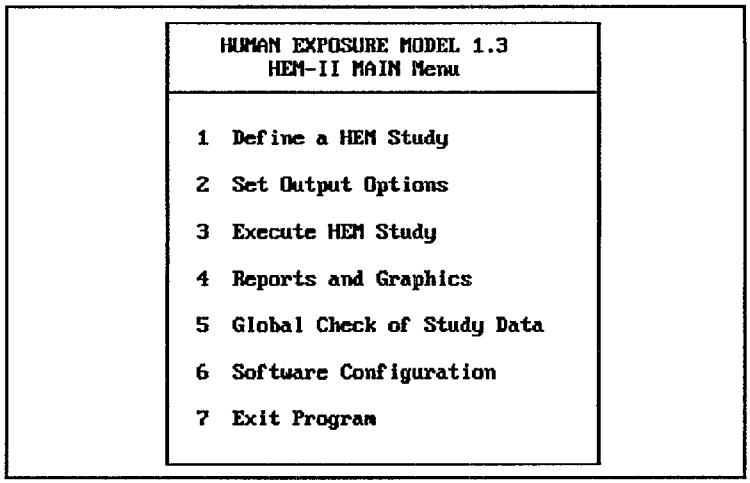
Section 3 will acquaint the user with the mechanics of operating the User Interface. In this section, a conceptual model of the User Interface is presented. A general description of various features of the Interface is given along with explanations of editing key functions. Specific details on the functions of menu choices are described in Sections 4 and 5.

CONTROL MENU SCREENS

Control menu screens, in general, are computer screen listings of the available alternatives at each point in the operation of a computer program. Control menu screens provide a way to select program processing options, leading the user through a hierarchical arrangement of major and subordinate control menus. These are often referred to as the control system of a software program because they allow the user to control the sequence of the appearance of the various menu and data entry screens.

The information that is supplied by the user in the menu control system is stored in the Study Definition Data Files. These control data are used later in the execution of the Technical Software System (TSS) to enable or disable optional technical processors such as population growth.

The control menu screen that occupies the highest position in this tree-structured hierarchy is called the Main Menu. This is the first computer screen that the user sees when the program is started, as well as the last upon completion of a HEM-II session. The **HEM-II MAIN MENU** appears as follows.



The diagram in Figure 3-1 shows the hierarchical structure of the HEM-II control menu screens.

DATA ENTRY/REVIEW SCREENS

Data entry screens are used to supply the character, numeric, and logical data with which the User Interface software then uses to builds the data files. These data files serve as input to the technical modeling segment of the system (i.e., the TSS). The mechanisms of data entry are discussed further under Data Entry.

The HEM-II User Interface offers a browse mode that allows the user to rapidly review the data in an existing study. Additionally, the data can be reviewed without making inadvertent changes in the existing data values. The **REVIEW MODE MENU** is displayed immediately after making a selection from the **HEM COMPONENT DATA MENU.**

NOTE: All discussions in this manual pertain to the Edit Mode.

After selecting the browse mode, the user can display the subsequent menus and data screens in a fashion similar to the edit mode. The data screens are presented along with current values. However, instead of entering a full-screen editing mode, the message **'Press Any Key to Continue...'** is displayed in the user message area at the bottom of the screen. When the user depresses any key on the terminal keyboard, the next data screen in the

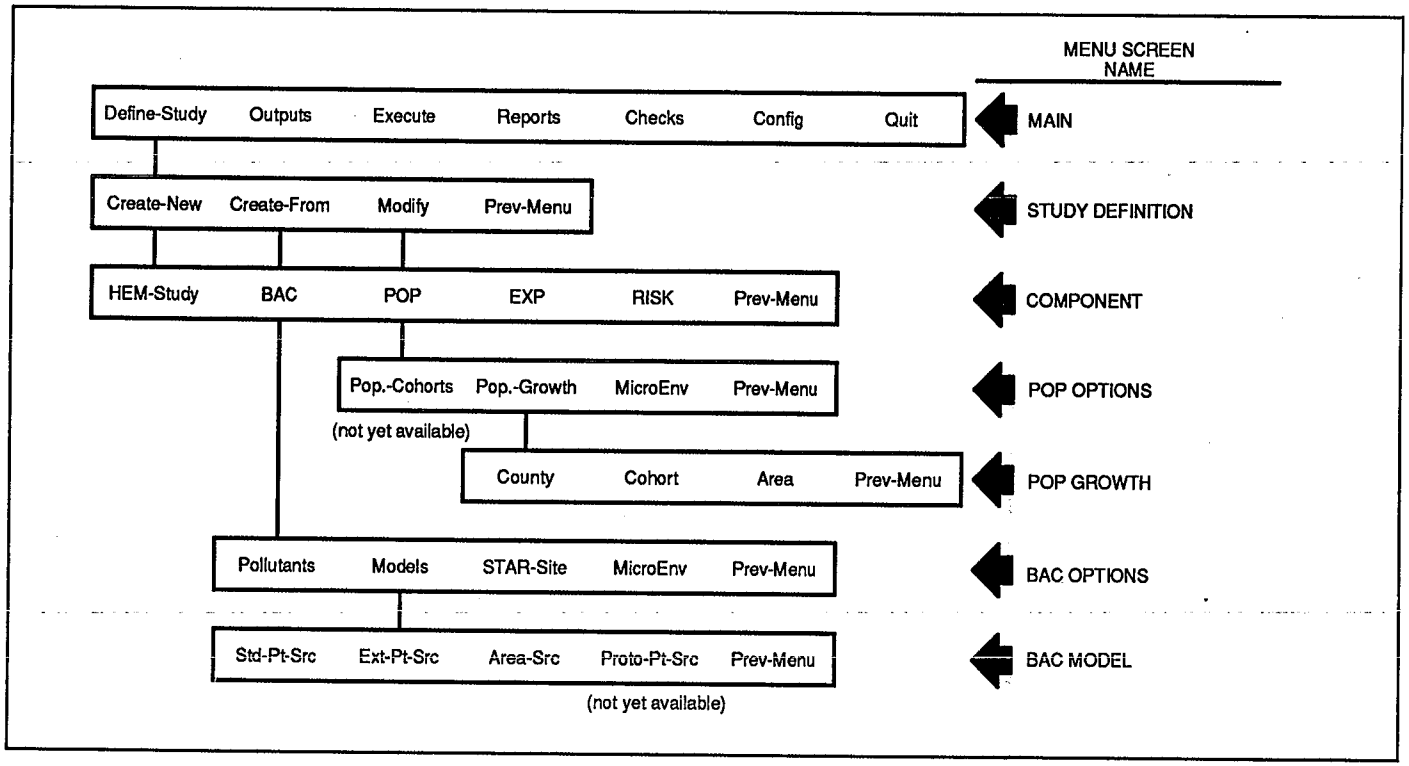


Figure 3-1. HEM-II Control Menus.

series will be displayed. This operation continues until all screens in a given series are displayed.

DATA ENTRY

Screen Conventions

Several conventions are followed throughout the HEM-II User Interface to provide a consistent manner for the user to find screen and window titles, messages, warnings, and error conditions.

- Messages will always appear on the last three lines of the terminal screen.
- The last line of the terminal screen will be reserved for warnings, error messages, and command status messages and indicators.
- Individual screens will be identified by a screen title at the top of a rectangular box (a "window"), which is used to mark the user's "working area."
- Whenever the message, **'Press Any Key to Continue...'** appears on the screen, the program will pause until the user has reviewed the information on the screen and depresses any key on the keyboard to allow program execution to continue.

Screen Windows

Screen windows are used to group data items that are related topically and possess the same level of detail. For example, all of the general data that describe an emissions source are contained in one window, and each individual emissions point within this source has a corresponding window. Subordinate windows are indicated visually on the computer screen; windows that correspond to a lower level on the data hierarchy appear indented and nested within the associated higher-level window, wherever possible.

Each window has a title located on the top line of the rectangle that forms its perimeter. The window title will be used to refer to this User's Guide.

Study Data Entry

HEM-II data are entered either by keystroking the requested information or by using the cursor to select from alternatives. For keystroke data entry, data entry fields are shown on the screen as a reverse video-shaded block. The length of the shaded block indicates the maximum length of input that can be accepted.

NOTE: A terminator key means the Return (Enter) Key or Cursor Keys.

Some requests for user keystrokes do not require the additional depressing of the tab or return input terminating keys. Examples are pauses in execution when messages such as **'Press Any Key to Continue...'** or **'Is the Above Correct (Y/N)?'** appear on the screen. For the sake of consistency, all selections that require the user to press a terminator key will highlight the entry field (or default value) in reverse video. This allows the user to confirm critical selections before continuing. This distinction is clearer if the user selects the use of the underline cursor in the terminal set up rather than the reverse video blinking block cursor.

Wherever a default data value appears in an entry field, that value will be accepted as the user response simply by depressing the Return Key on the terminal keyboard. Data that have been supplied by the user in previous editing sessions will appear as defaults when those data are updated to avoid redundant data entry.

A keystroke error occurs when data of the wrong type are entered, such as text where integers are expected. Keystroke errors are indicated by three beeps on the terminal. This distinguishes an error from the single beep heard when the maximum input width of an entry field is reached.

The user is prompted to enter a value by highlighting the item description. The item description is text explaining of the model variable

for which the user is to supply a value. The width of the shaded data entry area to the right of the description indicates the maximum number of characters or digits.

In some instances, multiple entries of data of a similar type are required. The user will be presented with a matrix to fill in, similar to the operation of an electronic spreadsheet.

The following editing keys are used:

Editing	*backspace*	Erase character to the left.
	left/right arrows	Move cursor between characters within a field.
Horizontal Movement	*tab*	Advance to the next column (staying on the same row).
	return	Advance to the next column (advancing to next row).
Vertical Movement	*up/down arrows*	Move to previous or next row.
	return	If in last column, move to first column of next row.

When data are to be selected by cursor, a predefined list of options is displayed horizontally on a single row of the screen display, similar to an electronic spreadsheet menu. The current value of that data item appears in reverse video when highlighted. The user positions the light bar to the desired selection using the left-right cursor keys (or tab). The user then accepts the selection by pressing the Return Key.

If the list of alternatives is relatively long (i.e., more than four items), a small framed pop-up window appears adjacent to the data entry field on the screen. This pop-up window presents a vertical list of the allowed values for this field with the current setting highlighted. The user positions the light bar

to the desired selection using up and down cursor arrow keys, and then accepts the value by pressing the Return Key.

Data Validation

User-supplied data are checked for correctness and consistency by several mechanisms:

1. At the completion of every data entry screen, the user must press the Screen Command Key, PF2, and then press the **A** key to indicate that the data shown are correct and should be accepted.

2. The program tests for data interdependencies between the fields on the screen.

3. Certain fields from different data entry screens are tested at the system level for consistency.

4. After data entry is completed, the user may execute a data check across all of the HEM-II Study Definition Files by using the **'Global Check of Study Data'** option from the Main Menu (see Section 4).

User Interface Organization

Figures 3-2 through 3-4 display menu trees for the HEM-II User Interface. These menu trees illustrate each control menu as a narrow horizontal rectangle listing all of the user options presented on that particular control menu. The vertical connecting lines then show the cause-and-effect interconnection of these control menus. The bottom level of the menu tree diagrams concludes in either a set of specific data entry screens or other control menus that have no lower levels or are not implemented in HEM-II. Data entry screens are depicted as rectangular boxes to distinguish them from control menus.

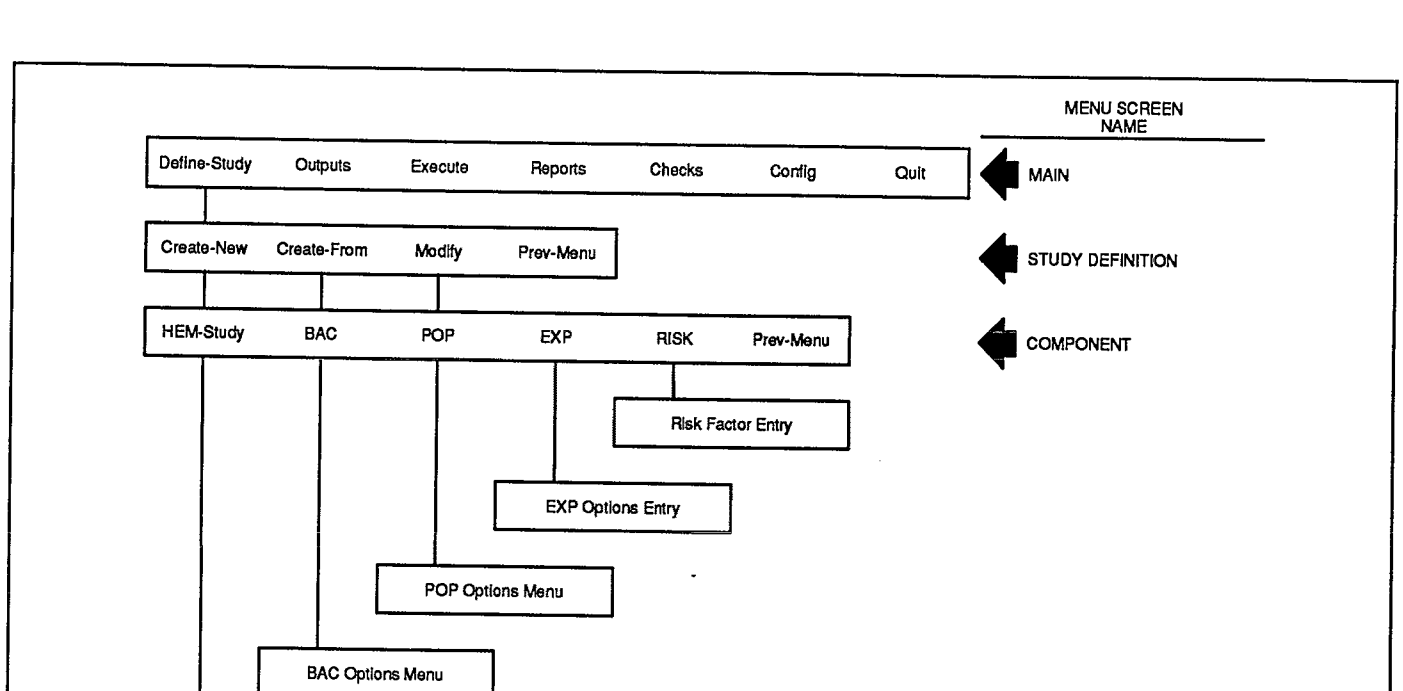


Figure 3-2. HEM-II Control Menu Diagram for Main Menu

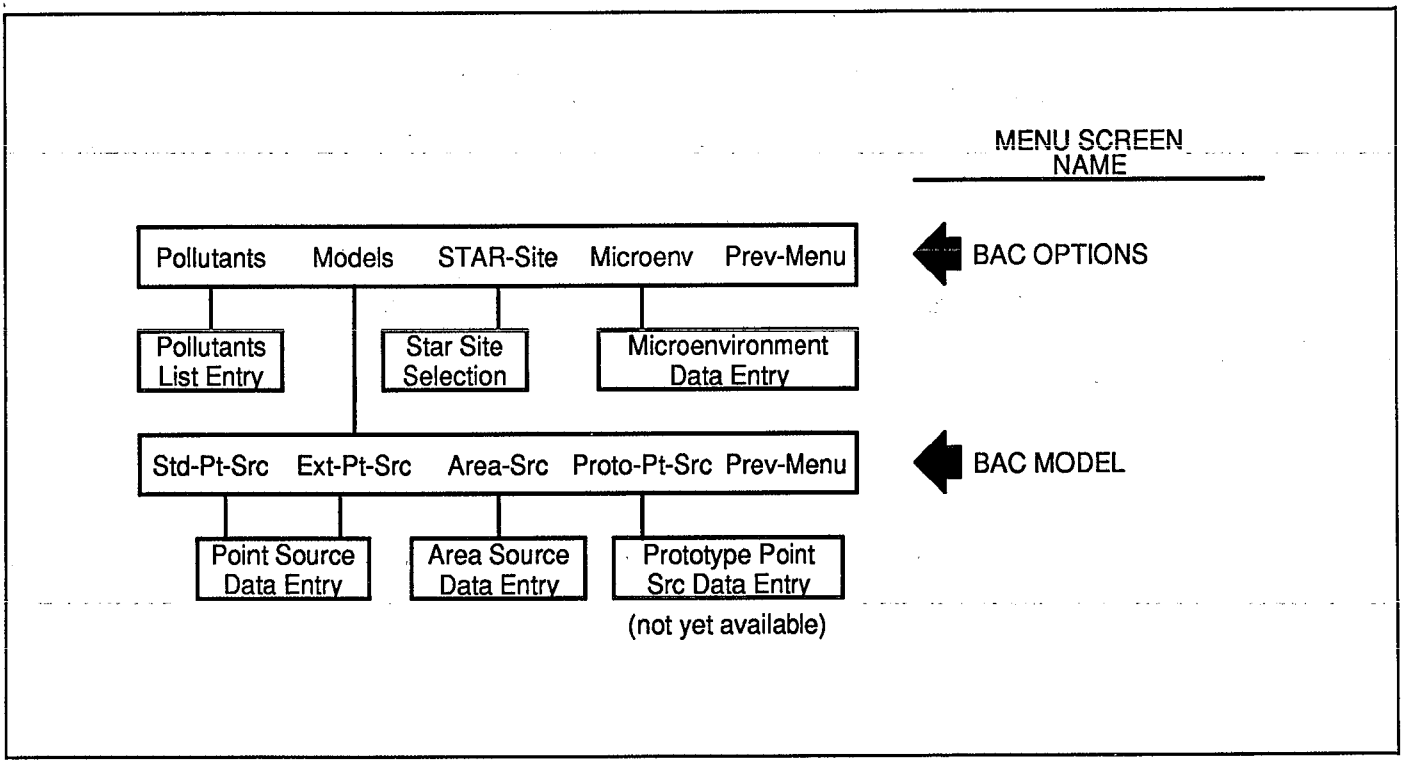


Figure 3-3. HEM-II Control Menu Diagram for BAC Options Menu.

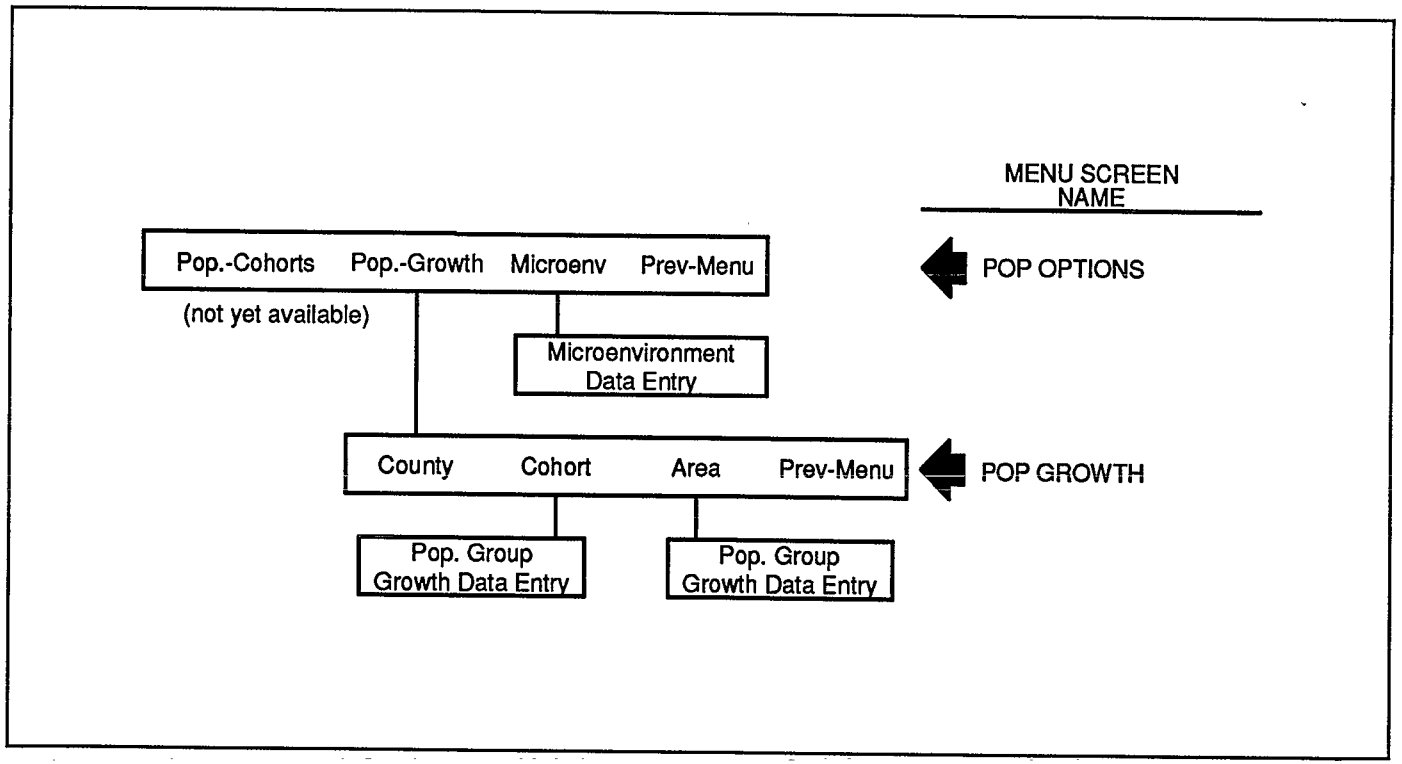


Figure 3-4. HEM-II Control Menu Diagram for POP Options Menu

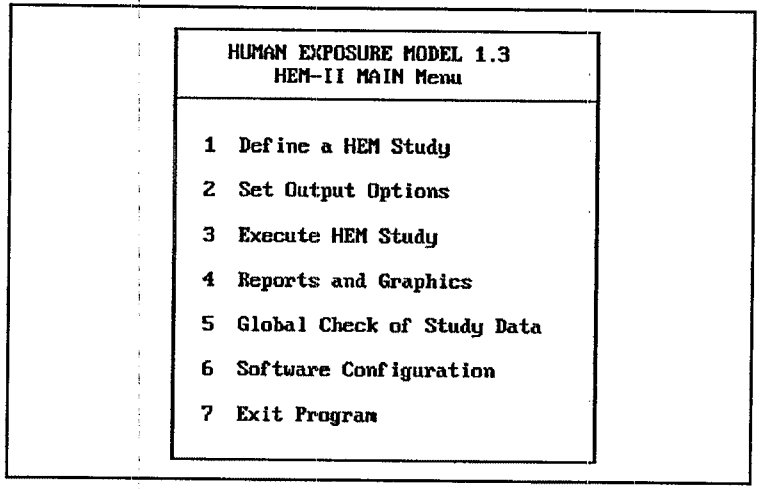
SECTION 4
USING HEM-II

DEFINING A HEM-II STUDY

Main Menu

NOTE: Refer to p. 2-10 for typographical conventions for the computer screens discussed in this section.

As shown below, seven selections appear on the **HEM-II MAIN MENU**. These will be discussed in the order in which they appear on the menu.



DEFINE A HEM STUDY

This selection passes program control from the **MAIN MENU** to the **STUDY DEFINITION MENU** and subsequently to the network of menus and data entry screens that allow the user to supply processing options and input data. The process of defining a HEM-II study is discussed more fully in later sections of this chapter.

SET OUTPUT OPTIONS

This selection invokes a control panel screen that allows the user to enable or disable various optional outputs created when the Technical Software System (TSS) processes the HEM-II study. See the

section Selecting Model Output Options for additional details.

EXECUTE HEM STUDY

This selection prompts the user for the name of the HEM-II study to be processed, and then invokes the HEM-II TSS. The TSS processes the Model Input Files generated from the User Interface. The batch mode processing of the HEM-II TSS is totally independent of the interactive User Interface, so the user may safely log off the VAX computer while the TSS continues to process the study. See the section Executing a HEM-II Study for additional details.

REPORTS AND GRAPHICS

This selection is chosen in order to prepare printed reports and graphics. Tabular reports of the TSS results may be printed on the VAX system printer. If the graphics outputs were enabled, the TSS results may be displayed on a VAX graphics terminal or on the VAX system plotter using the HEM-II Graphics Analysis Tools (GAT) from the **REPORTS/ GRPAHICS MENU.**

See Section 5, Reports and Graphics, for a detailed explanation of the type and contents of the various reports and graphical options available.

GLOBAL STUDY DATA CHECK

Choosing this selection activates a data checking routine designed to determine whether the study can be successfully processed. Various consistency and completeness checks are performed, and the user is informed of potential data input problems that may warrant correction before submitting the study for execution. See the section Checking User Data for Errors for more details.

NOTE: The 'Software Configuration' selection will be used only by the VAX system manager.

SOFTWARE CONFIGURATION

This selection is normally used only once when HEM-II is installed or a new user directory is created by the VAX system manager to configure the HEM-II for the following VAX/VMS considerations:

- Disk directory names for location of the HEM-II software,
- Disk directory names for location of the user data files,
- VAX system printer control,
- VAX batch queue options,
- VAX graphics terminal selection for use of GAT, and
- VAX plotter selection for use of GAT.

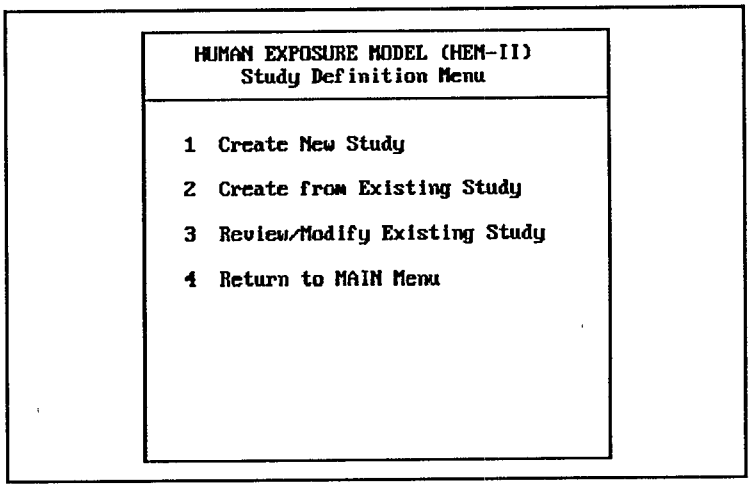
These settings may differ on different VAX systems and for each separate VAX user account.

EXIT PROGRAM

This selection terminates the current HEM-II User Interface session and returns the user to the VAX/VMS command prompt ($).

Study Definition Menu

The **HEM-II STUDY DEFINITION MENU** appears below. There are four selections on this menu.



CREATE NEW STUDY

This selection activates the first HEM-II User Interface session for creating a new study. The User Interface will request a name to use for this study and then verify that a study with this name does not already exist in the user directory. Program control will now proceed to the **COMPONENT DATA MENU**.

CREATE FROM EXISTING STUDY

This selection is for creating a new HEM-II study by ***copying*** all of the data that have been previously defined for a study of a different name. After verifying that the new study name was not previously used and that the old study does exist, the User Interface will copy all of the existing study data files to the new study. Program control will now proceed to the **COMPONENT DATA MENU**.

REVIEW/MODIFY EXISTING STUDY

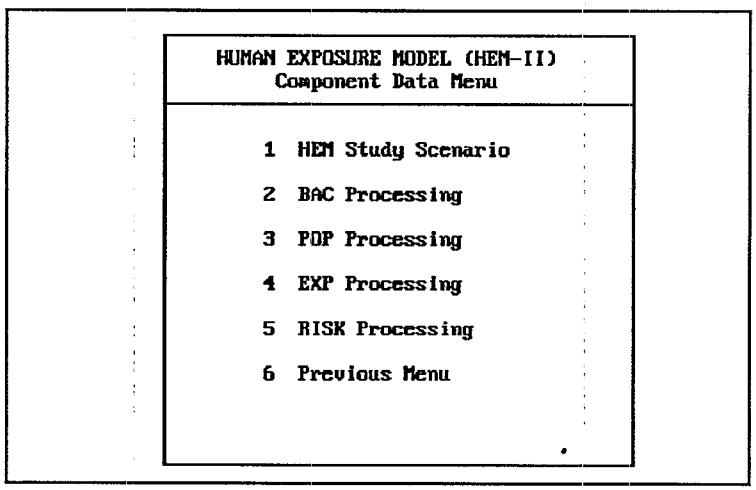
This selection enables the user to continue with a previous User Interface session, correct data entered in a previous session, or to review the user data on the screen. Program control will now proceed to the **COMPONENT DATA MENU**.

RETURN TO MAIN MENU

This selection passes program control back to the **MAIN MENU** and cancels the study definition operation.

Component Data Menu

The HEM-II **COMPONENT DATA MENU** is shown below. There are five selections on this menu that progress in the logical order for user data entry and one return option.



HEM STUDY SCENARIO

This option activates a set of data entry screens that allow the user to specify the HEM-II study scenario. The HEM-II study scenario represents the highest level of study processing options. This includes options for the geographic mode for processing source grids (source-specific or master grids) and options to enable the processing of microenvironments. Other options for long- and short-term modeling and deterministic or stochastic mathematical mode will be made in these study scenario screens of HEM-II. The selections made in these study scenario screens will determine the types of information appearing in subsequent data entry screens.

NOTE:
The HEM Study Scenario screen is described in detail in the tutorial. See pages 2-16 to 2-18.

NOTE: Breathing Air Components = BAC.

BAC PROCESSING

This option passes control to the **BAC OPTIONS MENU**.

NOTE: Population Processing Component = POP.

POP PROCESSING

This option passes control to the **POP OPTIONS MENU**.

NOTE: Exposure Processing Component = EXP.

EXP PROCESSING

This selection invokes a control panel that allows the user to select the mode of operation of the Exposure Component.

RISK PROCESSING

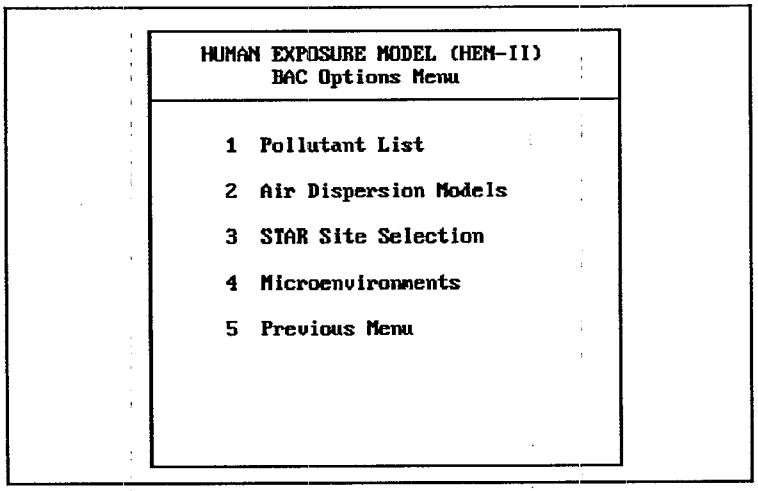
This selection invokes a data entry screen that allows the user to specify unit risk estimates for each of the pollutants previously specified in the BAC Pollutant List. Calculation of exposure and risk is discussed in Appendix E.

PREVIOUS MENU

This selection passes program control back to the **HEM-II MAIN MENU** and also creates the set of files that are used later as input to the TSS. These TSS input files differ somewhat in format and content from the files that are used by the User Interface to define a study.

BAC Options Menu

The **BAC OPTIONS MENU**, shown below, is used for specifying processing options for the Breathing Air Component (BAC). There are five selections on this menu.



POLLUTANT LIST

This selection invokes the data entry screen for the studywide pollutant list for the entire HEM-II study. This pollutant list is used in all subsequent data entry screens for BAC and RISK Processing.

AIR DISPERSION MODELS

This selection passes program control to the **BAC DISPERSION MODEL MENU** from which the user selects internally modeled point sources, externally modeled point sources, or studywide area sources. Prototype point sources will be implemented in a future version. Selection of one of these options then invokes a source editing facility that allows the user to enter descriptions of the various sources or revise existing descriptions. Additional information about these options is provided later in this section.

STAR SITE SELECTION

This selection invokes a control panel that allows the user to override the model's automatic selection of climatological data. This option allows a user-specified Stability Array (STAR) Site to be used for a small study area, rather than allowing the TSS to select the geographically closest STAR Site. A

list of STAR sites incorporated in HEM-II appears in Appendix G.

MICROENVIRONMENTS

NOTE: Refer to HEM-II Model Terminology and Appendix J for a definition and discussion of microenvironments.

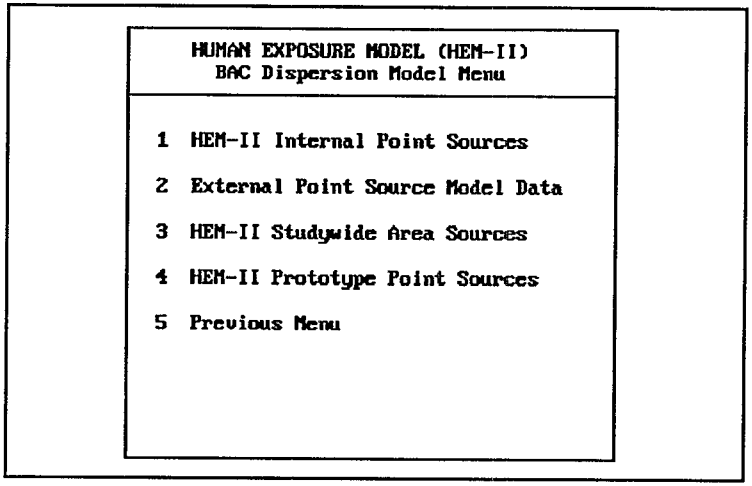
This selection invokes the **BAC MICROENVIRONMENTS POLLUTION COEFFICIENTS MENU**. This option allows the user to specify the ratio between the concentration in each microenvironment and the outdoor (ambient) concentration of each specific pollutant. This operation is not permitted if microenvironment processing is disabled in the HEM-II study scenario screen. Further details about this selection are discussed later in this section.

PREVIOUS MENU

This selection passes program control back to the **COMPONENT DATA MENU.**

BAC DISPERSION MODEL MENU

The **BAC DISPERSION MODEL MENU**, shown below, provides five selections to the HEM-II user that are further discussed below.



HEM-II Internal Point Sources

This option pertains to the ISCLT module within HEM-II. Details on this module are described in Appendix C. A series of menus will query the user for specific information required as input to ISCLT. Note that although ISCLT includes an area source option, the term "area source" within ISCLT is used differently than in the '**HEM-II Studywide Area Sources**' selection described below. Within ISCLT, the area option allows modeling of emissions from a non-stack-type source such as fugitive emissions or a storage pile. In these cases, the emissions are still treated as emissions from a point.

External Point Source Model Data

Advanced users may wish to use a dispersion model other than ISCLT. Choosing this option allows input of results from external models. See Appendix F for details.

HEM-II Studywide Area Sources

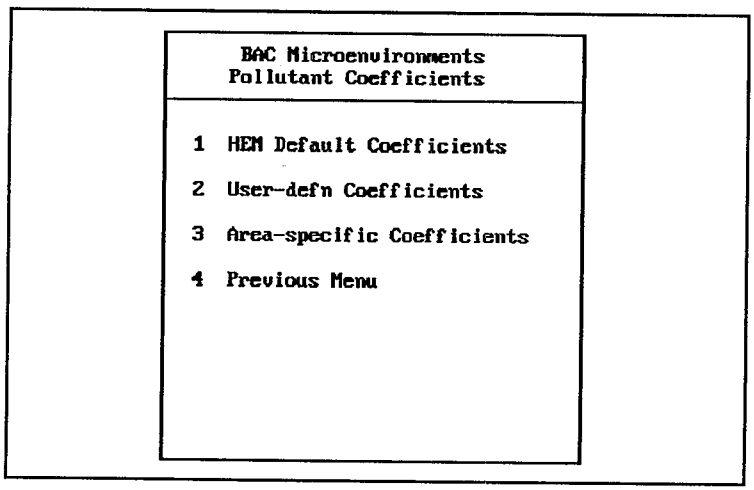
This selection pertains to the area source module within HEM-II. Area sources are groups of point sources that are too small and numerous to be modeled individually. For example, automobile emissions, residential emissions, or emissions from dry cleaners should be modeled as studywide area sources. Appendix D describes the Area Source Module in more detail.

HEM-II Prototype Area Sources

This option has not been implemented in HEM-II Version 1.3.

BAC MICROENVIRONMENTS POLLUTANT COEFFICIENTS MENU

The **BAC MICROENVIRONMENTS POLLUTANT COEFFICIENTS MENU**, shown below, provides the HEM-II user with four selections that are discussed below.



HEM-II Default Coefficients

This option should be selected only if default microenvironments were chosen at the **COMPONENT DATA MENU** level. The '**Outdoor**' coefficient is set to 1, the '**Indoor**' coefficient is set to 0.6. This means that indoor concentration levels will be set to 60% of the calculated ambient ('**Outdoor**') concentration.

User-defined (Defn) Coefficients

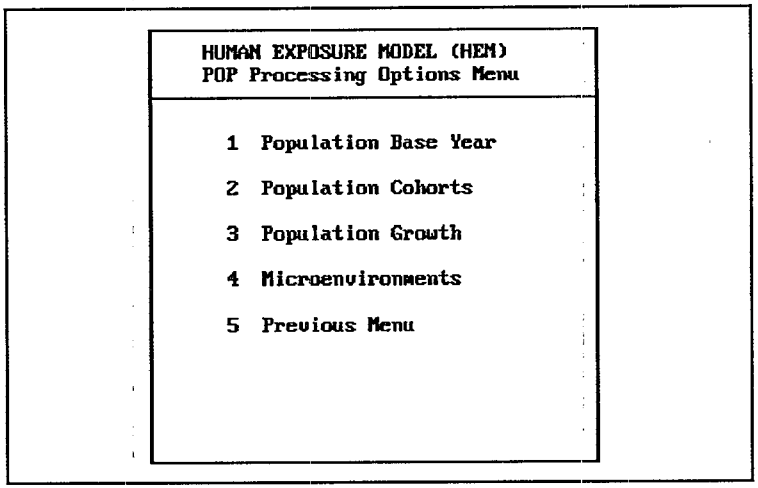
The user may choose to set the coefficients for each microenvironment. This option may be selected whether the user has selected '**Default Microenvironments**' or defined them. The user will be prompted to enter values for each microenvironment. Values should be set relative to the ambient exposure level (i.e., 1 or less).

Area-specific Coefficients

This option allows the user to define geographic regions. Within each region, the coefficients for each microenvironment are defined by the user. This option can be used for default or user-defined microenvironments.

POP Processing Options Menu

The **POP PROCESSING OPTIONS MENU**, shown below, is used for specifying population processing options. There are five selections on this menu.



POPULATION BASE YEAR

This selection invokes a control panel that allows the user to select between two alternative census population data bases, 1980 and 1983. However, the 1983 is a proprietary data base that is not yet on-line. When available, the 1990 census data will be added to the model.

POPULATION COHORTS

In future versions, this selection will activate the **POPULATION COHORTS MENU** (not yet implemented) in order to specify special sensitivity groups or subpopulations by age, sex, race, or other user-defined criteria.

POPULATION GROWTH

This option allows for population growth from the population base year until the specified study date. If the user does not supply growth rates, county-specific default growth factors will be used.

Further information about this selection is given later in this section.

MICROENVIRONMENTS

NOTE: Refer to HEM-II Model Terminology and Appendix J for a definition and discussion of microenvironments.

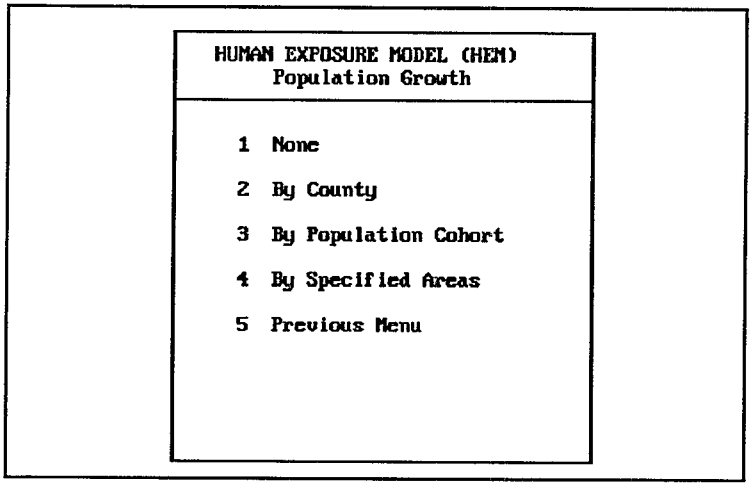
This selection invokes the **POP MICROENVIRONMENTS MENU** and an associated group of data entry screens that allow the study population to be distributed among the microenvironments specified in the HEM-II study scenario. An occupancy coefficient is used to weight the proportion of time spent in each microenvironment. This operation is not permitted if microenvironment processing is disabled in the HEM-II study scenario. Additional details about this selection are provided below.

PREVIOUS MENU

This selection passes program control back to the HEM-II **COMPONENT DATA MENU**.

POPULATION GROWTH MENU

The **POPULATION GROWTH MENU**, shown below, offers the HEM-II user five selections for which details are discussed below.



None

Select this option if no growth is desired. Populations from the 1980 U.S. census will be used without modification.

By County

This option uses county-specific growth rates derived from U.S. census projections. The user is prompted to enter the year at which population growth is stopped.

By Population Cohort

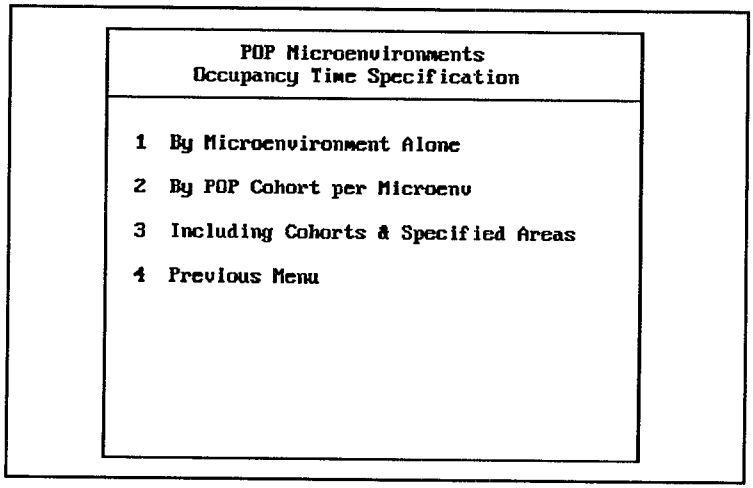
Currently, only one cohort, total population, is used in HEM-II Version 1.3. This option can be used to enter a user-defined growth rate for the entire population.

By Specified Areas

This selection allows the user to define different growth rates for different geographic areas. The user is first prompted to define specific rectangular regions by entering the latitude and longitude of the center of the rectangle and its height and width. Then the user is prompted to enter growth rates for each defined area as well as for any portion of the study area not included in an explicitly defined area.

POP MICROENVIRONMENTS

The **POP MICROENVIRONMENTS OCCUPANCY TIME SPECIFICATION MENU**, shown below, offers the HEM-II user four selections for which details are provided below.



By Microenvironment Alone

This option allows the user to define the proportion of time each microenvironment is occupied by the population. These occupancy rates should add up to one.

By POP Cohort per Microenvironment

Currently, only one cohort is available in HEM-II Version 1.3. Therefore, this option produces results identical to the option described above.

Including Cohorts & Specified Areas

This option allows the user to define rectangular regions on the grid and to specify different growth rates for each region. After defining the regions (by latitude, longitude, width, and height), the user is prompted to enter occupancy rates region by region.

NOTE: The following three sections discuss other functions available from the HEM-II MAIN MENU after the study has been defined.

CHECKING USER DATA FOR ERRORS

Choosing option 5, Global Check of Study Data, from the Main Menu invokes an interactive data checking facility designed to determine whether the study can be successfully processed.

First, a check is made to determine that the HEM-II Study Scenario has been described completely by the user. For example, a study for which no emissions sources of any type have been described would be meaningless to process and would result in a failure of the TSS upon executing the study.

Next, various geographic dependencies are checked. For instance, the boundaries of studywide area sources should extend far enough to include all of the point sources. Otherwise, the results would be biased by the omission of the area source contribution from some point source domains and not others. Also, for the master grid processing mode, all sources should be encompassed by the master grid.

Finally, data ranges are checked, where appropriate. Warnings are displayed for data values that fall outside the range of values normally expected for that variable.

SELECTING MODEL OUTPUT OPTIONS

When option 2 from the **HEM-II MAIN MENU**, '**Set Output Options**,' is selected, a control panel screen is invoked that allows the user to enable or disable various optional outputs that are created when the TSS processes the HEM-II study.

In Version 1.3 of HEM-II, most model outputs are fixed except those pertaining to graphics. Graphics output files are large and require additional processing time to produce, so they should normally be disabled unless the study has been previously processed to completion and graphics outputs are specifically desired.

EXECUTING A HEM-II STUDY

There are two modes of operation possible whenever a computer executes a program. These are called interactive and batch modes. The HEM-II User Interface is an example of computer software that operates in the interactive mode. The course of

its operation is directed by the user who interacts with the software, receiving information on the terminal display and entering control information and data from the terminal keyboard. HEM-II studies, however, are processed using an alternative mode of operation called batch mode.

The batch mode of operation requires no user intervention and continues processing unless the user issues a STOP or DELETE command to remove the job from the batch queue. Batch jobs continue running even after the user has logged out from the VAX computer system. Therefore, users will most frequently follow the steps below in the routine use of HEM-II:

1. Log onto the VAX computer.
2. Invoke the HEM-II User Interface.
3. Define a HEM-II study.
4. Submit the study for execution.
5. Exit the HEM-II User Interface.
6. Log off the VAX computer (the study continues processing in the batch mode).
7. Log back onto the VAX computer at a later time.
8. Check for the successful completion of the study. Refer back to Part 2 Step 1 in the tutorial.
9. Invoke the HEM-II User Interface again to produce reports and graphics.

NOTE: Detailed discussion of 'Reports and Graphics' appears in Section 5.

DIAGNOSING PROBLEMS

After executing a HEM-II study, the main log file should be checked for the message indicating successful completion. If the main log file contained an error message or did not give the message about successful completion, an error has occurred during the processing of the study. The user should now

consult the various log files, discussed below, that are created during execution to determine the cause of the problem.

Session Log Files

A set of files named 'SESSION.LOG' are created routinely during the use of the interactive HEM-II User Interface. Multiple versions of this file occur for each operation that is performed as a VAX/VMS "spawned process." If errors or inconsistent behavior are noticed during the operation of the User Interface, the first action to diagnose the cause is to exit the User Interface and examine these log files by issuing the following VAX/VMS command:

$ TYPE SESSION.LOG;*

The log file will show messages such as the following two:

1. Hardware disk errors or

2. Disk quota exceeded.

If the error message is unfamiliar to the user, the VAX/VMS manual or operator should be consulted.

Main Log File

When the TSS executes a HEM-II study, the processing of each TSS component is recorded in a log file whose name is "HEM_" followed by the name of the study, with the file name extension ".LOG." For example, when the tutorial study, HEMDEMO, is processed by the TSS, the main log file is created under the name "HEM_HEMDEMO.LOG." If an error occurs during processing, a descriptive error message will appear in the Main Log File or the user will be directed to the appropriate Component Log File to further diagnose the cause of the failure.

Component Log Files

Component Log Files are created as the TSS Supervisor program runs each separate processor that is part of the TSS. Individual processor programs exist for the following:

- The Source Grouping Processor,
- The Population Processor,
- The Area Model Input Generator,
- The Area Model,
- The Point Source Input Generator,
- ISCLT, and
- The Exposure Processor (also the Risk Processor in future releases).

TSS Diagnostic Messages

The TSS is able to trap and diagnose certain error conditions and report them with the following two internal routines:

1. The File Input/Output (I/O) Error Trapping Routine and
2. The Technical Error Trapping Routine.

The I/O Error Trapping Routine (IO_ERR) diagnoses file errors that may result from internal computer code errors or disk errors. The internal name, date, and time of each separate input file is evaluated for consistency. The numerical counts and identities of sources, emission points, pollutants, etc., are also tested for consistency between input files. Any mismatch is reported by the IO_ERR and execution of the TSS is terminated with an error message. The IO_ERR routine also checks for end-of-file (EOF) conditions when the program was expecting to read a value from the file.

Incorrect data type errors are also diagnosed by this routine. For example, if a read operation finds alphabetical text at the position in the file where a number should occur, an IO_ERR error message will be displayed.

A different routine, the Technical Error Trapping Routine (TECH_ERR) handles a different class of error conditions. This routine checks that critical numerical values are non-zero and within model maxima. This is essentially a second level of error detection in case the IO_ERR routine did not detect an erroneous value.

Errors that cannot be detected by the above routines may be detected by the internal FORTRAN array subscript and arithmetic overflow error detection facilities. If this happens, the TSS will terminate, and the Main Log File or Component Log File will contain a FORTRAN Traceback diagnostic message that will state the exact line number where the error occurred and then successive lines to indicate the sequence of routines that led up to where the error occurred. This information is extremely valuable in correcting software errors or in enhancing the internal error-trapping routines to cover additional possible error conditions.

If either of these types of error messages are observed, please record them and communicate these problems to Michael Dusetzina at (919) 541-5338 or FTS 629-5338, or Warren Peters at (919) 541-5337 or FTS 629-5337, U.S. Environmental Protection Agency, Pollutant Assessment Branch (MD-13), at Research Triangle Park, NC 27711.

GAT Diagnostic Messages

The HEM-II Graphics Analysis Tools (GAT) have been developed using a commercial VAX graphics development system called GRAFkit®.

NOTE: Computer Graphics Metafile = CGM.

NOTES:
1. NEVER attempt to cancel GAT by use of the Control-C or Control-Y key sequences.

2. When generating on-screen graphics, wait until the CGM Translator has completed its processing and the prompt <READY> appears in the top left-hand corner of the screen. Then press the Return Key to return to the GRAPHICS GENERATION MENU.

Some errors may arise from within the GRAFkit® system that may affect the behavior of GAT. In particular, the CGM Translator, which operates as a detached process within GRAFkit®, occasionally can cause program execution errors. Be sure to read margin notes 1 and 2 on this page.

Data errors that are detected by the CGM Translator or user interruptions of the CGM Translator may cause GAT to fail. Furthermore, since the CGM Translator retains its operating state from one invocation to the next, it may fail unexpectedly the next time GAT invokes the CGM Translator. In such cases, recognize that there may not be an actual error condition and so a second attempt to run GAT again with the same data may succeed.

SECTION 5
REPORTS AND GRAPHICS

Printed reports and on-screen or hard-copy computer graphics of HEM outputs may be prepared after the study has been processed successfully by the TSS.

PREPARING PRINTED REPORTS

HEM-II provides several options for obtaining printed tabular reports. These are available from the **HEM-II REPORTS/GRAPHICS MENU**. This menu is reached by selecting option 4,'**Reports and Graphics**,' from the Main Menu.

Three categories of printed reports are available:

1. User-supplied data reports,
2. ISCLT defaults report, and
3. Model output data reports.

These reports can be examined on screen or a copy can be printed from the VMS prompt. For example, the files containing the output reports are named:

<Study Name> _RPT#.DAT

To view a file on screen, issue the following command:

TYPE <STUDY NAME>_RPT#.DAT

To print a report, issue the following command:

PRINT <STUDY NAME>_RPT#.DAT

where # is 1, 2, 3, or 4, which correspond to the four output reports discussed in the following section. For example, RPT3 is the Source-group Exposure/Risk Report.

User-supplied HEM-II Study Definition Reports

The user-supplied data can be reviewed by printing the Study Definition Reports. A different report is generated for each user-input data file or "U" file. Examples of each of these reports appear in Appendix H.

The user should examine each of these reports after creating a study to verify that all values have been entered correctly. Note that some of the example reports appear incomplete. In some cases, such as "POP Microenvironment Data: File U14," options not yet implemented are shown; specification of more than one cohort, for example, is not yet possible. On some other reports, the Study Data and Study Time do not appear. This means that these pieces of information are not accessible from that file.

The user also needs to remember that the format of the report may affect a value shown. For example, if the decay rate is less than 10^{-4}, the value will appear as 0.0000 (see BAC Options/ Pollutant Data: File U20 in Appendix H). If this occurs, the user may check the U file, in this example, File U20, to verify the exact value.

HEM-II TSS Model Outputs

Four output reports are currently created when the TSS processes a HEM-II study. These are retained after the TSS completes and may be printed afterwards from the **HEM-II REPORTS/GRAPHICS MENU**. When option **2, 'Print HEM Model Outputs,'** is selected from the **HEM-II REPORTS/GRAPHICS MENU**, these reports will be printed on the VAX system printer according to the printer command specified under the **'Software**

Configuration' selection on the **HEM-II MAIN MENU.** The names of these reports are:

1. Source-specific Maximum Concentration Report,
2. Source-specific Exposure/Risk Report,
3. Source-group Exposure/Risk Report, and
4. Study Exposure/Risk Report.

Each of these four reports are discussed in turn in the following subsections with examples included.

REPORT 1: SOURCE-SPECIFIC MAXIMUM CONCENTRATION REPORT

Report 1 summarizes the maximum concentrations for each pollutant by source group and source number. The cohort number is also shown; in HEM-II Version 1.3, this will always be 1. Cohorts will provide a means for defining population subgroupings in future versions. In the current version, only one cohort, total population, is available.

The HEM Study Source List, at the top of Report 1, gives the name of each source as it was defined by the user. The number assigned by the program to the source precedes the name. In the summary tables that follow in this report and others, this number will be used to identify the source. Similarly, each pollutant defined by the user is listed with its identification number.

The last table in Report 1 lists the maximum concentration of each pollutant from each source. The maximum concentration is the highest concentration of a pollutant that is assigned to a population BGED in the study area. It may not necessarily be the highest concentration predicted by the dispersion model; concentrations that occur in unpopulated areas are not included. The table also shows the population at the BGED that is

NOTE: BGED = Block Group/Enumeration District.

exposed to the maximum concentration. Finally, the maximum risk is calculated as the product of the maximum concentration and the unit risk estimate (URE) for the pollutant. The URE represents the risk to an individual over a 70-year lifespan. UREs are discussed in the preamble to the Proposed and Final National Emission Standards for Hazardous Air Pollutants (NESHAP) for Benzene, 53 FR 28496 and 54 FR 38044, respectively.

```
**  EPA HUMAN EXPOSURE MODEL  (HEM-II VERSION 1.3 )  **
REPORT 1
SOURCE-SPECIFIC MAXIMUM CONCENTRATION REPORT

  STUDY NAME : MEMDEMO
  STUDY DATE : 01/31/90
  STUDY TIME : 10:20:52

  HEM STUDY SOURCE LIST :        NUM     NAME

                                  1      DEMO POINT SOURCE #1
                                  2      HEM DEMO PLANT #2
                                  3      GASOLINE STATIONS AE H-B AREA

  HEM STUDY POLLUTANT LIST :     NUM     NAME

                                  1      CHLOROFORM
                                  2      BENZENE
                                  3      STYRENE

 SOURCE  SOURCE  POLL  COHORT  MAXIMUM      POPULATION    MAXIMUM
 GROUP    NUM    NUM    NUM    CONC         EXPOSED       RISK
                               (ug/m**3)    TO MAX        (Cancer
                                                          Prob)
 -----  -----  -----  -----  --------     ----------    ----------
   1      1      1      1     3.84E-02     2.18E+03      8.84E-07
   1      2      1      1     1.29E-02     1.14E+03      2.97E-07
   1      1      2      1     7.56E-02     2.18E+03      6.11E-07
   1      2      2      1     8.66E-04     1.14E+03      7.19E-09
   1      3      2      1     4.42E-01     5.92E+03      3.67E-06
   1      1      3      1     1.09E-01     2.18E+03      1.09E-08
   1      2      3      1     1.04E-03     1.14E+03      1.04E-10

NOTES : ----------

  MAXIMUM CONC ::: Highest Concentration assigned to any Population Centroid in the Study Area.
  MAXIMUM RISK ::: MAXIMUM CONC * Unit Risk Estimate for pollutant
```

REPORT 2: SOURCE-SPECIFIC EXPOSURE/RISK REPORT

Report 2 provides much more detail on the exposure and risk estimates than were given in Report 1. In addition, a description of the dispersion modeling parameters for each source is given.

Following the source description, two tables are given for each pollutant. The first table summarizes the exposure of the entire population in the study area. Concentration intervals are listed in descending order; concentration lower bounds (CONC LB) and concentration upper bounds

(CONC UB) define the limits of each interval. For example, the first line of the table shows the number of people exposed to the highest concentrations of pollutants. EXPOSURE for that interval is calculated as the cumulative product of the number of people at each BGED exposed to a concentration within that interval and the concentration to which they are exposed. The last two columns are cumulative values for population and exposure. Thus, the CUMULATIVE POPULATION in the last line is the total population of the study area; CUMULATIVE EXPOSURE is the sum of the total population's exposure.

Below the population exposure table, TOTAL MAXIMUM EXPOSURE is shown. The values for the items MAXIMUM EXPOSURE and POPULATION EXPOSED are the same as are given in Report 1. The product of these two values is the TOTAL MAXIMUM EXPOSURE.

The risk table that follows is similar to the exposure table. The URE is multiplied by the exposure for each population centroid to estimate the probable number of cancers expected to occur in each group. Again, risk levels are divided into intervals, and the risks for population centroids within each interval are summed to get the RISK for that interval. Below this table, MAXIMUM RISK (also given in Report 1) is reported, followed by the number of people to whom that risk number applies. The product of these two is the TOTAL MAXIMUM RISK, or probable number of cancers in that group of people. ANNUAL INCIDENCE is the estimated annual occurrences of cancer in the study population. ANNUAL INCIDENCE is calculated by dividing the CUMULATIVE RISK for the total population by 70 years. Therefore, the CUMULATIVE RISK represents the risk to the entire population over 70 years. Dividing CUMULATIVE RISK by 70 gives an estimate of the probable number of cancers occurring each year in the population.

The risk and exposure tables are repeated for each pollutant and for each source.

```
**   EPA HUMAN EXPOSURE MODEL  (HEM-II VERSION 1.3  )   **
-------------------------------------------------
                    REPORT 2
          SOURCE-SPECIFIC EXPOSURE/RISK REPORT

   STUDY NAME : HEMDEMO
   STUDY DATE : 01/31/90
   STUDY TIME : 10:20:52

   Source ID         : DEMO POINT SOURCE #1
   Source Type       : POINT
   Source Grid Type : POLAR
   Source Latitude   :  4.1689E+01
   Source Longitude :  8.7564E+01

   Maximum Modeling Radius (Km)      :  5.0000E+01
   Number of Polar Grid Rings        : 10
   Distance to Polar Grid Rings (Km) :  2.0000E-01 5.0000E-01 1.0000E+00 2.0000E+00 5.0000E+00
                                        1.0000E+01 2.0000E+01 3.0000E+01 4.0000E+01 5.0000E+01
```

```
                    SOURCE-SPECIFIC EXPOSURE SUMMARY

   STUDY NAME : HEMDEMO
   STUDY DATE : 01/31/90
   STUDY TIME : 10:20:52

   Source Group Name : SOURCE GROUP NUMBER    1
   Source Name       : DEMO POINT SOURCE #1
   Pollutant Name    : CHLOROFORM

                          POPULATION                CUMULATIVE  CUMULATIVE
    CONC LB     CONC UB    EXPOSED     EXPOSURE     POPULATION   EXPOSURE
   (ug/m**3)   (ug/m**3)  (persons)  (p-ug/m**3)  (persons)   (p-ug/m**3)

   2.5000E-02  5.0000E-02  3.1370E+03  1.1715E+02  3.1370E+03  1.1715E+02
   1.0000E-02  2.5000E-02  9.0160E+03  1.2382E+02  1.2153E+04  2.4097E+02
   5.0000E-03  1.0000E-02  2.9586E+04  2.0214E+02  4.1739E+04  4.4311E+02
   2.5000E-03  5.0000E-03  1.0330E+05  3.4620E+02  1.4504E+05  7.8931E+02
   1.0000E-03  2.5000E-03  2.3462E+05  3.5427E+02  3.7966E+05  1.1436E+03
   5.0000E-04  1.0000E-03  4.6221E+05  3.1743E+02  8.4187E+05  1.4610E+03
   2.5000E-04  5.0000E-04  1.0901E+06  3.7748E+02  1.9320E+06  1.8385E+03
   1.0000E-04  2.5000E-04  2.8379E+06  4.4510E+02  4.7698E+06  2.2836E+03
   5.0000E-05  1.0000E-04  1.3481E+06  1.0643E+02  6.1179E+06  2.3900E+03
   2.5000E-05  5.0000E-05  3.6261E+04  1.7147E+00  6.1542E+06  2.3917E+03

   MAXIMUM      POPULATION  TOTAL MAXIMUM
   EXPOSURE      EXPOSED      EXPOSURE
   (ug/m**3)    (persons)    (p_ug/m**3)

   3.8418E-02  2.1830E+03  8.3867E+01
```

SOURCE-SPECIFIC RISK SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : DEMO POINT SOURCE #1
Pollutant Name : CHLOROFORM

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
5.0000E-07	1.0000E-06	3.1370E+03	2.6945E-03	3.1370E+03	2.6945E-03
2.5000E-07	5.0000E-07	6.5410E+03	2.2568E-03	9.6780E+03	4.9514E-03
1.0000E-07	2.5000E-07	4.5519E+04	6.6612E-03	5.5197E+04	1.1613E-02
5.0000E-08	1.0000E-07	1.1099E+05	7.6685E-03	1.6618E+05	1.9281E-02
2.5000E-08	5.0000E-08	1.8502E+05	6.3381E-03	3.5120E+05	2.5619E-02
1.0000E-08	2.5000E-08	6.5242E+05	9.7199E-03	1.0036E+06	3.5339E-02
5.0000E-09	1.0000E-08	1.2294E+06	8.5562E-03	2.2330E+06	4.3895E-02
2.5000E-09	5.0000E-09	2.2153E+06	7.8558E-03	4.4484E+06	5.1751E-02
1.0000E-09	2.5000E-09	1.7058E+06	3.2589E-03	6.1542E+06	5.5010E-02

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)	ANNUAL INCIDENCE (Number of cancers per year)	RECIPROCAL OF ANNUAL INCIDENCE
8.8362E-07	2.1830E+03	1.9289E-03	7.8586E-04	1.2725E+03

SOURCE-SPECIFIC EXPOSURE SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : DEMO POINT SOURCE #1
Pollutant Name : BENZENE

CONC LB (ug/m**3)	CONC UB (ug/m**3)	POPULATION EXPOSED (persons)	EXPOSURE (p-ug/m**3)	CUMULATIVE POPULATION (persons)	CUMULATIVE EXPOSURE (p-ug/m**3)
5.0000E-02	1.0000E-01	3.1370E+03	2.2454E+02	3.1370E+03	2.2454E+02
2.5000E-02	5.0000E-02	4.5620E+03	1.4627E+02	7.6990E+03	3.7082E+02
1.0000E-02	2.5000E-02	3.1966E+04	4.5855E+02	3.9665E+04	8.2937E+02
5.0000E-03	1.0000E-02	9.7648E+04	6.4597E+02	1.3731E+05	1.4753E+03
2.5000E-03	5.0000E-03	1.4672E+05	5.0615E+02	2.8403E+05	1.9815E+03
1.0000E-03	2.5000E-03	5.1909E+05	7.8066E+02	8.0312E+05	2.7624E+03
5.0000E-04	1.0000E-03	1.0479E+06	7.2181E+02	1.8510E+06	3.4842E+03
2.5000E-04	5.0000E-04	1.9762E+06	6.8681E+02	3.8272E+06	4.1710E+03
1.0000E-04	2.5000E-04	2.2740E+06	4.0830E+02	6.1012E+06	4.5793E+03
5.0000E-05	1.0000E-04	5.2916E+04	4.9162E+00	6.1542E+06	4.5842E+03

MAXIMUM EXPOSURE (ug/m**3)	POPULATION EXPOSED (persons)	TOTAL MAXIMUM EXPOSURE (p_ug/m**3)
7.3635E-02	2.1830E+03	1.6074E+02

SOURCE-SPECIFIC RISK SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : DEMO POINT SOURCE #1
Pollutant Name : BENZENE

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
5.0000E-07	1.0000E-06	3.0990E+03	1.8450E-03	3.0990E+03	1.8450E-03
2.5000E-07	5.0000E-07	2.4970E+03	7.6312E-04	5.5960E+03	2.6081E-03
1.0000E-07	2.5000E-07	2.2655E+04	3.2388E-03	2.8251E+04	5.8470E-03
5.0000E-08	1.0000E-07	6.4499E+04	4.3655E-03	9.2750E+04	1.0212E-02
2.5000E-08	5.0000E-08	1.3913E+05	5.0611E-03	2.3188E+05	1.5274E-02
1.0000E-08	2.5000E-08	4.0997E+05	6.1861E-03	6.4186E+05	2.1460E-02
5.0000E-09	1.0000E-08	8.4806E+05	5.8130E-03	1.4899E+06	2.7273E-02
2.5000E-09	5.0000E-09	1.7306E+06	5.9652E-03	3.2206E+06	3.3238E-02
1.0000E-09	2.5000E-09	2.7598E+06	4.6582E-03	5.9803E+06	3.7896E-02
5.0000E-10	1.0000E-09	1.7383E+05	1.5276E-04	6.1542E+06	3.8049E-02

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)	ANNUAL INCIDENCE (Number of cancers per year)	RECIPROCAL OF ANNUAL INCIDENCE
6.1117E-07	2.1830E+03	1.3342E-03	5.4355E-04	1.8397E+03

SOURCE-SPECIFIC EXPOSURE SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : DEMO POINT SOURCE #1
Pollutant Name : STYRENE

CONC LB (ug/m**3)	CONC UB (ug/m**3)	POPULATION EXPOSED (persons)	EXPOSURE (p-ug/m**3)	CUMULATIVE POPULATION (persons)	CUMULATIVE EXPOSURE (p-ug/m**3)
1.0000E-01	2.5000E-01	2.1830E+03	2.3762E+02	2.1830E+03	2.3762E+02
5.0000E-02	1.0000E-01	2.3400E+03	1.7650E+02	4.5230E+03	4.1412E+02
2.5000E-02	5.0000E-02	1.1551E+04	3.7123E+02	1.6074E+04	7.8535E+02
1.0000E-02	2.5000E-02	5.9093E+04	8.6800E+02	7.5167E+04	1.6533E+03
5.0000E-03	1.0000E-02	1.3357E+05	9.5735E+02	2.0874E+05	2.6107E+03
2.5000E-03	5.0000E-03	2.3212E+05	7.9193E+02	4.4086E+05	3.4026E+03
1.0000E-03	2.5000E-03	8.5039E+05	1.2672E+03	1.2912E+06	4.6699E+03
5.0000E-04	1.0000E-03	1.5389E+06	1.0658E+03	2.8302E+06	5.7357E+03
2.5000E-04	5.0000E-04	2.3456E+06	8.4261E+02	5.1758E+06	6.5783E+03
1.0000E-04	2.5000E-04	9.7838E+05	1.9827E+02	6.1542E+06	6.7766E+03

MAXIMUM EXPOSURE (ug/m**3)	POPULATION EXPOSED (persons)	TOTAL MAXIMUM EXPOSURE (p_ug/m**3)
1.0885E-01	2.1830E+03	2.3762E+02

SOURCE-SPECIFIC RISK SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : DEMO POINT SOURCE #1
Pollutant Name : STYRENE

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
1.0000E-08	2.5000E-08	2.1830E+03	2.3762E-05	2.1830E+03	2.3762E-05
5.0000E-09	1.0000E-08	2.3400E+03	1.7650E-05	4.5230E+03	4.1412E-05
2.5000E-09	5.0000E-09	1.1551E+04	3.7123E-05	1.6074E+04	7.8535E-05
1.0000E-09	2.5000E-09	5.9093E+04	8.6800E-05	7.5167E+04	1.6533E-04
5.0000E-10	1.0000E-09	1.3357E+05	9.5735E-05	2.0874E+05	2.6107E-04
2.5000E-10	5.0000E-10	2.3212E+05	7.9193E-05	4.4086E+05	3.4026E-04
1.0000E-10	2.5000E-10	8.5039E+05	1.2672E-04	1.2912E+06	4.6699E-04
5.0000E-11	1.0000E-10	1.5389E+06	1.0658E-04	2.8302E+06	5.7357E-04
2.5000E-11	5.0000E-11	2.3456E+06	8.4261E-05	5.1758E+06	6.5783E-04
1.0000E-11	2.5000E-11	9.7838E+05	1.9827E-05	6.1542E+06	6.7766E-04

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)	ANNUAL INCIDENCE (Number of cancers per year)	RECIPROCAL OF ANNUAL INCIDENCE
1.0885E-08	2.1830E+03	2.3762E-05	9.6809E-06	1.0330E+05

Source ID : HEM DEMO PLANT #2
Source Type : POINT
Source Grid Type : POLAR
Source Latitude : 4.1364E+01
Source Longitude : 8.7914E+01

Maximum Modeling Radius (Km) : 4.0000E+01
Number of Polar Grid Rings : 10
Distance to Polar Grid Rings (Km) : 1.0000E-01 2.5000E-01 5.0000E-01 1.0000E+00 2.0000E+00
5.0000E+00 1.0000E+01 2.0000E+01 3.0000E+01 4.0000E+01

SOURCE-SPECIFIC EXPOSURE SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : HEM DEMO PLANT #2
Pollutant Name : CHLOROFORM

CONC LB (ug/m**3)	CONC UB (ug/m**3)	POPULATION EXPOSED (persons)	EXPOSURE (p-ug/m**3)	CUMULATIVE POPULATION (persons)	CUMULATIVE EXPOSURE (p-ug/m**3)
1.0000E-02	2.5000E-02	1.1350E+03	1.4636E+01	1.1350E+03	1.4636E+01
5.0000E-03	1.0000E-02	3.6040E+03	2.4055E+01	4.7390E+03	3.8691E+01
2.5000E-03	5.0000E-03	5.5729E+04	1.9646E+02	6.0468E+04	2.3515E+02
1.0000E-03	2.5000E-03	7.9797E+05	1.1773E+03	8.5844E+05	1.4124E+03
5.0000E-04	1.0000E-03	1.8742E+05	1.5212E+02	1.0459E+06	1.5645E+03
2.5000E-04	5.0000E-04	3.0060E+03	1.2819E+00	1.0489E+06	1.5658E+03

MAXIMUM EXPOSURE (ug/m**3)	POPULATION EXPOSED (persons)	TOTAL MAXIMUM EXPOSURE (p_ug/m**3)
1.2895E-02	1.1350E+03	1.4636E+01

SOURCE-SPECIFIC RISK SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : HEM DEMO PLANT #2
Pollutant Name : CHLOROFORM

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
2.5000E-07	5.0000E-07	1.1350E+03	3.3663E-04	1.1350E+03	3.3663E-04
1.0000E-07	2.5000E-07	2.0574E+04	2.3653E-03	2.1709E+04	2.7019E-03
5.0000E-08	1.0000E-07	8.7424E+04	5.2537E-03	1.0913E+05	7.9557E-03
2.5000E-08	5.0000E-08	6.6261E+05	2.2444E-02	7.7174E+05	3.0400E-02
1.0000E-08	2.5000E-08	2.7529E+05	5.5971E-03	1.0470E+06	3.5997E-02
5.0000E-09	1.0000E-08	1.8310E+03	1.6843E-05	1.0489E+06	3.6014E-02

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)	ANNUAL INCIDENCE (Number of cancers per year)	RECIPROCAL OF ANNUAL INCIDENCE
2.9659E-07	1.1350E+03	3.3663E-04	5.1448E-04	1.9437E+03

SOURCE-SPECIFIC EXPOSURE SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : HEM DEMO PLANT #2
Pollutant Name : BENZENE

CONC LB (ug/m**3)	CONC UB (ug/m**3)	POPULATION EXPOSED (persons)	EXPOSURE (p-ug/m**3)	CUMULATIVE POPULATION (persons)	CUMULATIVE EXPOSURE (p-ug/m**3)
5.0000E-04	1.0000E-03	2.1779E+04	1.3224E+01	2.1779E+04	1.3224E+01
2.5000E-04	5.0000E-04	4.1996E+05	1.2858E+02	4.4174E+05	1.4211E+02
1.0000E-04	2.5000E-04	6.0451E+05	1.1855E+02	1.0462E+06	2.6066E+02
5.0000E-05	1.0000E-04	2.6170E+03	2.3334E-01	1.0489E+06	2.6089E+02

MAXIMUM EXPOSURE (ug/m**3)	POPULATION EXPOSED (persons)	TOTAL MAXIMUM EXPOSURE (p_ug/m**3)
8.6629E-04	1.1350E+03	9.8324E-01

SOURCE-SPECIFIC RISK SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : HEM DEMO PLANT #2
Pollutant Name : BENZENE

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
5.0000E-09	1.0000E-08	1.1797E+04	6.4302E-05	1.1797E+04	6.4302E-05
2.5000E-09	5.0000E-09	1.9484E+05	5.8276E-04	2.0664E+05	6.4706E-04
1.0000E-09	2.5000E-09	8.1448E+05	1.4925E-03	1.0211E+06	2.1395E-03
5.0000E-10	1.0000E-09	2.7746E+04	2.5854E-05	1.0489E+06	2.1654E-03

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)	ANNUAL INCIDENCE (Number of cancers per year)	RECIPROCAL OF ANNUAL INCIDENCE
7.1902E-09	1.1350E+03	8.1609E-06	3.0934E-05	3.2327E+04

SOURCE-SPECIFIC EXPOSURE SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : HEM DEMO PLANT #2
Pollutant Name : STYRENE

CONC LB (ug/m**3)	CONC UB (ug/m**3)	POPULATION EXPOSED (persons)	EXPOSURE (p-ug/m**3)	CUMULATIVE POPULATION (persons)	CUMULATIVE EXPOSURE (p-ug/m**3)
1.0000E-03	2.5000E-03	1.1350E+03	1.1799E+00	1.1350E+03	1.1799E+00
5.0000E-04	1.0000E-03	3.9626E+04	2.4875E+01	4.0761E+04	2.6055E+01
2.5000E-04	5.0000E-04	6.8551E+05	2.2248E+02	7.2627E+05	2.4853E+02
1.0000E-04	2.5000E-04	3.2259E+05	6.4537E+01	1.0489E+06	3.1307E+02

MAXIMUM EXPOSURE (ug/m**3)	POPULATION EXPOSED (persons)	TOTAL MAXIMUM EXPOSURE (p_ug/m**3)
1.0396E-03	1.1350E+03	1.1799E+00

SOURCE-SPECIFIC RISK SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

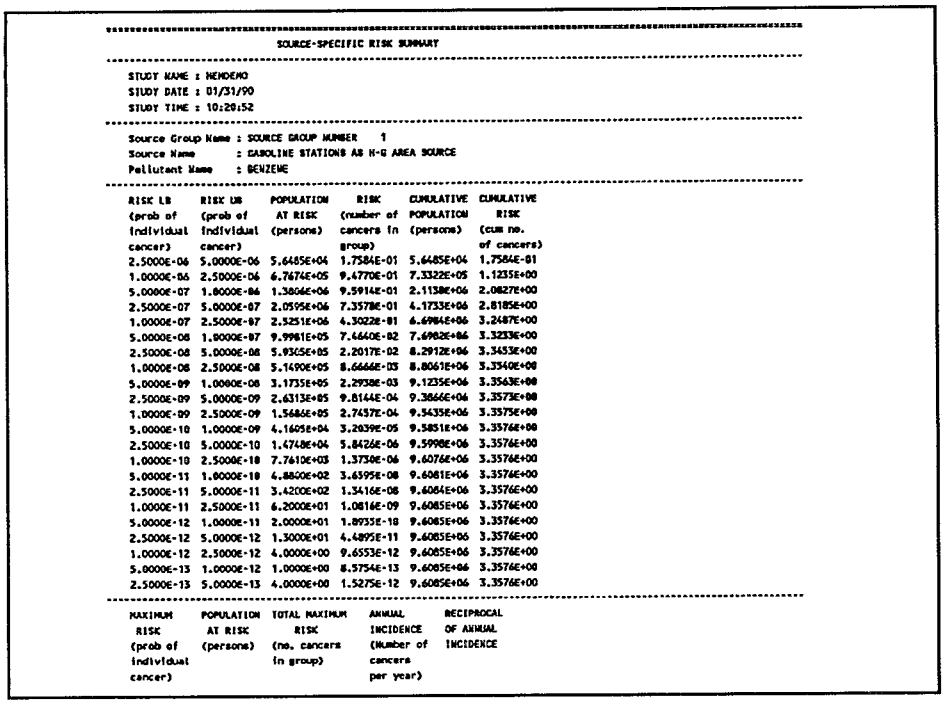
Source Group Name : SOURCE GROUP NUMBER 1
Source Name : HEM DEMO PLANT #2
Pollutant Name : STYRENE

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
1.0000E-10	2.5000E-10	1.1350E+03	1.1799E-07	1.1350E+03	1.1799E-07
5.0000E-11	1.0000E-10	3.9626E+04	2.4875E-06	4.0761E+04	2.6055E-06
2.5000E-11	5.0000E-11	6.8551E+05	2.2248E-05	7.2627E+05	2.4853E-05
1.0000E-11	2.5000E-11	3.2259E+05	6.4537E-06	1.0489E+06	3.1307E-05

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)	ANNUAL INCIDENCE (Number of cancers per year)	RECIPROCAL OF ANNUAL INCIDENCE
1.0396E-10	1.1350E+03	1.1799E-07	4.4724E-07	2.2359E+06

```
Source ID        : GASOLINE STATIONS AS N-G AREA SOURCE
Source Type      : AREA
Source Grid Type : CART
Source Latitude  :  4.1689E+01
Source Longitude :  8.7850E+01

Number of Grid Cells in East-West Direction :  55
Length of Cells in East-West Direction (Km) :  5.0000E+00
Number of Grid Cells in North-South Direction :  55
Length of Cells in North-South Direction (Km) :  5.0000E+00
```

```
                    SOURCE-SPECIFIC EXPOSURE SUMMARY

STUDY NAME : NEWDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER    1
Source Name       : GASOLINE STATIONS AS N-G AREA SOURCE
Pollutant Name    : BENZENE

                          POPULATION                    CUMULATIVE  CUMULATIVE
 CONC LB      CONC UB     EXPOSED      EXPOSURE         POPULATION  EXPOSURE
(ug/m**3)    (ug/m**3)    (persons)   (p-ug/m**3)       (persons)  (p-ug/m**3)

2.5000E-01  5.0000E-01  1.2580E+05  4.0611E+04  1.2580E+05  4.0611E+04
1.0000E-01  2.5000E-01  8.7692E+05  1.2463E+05  1.0027E+06  1.6504E+05
5.0000E-02  1.0000E-01  1.6337E+06  1.1449E+05  2.6364E+06  2.7953E+05
2.5000E-02  5.0000E-02  2.1341E+06  7.6423E+04  4.7705E+06  3.5595E+05
1.0000E-02  2.5000E-02  2.2404E+06  3.8897E+04  7.0110E+06  3.9485E+05
5.0000E-03  1.0000E-02  8.9111E+05  6.6704E+03  7.9021E+06  4.0152E+05
2.5000E-03  5.0000E-03  5.1223E+05  1.8693E+03  8.4143E+06  4.0339E+05
1.0000E-03  2.5000E-03  4.6977E+05  7.9288E+02  8.8841E+06  4.0418E+05
5.0000E-04  1.0000E-03  3.2088E+05  2.3539E+02  9.2049E+06  4.0442E+05
2.5000E-04  5.0000E-04  2.2459E+05  8.4710E+01  9.4295E+06  4.0450E+05
1.0000E-04  2.5000E-04  1.2934E+05  2.3086E+01  9.5589E+06  4.0453E+05
5.0000E-05  1.0000E-04  3.3125E+04  2.5662E+00  9.5920E+06  4.0453E+05
2.5000E-05  5.0000E-05  9.5320E+03  3.5839E-01  9.6015E+06  4.0453E+05
1.0000E-05  2.5000E-05  6.1670E+03  1.1862E-01  9.6077E+06  4.0453E+05
5.0000E-06  1.0000E-05  5.1700E+02  3.9760E-03  9.6082E+06  4.0453E+05
2.5000E-06  5.0000E-06  2.2400E+02  9.1366E-04  9.6084E+06  4.0453E+05
1.0000E-06  2.5000E-06  6.0000E+01  9.4629E-05  9.6085E+06  4.0453E+05
5.0000E-07  1.0000E-06  3.0000E+00  2.5520E-06  9.6085E+06  4.0453E+05
2.5000E-07  5.0000E-07  1.7000E+01  6.5723E-06  9.6085E+06  4.0453E+05
1.0000E-07  2.5000E-07  1.0000E+00  1.0332E-07  9.6085E+06  4.0453E+05
2.5000E-08  5.0000E-08  4.0000E+00  1.8404E-07  9.6085E+06  4.0453E+05

MAXIMUM      POPULATION  TOTAL MAXIMUM
EXPOSURE      EXPOSED      EXPOSURE
(ug/m**3)    (persons)   (p_ug/m**3)

4.4191E-01  5.9240E+03  2.6178E+03
```



SOURCE-SPECIFIC RISK SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Source Name : GASOLINE STATIONS AS H-G AREA SOURCE
Pollutant Name : BENZENE

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
2.5000E-06	5.0000E-06	5.6485E+04	1.7584E-01	5.6485E+04	1.7584E-01
1.0000E-06	2.5000E-06	6.7674E+05	9.4770E-01	7.3322E+05	1.1235E+00
5.0000E-07	1.0000E-06	1.3866E+06	9.5914E-01	2.1138E+06	2.0827E+00
2.5000E-07	5.0000E-07	2.0595E+06	7.3578E-01	4.1733E+06	2.8185E+00
1.0000E-07	2.5000E-07	2.5251E+06	4.3022E-01	6.6984E+06	3.2487E+00
5.0000E-08	1.0000E-07	9.9981E+05	7.4640E-02	7.6982E+06	3.3233E+00
2.5000E-08	5.0000E-08	5.9305E+05	2.2017E-02	8.2912E+06	3.3453E+00
1.0000E-08	2.5000E-08	5.1490E+05	8.6666E-03	8.8061E+06	3.3540E+00
5.0000E-09	1.0000E-08	3.1735E+05	2.2938E-03	9.1235E+06	3.3563E+00
2.5000E-09	5.0000E-09	2.6313E+05	9.8144E-04	9.3866E+06	3.3573E+00
1.0000E-09	2.5000E-09	1.5686E+05	2.7437E-04	9.5435E+06	3.3575E+00
5.0000E-10	1.0000E-09	4.1605E+04	3.2039E-05	9.5851E+06	3.3576E+00
2.5000E-10	5.0000E-10	1.4748E+04	5.8426E-06	9.5998E+06	3.3576E+00
1.0000E-10	2.5000E-10	7.7610E+03	1.3750E-06	9.6076E+06	3.3576E+00
5.0000E-11	1.0000E-10	4.8800E+02	3.6395E-08	9.6081E+06	3.3576E+00
2.5000E-11	5.0000E-11	3.4200E+02	1.3416E-08	9.6084E+06	3.3576E+00
1.0000E-11	2.5000E-11	6.2000E+01	1.0816E-09	9.6085E+06	3.3576E+00
5.0000E-12	1.0000E-11	2.0000E+01	1.8935E-10	9.6085E+06	3.3576E+00
2.5000E-12	5.0000E-12	1.3000E+01	4.4895E-11	9.6085E+06	3.3576E+00
1.0000E-12	2.5000E-12	4.0000E+00	9.6553E-12	9.6085E+06	3.3576E+00
5.0000E-13	1.0000E-12	1.0000E+00	8.5754E-13	9.6085E+06	3.3576E+00
2.5000E-13	5.0000E-13	4.0000E+00	1.5275E-12	9.6085E+06	3.3576E+00

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)	ANNUAL INCIDENCE (Number of cancers per year)	RECIPROCAL OF ANNUAL INCIDENCE
3.6678E-06	5.9240E+03	2.1728E-02	4.7966E-02	2.0848E+01

REPORT 3: SOURCE-GROUP EXPOSURE/RISK REPORT

Report 3 is similar to Report 2 except that pollutant-specific information is summarized for source groups rather than for individual sources. In the example shown here, Source Group 1 includes one area source and two point sources. The geographic boundaries of the source group grid are also shown.

The exposure and risk tables are constructed in the same way as described for Report 2. Note that these tables do provide new information not given in Report 2. For example, the MAXIMUM EXPOSURE for chloroform within Source Group 1 area is higher than for either of the two individual point sources alone. The maxima shown on this source group report are determined by summing the contribution of each source at a population BGED. Because the individual maxima were at different BGEDs, the Source Group Maximum will differ from the sum of the two individual maxima. CUMULATIVE EXPOSURE, on the other hand, sums over the entire grid. Therefore, the source group cumulative values are equal to the sum of the source-specific cumulative values for each pollutant shown in Report 2.

Report 3 will give pollutant-specific summaries for each source group defined in the study.

```
**   EPA HUMAN EXPOSURE MODEL  (HEM-II VERSION 1.3  ) **
                    REPORT 3
          SOURCE-GROUP EXPOSURE/RISK REPORT

   STUDY NAME : HEMDEMO
   STUDY DATE : 01/31/90
   STUDY TIME : 10:20:52

       SOURCE GROUP ID : SOURCE GROUP NUMBER    1

       Source Group Center Latitude     :  0.0000E+00
       Source Group Center Longitude    :  0.0000E+00
       Source Group SW Corner Latitude  :  4.0428E+01
       Source Group SW Corner Longitude :  8.9551E+01
       Source Group NE Corner Latitude  :  4.2928E+01
       Source Group NE Corner Longitude :  8.6182E+01


       Total Number of Sources in Source Group      :  3

       Total Number of Area Sources                 :  1
       Total Number of Point Sources                :  2
       Total Number of Prototype Sources            :  0
```

```
                    SOURCE GROUP EXPOSURE SUMMARY

   STUDY NAME : HEMDEMO
   STUDY DATE : 01/31/90
   STUDY TIME : 10:20:52


    Source Group Name : SOURCE GROUP NUMBER    1
    Pollutant Name    : CHLOROFORM

                          POPULATION                    CUMULATIVE  CUMULATIVE
    CONC LB     CONC UB    EXPOSED     EXPOSURE        POPULATION  EXPOSURE
   (ug/m**3)   (ug/m**3)  (persons)  (p-ug/m**3)      (persons)   (p-ug/m**3)

   2.5000E-02  5.0000E-02  3.1370E+03  1.1715E+02      3.1370E+03  1.1715E+02
   1.0000E-02  2.5000E-02  1.0151E+04  1.3854E+02      1.3288E+04  2.5570E+02
   5.0000E-03  1.0000E-02  3.3190E+04  2.2646E+02      4.6478E+04  4.8216E+02
   2.5000E-03  5.0000E-03  1.7169E+05  5.8134E+02      2.1816E+05  1.0635E+03
   1.0000E-03  2.5000E-03  1.0430E+06  1.7142E+03      1.2611E+06  2.7777E+03
   5.0000E-04  1.0000E-03  5.5619E+05  4.0906E+02      1.8173E+06  3.1867E+03
   2.5000E-04  5.0000E-04  8.4840E+05  2.9367E+02      2.6657E+06  3.4804E+03
   1.0000E-04  2.5000E-04  2.4470E+06  3.8268E+02      5.1127E+06  3.8631E+03
   5.0000E-05  1.0000E-04  1.1803E+06  9.2772E+01      6.2930E+06  3.9559E+03
   2.5000E-05  5.0000E-05  3.6261E+04  1.7147E+00      6.3293E+06  3.9576E+03

   MAXIMUM      POPULATION  TOTAL MAXIMUM
   EXPOSURE      EXPOSED      EXPOSURE
   (ug/m**3)    (persons)    (p_ug/m**3)

   3.8418E-02  2.1830E+03  8.3867E+01
```

SOURCE GROUP RISK SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Pollutant Name : CHLOROFORM

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
5.0000E-07	1.0000E-06	3.1370E+03	2.6945E-03	3.1370E+03	2.6945E-03
2.5000E-07	5.0000E-07	7.6760E+03	2.5956E-03	1.0813E+04	5.2901E-03
1.0000E-07	2.5000E-07	6.6093E+04	9.0701E-03	7.6906E+04	1.4360E-02
5.0000E-08	1.0000E-07	2.2943E+05	1.4808E-02	3.0633E+05	2.9168E-02
2.5000E-08	5.0000E-08	8.8692E+05	3.3090E-02	1.1933E+06	6.2258E-02
1.0000E-08	2.5000E-08	7.5817E+05	1.2475E-02	1.9514E+06	7.4733E-02
5.0000E-09	1.0000E-08	9.6635E+05	6.6641E-03	2.9178E+06	8.1397E-02
2.5000E-09	5.0000E-09	1.9194E+06	6.7933E-03	4.8372E+06	8.8190E-02
1.0000E-09	2.5000E-09	1.4921E+06	2.8337E-03	6.3293E+06	9.1024E-02

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)
8.8362E-07	2.1830E+03	1.9289E-03

SOURCE GROUP EXPOSURE SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Pollutant Name : BENZENE

CONC LB (ug/m**3)	CONC UB (ug/m**3)	POPULATION EXPOSED (persons)	EXPOSURE (p-ug/m**3)	CUMULATIVE POPULATION (persons)	CUMULATIVE EXPOSURE (p-ug/m**3)
2.5000E-01	5.0000E-01	1.2580E+05	4.0460E+04	1.2580E+05	4.0460E+04
1.0000E-01	2.5000E-01	8.8610E+05	1.2582E+05	1.0100E+06	1.6628E+05
5.0000E-02	1.0000E-01	1.6825E+06	1.1810E+05	2.6923E+06	2.8439E+05
2.5000E-02	5.0000E-02	2.7317E+06	7.6950E+04	4.8439E+06	3.6134E+05
1.0000E-02	2.5000E-02	2.2068E+06	3.8247E+04	7.0507E+06	3.9958E+05
5.0000E-03	1.0000E-02	9.0293E+05	6.8461E+03	7.9537E+06	4.0643E+05
2.5000E-03	5.0000E-03	5.0108E+05	1.0385E+03	8.4548E+06	4.0827E+05
1.0000E-03	2.5000E-03	4.5703E+05	7.6205E+02	8.9118E+06	4.0903E+05
5.0000E-04	1.0000E-03	3.2233E+05	2.3916E+02	9.2341E+06	4.0927E+05
2.5000E-04	5.0000E-04	2.1223E+05	7.9217E+01	9.4463E+06	4.0935E+05
1.0000E-04	2.5000E-04	1.1912E+05	2.1266E+01	9.5655E+06	4.0937E+05
5.0000E-05	1.0000E-04	2.9690E+04	2.3267E+00	9.5952E+06	4.0937E+05
2.5000E-05	5.0000E-05	6.8660E+03	2.4726E-01	9.6020E+06	4.0937E+05
1.0000E-05	2.5000E-05	5.8590E+03	1.1262E-01	9.6079E+06	4.0937E+05
5.0000E-06	1.0000E-05	3.6200E+02	2.9433E-03	9.6082E+06	4.0937E+05
2.5000E-06	5.0000E-06	2.1700E+02	8.8667E-04	9.6085E+06	4.0937E+05
1.0000E-06	2.5000E-06	3.2000E+01	4.9502E-05	9.6085E+06	4.0937E+05
5.0000E-07	1.0000E-06	3.0000E+00	2.3520E-06	9.6085E+06	4.0937E+05
2.5000E-07	5.0000E-07	1.7000E+01	6.3723E-06	9.6085E+06	4.0937E+05
1.0000E-07	2.5000E-07	1.0000E+00	1.0332E-07	9.6085E+06	4.0937E+05
2.5000E-08	5.0000E-08	4.0000E+00	1.8404E-07	9.6085E+06	4.0937E+05

MAXIMUM EXPOSURE (ug/m**3)	POPULATION EXPOSED (persons)	TOTAL MAXIMUM EXPOSURE (p_ug/m**3)
4.4219E-01	5.9240E+03	2.6195E+03

SOURCE GROUP RISK SUMMARY

STUDY NAME : BENDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Pollutant Name : BENZENE

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
2.5000E-06	5.0000E-06	5.6485E+04	1.7606E-01	5.6485E+04	1.7606E-01
1.0000E-06	2.5000E-06	4.8033E+05	9.5375E-01	7.3681E+05	1.1298E+00
5.0000E-07	1.0000E-06	1.4194E+06	9.8716E-01	2.1563E+06	2.1170E+00
2.5000E-07	5.0000E-07	2.0759E+06	7.4275E-01	4.2322E+06	2.8597E+00
1.0000E-07	2.5000E-07	2.5019E+06	4.2783E-01	6.7340E+06	3.2876E+00
5.0000E-08	1.0000E-07	1.0353E+06	7.7358E-02	7.7693E+06	3.3649E+00
2.5000E-08	5.0000E-08	5.5765E+05	2.0808E-02	8.3270E+06	3.3857E+00
1.0000E-08	2.5000E-08	4.9994E+05	8.4531E-03	8.8269E+06	3.3942E+00
5.0000E-09	1.0000E-08	3.3161E+05	2.4183E-03	9.1585E+06	3.3966E+00
2.5000E-09	5.0000E-09	2.4521E+05	9.0689E-04	9.4037E+06	3.3975E+00
1.0000E-09	2.5000E-09	1.4725E+05	2.5968E-04	9.5510E+06	3.3978E+00
5.0000E-10	1.0000E-09	3.8769E+04	2.9937E-05	9.5898E+06	3.3978E+00
2.5000E-10	5.0000E-10	1.0632E+04	4.1946E-06	9.6004E+06	3.3978E+00
1.0000E-10	2.5000E-10	7.3900E+03	1.3058E-06	9.6078E+06	3.3978E+00
5.0000E-11	1.0000E-10	4.0400E+02	3.0583E-08	9.6082E+06	3.3978E+00
2.5000E-11	5.0000E-11	2.5200E+02	9.4850E-09	9.6084E+06	3.3978E+00
1.0000E-11	2.5000E-11	5.1000E+01	8.7523E-10	9.6085E+06	3.3978E+00
5.0000E-12	1.0000E-11	3.0000E+00	2.1181E-11	9.6085E+06	3.3978E+00
2.5000E-12	5.0000E-12	1.3000E+01	4.4895E-11	9.6085E+06	3.3978E+00
1.0000E-12	2.5000E-12	4.0000E+00	9.6553E-12	9.6085E+06	3.3978E+00
5.0000E-13	1.0000E-12	1.0000E+00	8.5754E-13	9.6085E+06	3.3978E+00
2.5000E-13	5.0000E-13	4.0000E+00	1.5275E-12	9.6085E+06	3.3978E+00

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)
3.6702E-06	5.9240E+03	2.1742E-02

SOURCE GROUP EXPOSURE SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Source Group Name : SOURCE GROUP NUMBER 1
Pollutant Name : STYRENE

CONC LB (ug/m**3)	CONC UB (ug/m**3)	POPULATION EXPOSED (persons)	EXPOSURE (p-ug/m**3)	CUMULATIVE POPULATION (persons)	CUMULATIVE EXPOSURE (p-ug/m**3)
1.0000E-01	2.5000E-01	2.1830E+03	2.3762E+02	2.1830E+03	2.3762E+02
5.0000E-02	1.0000E-01	2.3400E+03	1.7650E+02	4.5230E+03	4.1412E+02
2.5000E-02	5.0000E-02	1.1551E+04	3.7123E+02	1.6074E+04	7.8535E+02
1.0000E-02	2.5000E-02	5.9093E+04	8.6800E+02	7.5167E+04	1.6533E+03
5.0000E-03	1.0000E-02	1.3357E+05	9.5735E+02	2.0874E+05	2.6107E+03
2.5000E-03	5.0000E-03	2.3681E+05	8.0415E+02	4.4555E+05	3.4148E+03
1.0000E-03	2.5000E-03	1.0321E+06	1.5142E+03	1.4777E+06	4.9291E+03
5.0000E-04	1.0000E-03	1.6318E+06	1.1556E+03	3.1095E+06	6.0847E+03
2.5000E-04	5.0000E-04	2.2128E+06	8.0368E+02	5.3223E+06	6.8883E+03
1.0000E-04	2.5000E-04	1.0070E+06	2.0132E+02	6.3293E+06	7.0897E+03

MAXIMUM EXPOSURE (ug/m**3)	POPULATION EXPOSED (persons)	TOTAL MAXIMUM EXPOSURE (p_ug/m**3)
1.0885E-01	2.1830E+03	2.3762E+02

SOURCE GROUP RISK SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

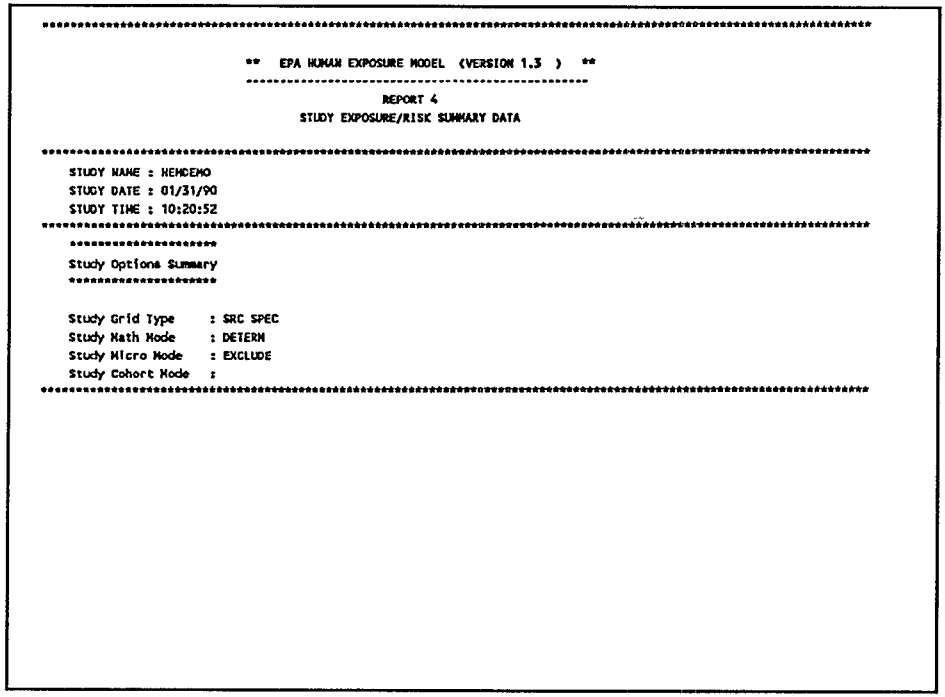
Source Group Name : SOURCE GROUP NUMBER 1
Pollutant Name : STYRENE

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
1.0000E-08	2.5000E-08	2.1830E+03	2.3762E-05	2.1830E+03	2.3762E-05
5.0000E-09	1.0000E-08	2.3400E+03	1.7650E-05	4.5230E+03	4.1412E-05
2.5000E-09	5.0000E-09	1.1551E+04	3.7123E-05	1.6074E+04	7.8535E-05
1.0000E-09	2.5000E-09	5.9093E+04	8.6800E-05	7.5167E+04	1.6533E-04
5.0000E-10	1.0000E-09	1.3357E+05	9.5735E-05	2.0874E+05	2.6107E-04
2.5000E-10	5.0000E-10	2.3681E+05	8.0415E-05	4.4555E+05	3.4148E-04
1.0000E-10	2.5000E-10	1.0321E+06	1.5142E-04	1.4777E+06	4.9291E-04
5.0000E-11	1.0000E-10	1.6318E+06	1.1556E-04	3.1095E+06	6.0847E-04
2.5000E-11	5.0000E-11	2.2128E+06	8.0368E-05	5.3223E+06	6.8883E-04
1.0000E-11	2.5000E-11	1.0070E+06	2.0132E-05	6.3293E+06	7.0897E-04

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)
1.0885E-08	2.1830E+03	2.3762E-05

Report 4: Study Exposure/Risk Report

Report 4 summarizes exposure and risk estimates for all source groups. In the example used here, only one source group was defined. Therefore, Reports 3 and 4 give the same exposure and risk results. When more than one source group is defined, the studywide MAXIMUM EXPOSURE and MAXIMUM RISK values reported in Report 4 are likely to be different from any of those reported for individual source groups in Report 3.



```
**  EPA HUMAN EXPOSURE MODEL  (VERSION 1.3 )  **
REPORT 4
STUDY EXPOSURE/RISK SUMMARY DATA

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Study Options Summary

Study Grid Type     : SRC SPEC
Study Math Mode     : DETERM
Study Micro Mode    : EXCLUDE
Study Cohort Mode   :
```

STUDY EXPOSURE SUMMARY

STUDY NAME : NEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Pollutant Name : CHLOROFORM

CONC LB (ug/m**3)	CONC UB (ug/m**3)	POPULATION EXPOSED (persons)	EXPOSURE (p-ug/m**3)	CUMULATIVE POPULATION (persons)	CUMULATIVE EXPOSURE (p-ug/m**3)
2.5000E-02	5.0000E-02	3.1370E+03	1.1715E+02	1.1715E+02	3.1370E+03
1.0000E-02	2.5000E-02	1.0151E+04	1.3854E+02	2.5570E+02	1.3288E+04
5.0000E-03	1.0000E-02	3.3190E+04	2.2646E+02	4.8216E+02	4.6478E+04
2.5000E-03	5.0000E-03	1.7169E+05	5.8134E+02	1.0635E+03	2.1816E+05
1.0000E-03	2.5000E-03	1.0430E+06	1.7142E+03	2.7777E+03	1.2611E+06
5.0000E-04	1.0000E-03	5.5619E+05	4.0906E+02	3.1867E+03	1.8173E+06
2.5000E-04	5.0000E-04	8.4840E+05	2.9367E+02	3.4804E+03	2.6657E+06
1.0000E-04	2.5000E-04	2.4470E+06	3.8268E+02	3.8631E+03	5.1127E+06
5.0000E-05	1.0000E-04	1.1803E+06	9.2772E+01	3.9559E+03	6.2930E+06
2.5000E-05	5.0000E-05	3.6261E+04	1.7147E+00	3.9576E+03	6.3293E+06

MAXIMUM EXPOSURE (ug/m**3)	POPULATION EXPOSED (persons)	TOTAL MAXIMUM EXPOSURE (p_ug/m**3)
2.1830E+03	3.8418E-02	8.3867E+01

STUDY RISK SUMMARY

STUDY NAME : NEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Pollutant Name : CHLOROFORM

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
5.0000E-07	1.0000E-06	3.1370E+03	2.6945E-03	3.1370E+03	2.6945E-03
2.5000E-07	5.0000E-07	7.6760E+03	2.5956E-03	1.0813E+04	5.2901E-03
1.0000E-07	2.5000E-07	6.6093E+04	9.0701E-03	7.6906E+04	1.4360E-02
5.0000E-08	1.0000E-07	2.2943E+05	1.4808E-02	3.0633E+05	2.9168E-02
2.5000E-08	5.0000E-08	8.8692E+05	3.3090E-02	1.1933E+06	6.2258E-02
1.0000E-08	2.5000E-08	7.5817E+05	1.2675E-02	1.9514E+06	7.4733E-02
5.0000E-09	1.0000E-08	9.6635E+05	6.6641E-03	2.9178E+06	8.1397E-02
2.5000E-09	5.0000E-09	1.9194E+06	6.7933E-03	4.8372E+06	8.8190E-02
1.0000E-09	2.5000E-09	1.4921E+06	2.8337E-03	6.3293E+06	9.1024E-02

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)
2.1830E+03	8.8362E-07	1.9289E-03

STUDY EXPOSURE SUMMARY

STUDY NAME : NEMOEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Pollutant Name : BENZENE

CONC LB (ug/m**3)	CONC UB (ug/m**3)	POPULATION EXPOSED (persons)	EXPOSURE (p-ug/m**3)	CUMULATIVE POPULATION (persons)	CUMULATIVE EXPOSURE (p-ug/m**3)
2.5000E-01	5.0000E-01	1.2580E+05	4.0460E+04	4.0460E+04	1.2580E+05
1.0000E-01	2.5000E-01	8.8419E+05	1.2582E+05	1.6628E+05	1.0100E+06
5.0000E-02	1.0000E-01	1.6823E+06	1.1810E+05	2.8439E+05	2.0923E+06
2.5000E-02	5.0000E-02	2.1917E+06	7.6950E+04	3.6134E+05	4.8439E+06
1.0000E-02	2.5000E-02	2.2068E+06	3.8247E+04	3.9958E+05	7.0507E+06
5.0000E-03	1.0000E-02	9.0293E+05	6.8461E+03	4.0643E+05	7.9537E+06
2.5000E-03	5.0000E-03	5.0108E+05	1.8385E+03	4.0827E+05	8.4548E+06
1.0000E-03	2.5000E-03	4.5703E+05	7.6205E+02	4.0903E+05	8.9118E+06
5.0000E-04	1.0000E-03	3.2233E+05	2.3916E+02	4.0927E+05	9.2341E+06
2.5000E-04	5.0000E-04	2.1223E+05	7.9217E+01	4.0935E+05	9.4663E+06
1.0000E-04	2.5000E-04	1.1912E+05	2.1266E+01	4.0937E+05	9.5655E+06
5.0000E-05	1.0000E-04	2.9696E+04	2.3267E+00	4.0937E+05	9.5952E+06
2.5000E-05	5.0000E-05	6.8660E+03	2.4726E-01	4.0937E+05	9.6020E+06
1.0000E-05	2.5000E-05	5.8590E+03	1.1262E-01	4.0937E+05	9.6079E+06
5.0000E-06	1.0000E-05	3.6200E+02	2.9435E-03	4.0937E+05	9.6082E+06
2.5000E-06	5.0000E-06	2.1700E+02	8.8667E-04	4.0937E+05	9.6085E+06
1.0000E-06	2.5000E-06	3.2000E+01	4.9502E-05	4.0937E+05	9.6085E+06
5.0000E-07	1.0000E-06	3.0000E+00	2.5520E-06	4.0937E+05	9.6085E+06
2.5000E-07	5.0000E-07	1.7000E+01	6.5723E-06	4.0937E+05	9.6085E+06
1.0000E-07	2.5000E-07	1.0000E+00	1.0332E-07	4.0937E+05	9.6085E+06
2.5000E-08	5.0000E-08	4.0000E+00	1.8404E-07	4.0937E+05	9.6085E+06

MAXIMUM EXPOSURE (ug/m**3)	POPULATION EXPOSED (persons)	TOTAL MAXIMUM EXPOSURE (p_ug/m**3)
5.9240E+03	4.4219E-01	2.6195E+03

STUDY RISK SUMMARY

STUDY NAME : NEMOEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Pollutant Name : BENZENE

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
2.5000E-06	5.0000E-06	5.6485E+04	1.7606E-01	5.6485E+04	1.7606E-01
1.0000E-06	2.5000E-06	6.8033E+05	9.5375E-01	7.3681E+05	1.1298E+00
5.0000E-07	1.0000E-06	1.4194E+06	9.8714E-01	2.1543E+06	2.1170E+00
2.5000E-07	5.0000E-07	2.0759E+06	7.4275E-01	4.2322E+06	2.8597E+00
1.0000E-07	2.5000E-07	2.5019E+06	4.2783E-01	6.7340E+06	3.2876E+00
5.0000E-08	1.0000E-07	1.0353E+06	7.7358E-02	7.7693E+06	3.3649E+00
2.5000E-08	5.0000E-08	5.5765E+05	2.0808E-02	8.3270E+06	3.3857E+00
1.0000E-08	2.5000E-08	4.9994E+05	8.4331E-03	8.8269E+06	3.3942E+00
5.0000E-09	1.0000E-08	3.3161E+05	2.4183E-03	9.1585E+06	3.3966E+00
2.5000E-09	5.0000E-09	2.4521E+05	9.0869E-04	9.4037E+06	3.3975E+00
1.0000E-09	2.5000E-09	1.4725E+05	2.5968E-04	9.5510E+06	3.3978E+00
5.0000E-10	1.0000E-09	3.8769E+04	2.9937E-05	9.5898E+06	3.3978E+00
2.5000E-10	5.0000E-10	1.0432E+04	4.1946E-06	9.6004E+06	3.3978E+00
1.0000E-10	2.5000E-10	7.3900E+03	1.3058E-06	9.6078E+06	3.3978E+00
5.0000E-11	1.0000E-10	4.0400E+02	3.0983E-08	9.6082E+06	3.3978E+00
2.5000E-11	5.0000E-11	2.5200E+02	9.6850E-09	9.6084E+06	3.3978E+00
1.0000E-11	2.5000E-11	9.1000E+01	8.7523E-10	9.6085E+06	3.3978E+00
5.0000E-12	1.0000E-11	3.0000E+00	2.1181E-11	9.6085E+06	3.3978E+00
2.5000E-12	5.0000E-12	1.3000E+01	4.4895E-11	9.6085E+06	3.3978E+00
1.0000E-12	2.5000E-12	4.0000E+00	9.6593E-12	9.6085E+06	3.3978E+00
5.0000E-13	1.0000E-12	1.0000E+00	8.5754E-13	9.6085E+06	3.3978E+00
2.5000E-13	5.0000E-13	4.0000E+00	1.9275E-12	9.6085E+06	3.3978E+00

MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)
5.9240E+03	3.6702E-06	2.1742E-02

STUDY EXPOSURE SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Pollutant Name : STYRENE

CONC LB (ug/m**3)	CONC UB (ug/m**3)	POPULATION EXPOSED (persons)	EXPOSURE (p-ug/m**3)	CUMULATIVE POPULATION (persons)	CUMULATIVE EXPOSURE (p-ug/m**3)
1.0000E-01	2.5000E-01	2.1830E+03	2.3762E+02	2.3762E+02	2.1830E+03
5.0000E-02	1.0000E-01	2.3400E+03	1.7650E+02	4.1412E+02	4.5230E+03
2.5000E-02	5.0000E-02	1.1551E+04	3.7123E+02	7.8535E+02	1.6074E+04
1.0000E-02	2.5000E-02	5.9093E+04	8.6800E+02	1.6533E+03	7.5167E+04
5.0000E-03	1.0000E-02	1.3357E+05	9.5735E+02	2.6107E+03	2.0874E+05
2.5000E-03	5.0000E-03	2.3681E+05	8.0415E+02	3.4148E+03	4.4555E+05
1.0000E-03	2.5000E-03	1.0321E+06	1.5142E+03	4.9291E+03	1.4777E+06
5.0000E-04	1.0000E-03	1.6318E+06	1.1556E+03	6.0847E+03	3.1095E+06
2.5000E-04	5.0000E-04	2.2128E+06	8.0368E+02	6.8883E+03	5.3223E+06
1.0000E-04	2.5000E-04	1.0070E+06	2.0132E+02	7.0897E+03	6.3293E+06

MAXIMUM EXPOSURE (ug/m**3)	POPULATION EXPOSED (persons)	TOTAL MAXIMUM EXPOSURE (p_ug/m**3)
2.1830E+03	1.0885E-01	2.3762E+02

STUDY RISK SUMMARY

STUDY NAME : HEMDEMO
STUDY DATE : 01/31/90
STUDY TIME : 10:20:52

Pollutant Name : STYRENE

RISK LB (prob of individual cancer)	RISK UB (prob of individual cancer)	POPULATION AT RISK (persons)	RISK (number of cancers in group)	CUMULATIVE POPULATION (persons)	CUMULATIVE RISK (cum no. of cancers)
1.0000E-08	2.5000E-08	2.1830E+03	2.3762E-05	2.1830E+03	2.3762E-05
5.0000E-09	1.0000E-08	2.3400E+03	1.7650E-05	4.5230E+03	4.1412E-05
2.5000E-09	5.0000E-09	1.1551E+04	3.7123E-05	1.6074E+04	7.8535E-05
1.0000E-09	2.5000E-09	5.9093E+04	8.6800E-05	7.5167E+04	1.6533E-04
5.0000E-10	1.0000E-09	1.3357E+05	9.5735E-05	2.0874E+05	2.6107E-04
2.5000E-10	5.0000E-10	2.3681E+05	8.0415E-05	4.4555E+05	3.4148E-04
1.0000E-10	2.5000E-10	1.0321E+06	1.5142E-04	1.4777E+06	4.9291E-04
5.0000E-11	1.0000E-10	1.6318E+06	1.1556E-04	3.1095E+06	6.0847E-04
2.5000E-11	5.0000E-11	2.2128E+06	8.0368E-05	5.3223E+06	6.8883E-04
1.0000E-11	2.5000E-11	1.0070E+06	2.0132E-05	6.3293E+06	7.0897E-04

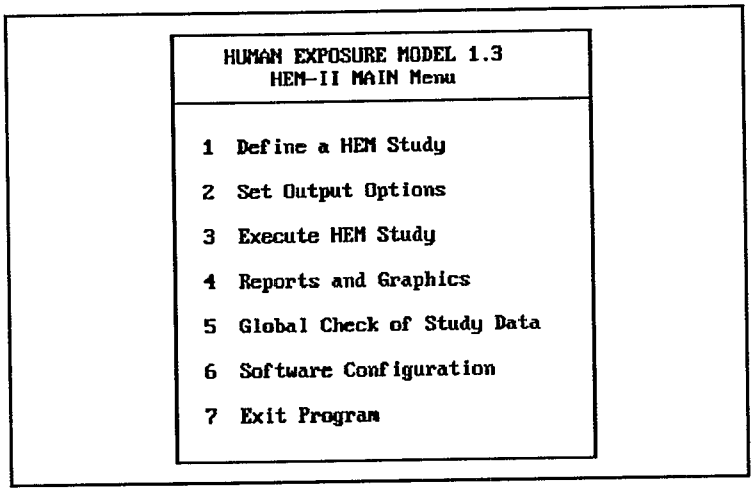
MAXIMUM RISK (prob of individual cancer)	POPULATION AT RISK (persons)	TOTAL MAXIMUM RISK (no. cancers in group)
2.1830E+03	1.0885E-08	2.3762E-05

ISCLT Model Defaults

The ISCLT Model Defaults Report (Appendix I) describes various model inputs that are given predetermined values when this dispersion model is run in the HEM-II system. Some of the default values correspond to what is known as the regulatory default mode of ISCLT.

Preparing HEM-II Graphical Outputs

The Main Menu of the HEM-II User Interface (Version 1.3) is repeated below.



To produce graphical results for a study, the user must perform the following steps:

1. Select '**Define a HEM Study**' and supply all required data.
2. Use '**Set Output Options**' to enable graphics outputs for studywide and/or source-specific graphics data.
3. Select '**Execute HEM Study.**'
4. Select '**Reports and Graphics**' from the **HEM-II MAIN MENU** and enter the GAT subsystem.

5. Use GAT to produce computer-generated graphics from HEM-II graphics output data sets.

Four types of graphical representations of data are available from GAT. These are shown in Table 5-1 with the types of data that are appropriate for each type of representation.

Table 5-1. Types of HEM-II Graphics

Data	Graphical Representation			
	Plan View	Bar Charts	Contour	Surface
Source Locations	X			
BGED Locations	X			
Studywide Concentrations		X	X	X
Source-specific Concentrations		X	X	X
Studywide Population			X	X
Studywide Exposure		X	X	X
Source-specific Exposure		X	X	X
Studywide Risk		X	X	X
Source-specific Risk		X	X	X

The Plan View Graphic (see Figure 5-1) of location data represents a "birds-eye view" with latitude and longitude as the x- and y-axes, respectively. This graphic illustrates the geographic relation between the various emissions sources in a study and the surrounding population centers. Each population center BGED is shown as a dot.

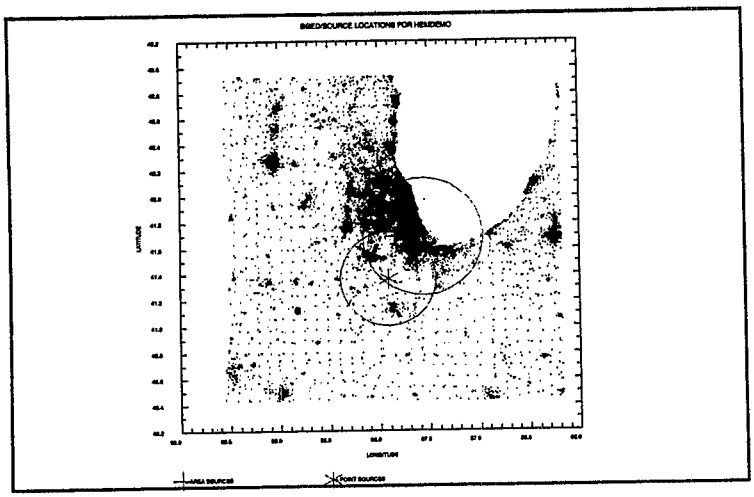


Figure 5-1. Plan View Graphic.

Figure 5-2 shows an example of a Bar Chart Graphic where the height of each bar represents the number of people exposed to each interval of concentration shown on the x-axis. The units and scale of the x-axis will change for different data.

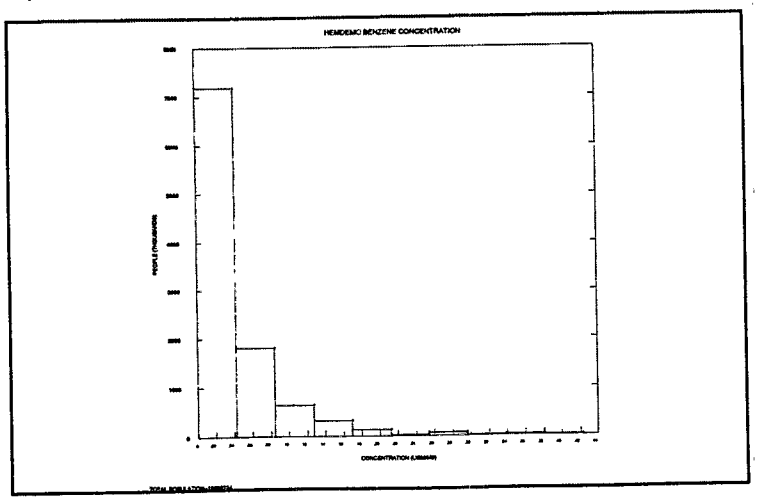


Figure 5-2. Bar Chart Graphic.

The two-dimensional Contour Graphic depicts how data are distributed over a region by the use of isopleth lines. Figure 5-3 shows a contour graphic depicting air concentration for benzene over a region of latitude and longitude.

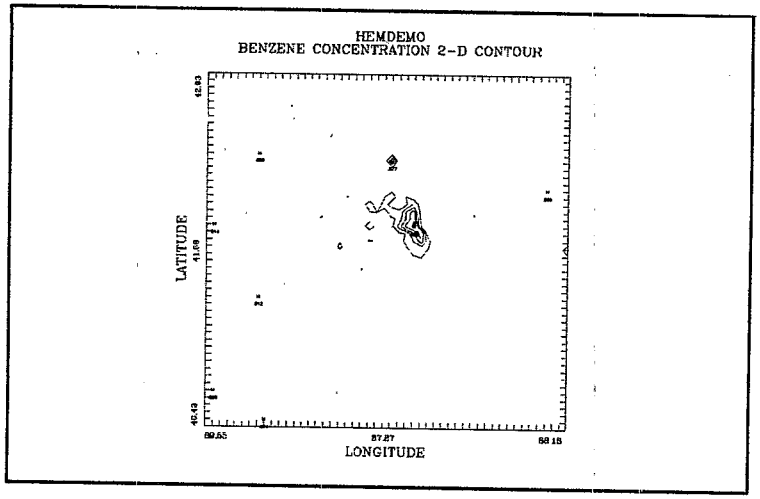


Figure 5-3. Contour Graphic.

Figure 5-4 is an example of a three-dimensional surface. This Surface Graphic presents the same data as in the Contour Graphic (Figure 5-3). However, the region is rotated in the plane perpendicular to the page. Also the viewpoint, or azimuthal angle, is elevated slightly above this plane. The three-dimensional nature of this graphic aids in visualizing the data. Note how visible the locations of the maximum concentrations become.

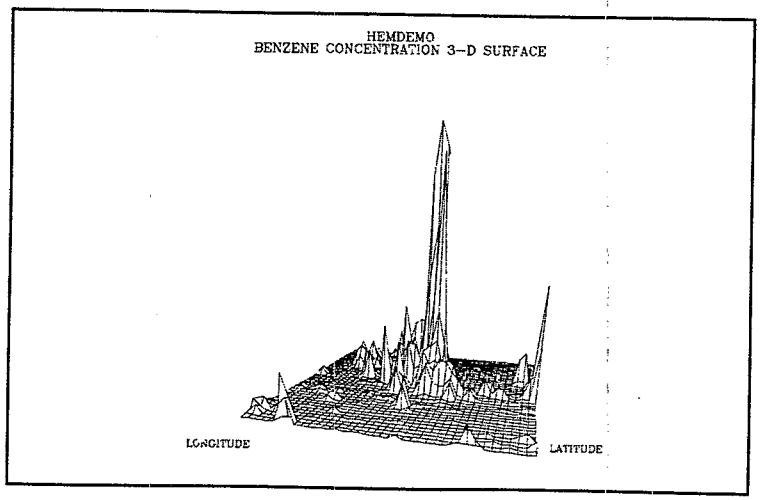


Figure 5-4. Surface Graphic.

Contour and Surface Graphics complement each other. The Surface Graphic enables the user to easily identify points of maximum concentration, risk, etc. The Contour Graphic better presents the quantitative value and the locations of these maxima.

Creating Graphics Output Data Sets

After the user has defined a HEM-II study under selection 1 of the **HEM-II MAIN MENU,** the next step is to enable graphics data output as an output option by selecting item 2 from the **MAIN MENU.** An **OUTPUT OPTIONS SELECTION SCREEN,** shown below, will appear that allows the user to specify either the output of studywide data, source-specific data, or both, for graphics production. This HEM study should then be executed by selecting main menu option 3 and then specifying the name of the study to process. The graphics output data sets specified above are created as the model processes the study. The user must wait until after the study has been completely processed before producing graphics.

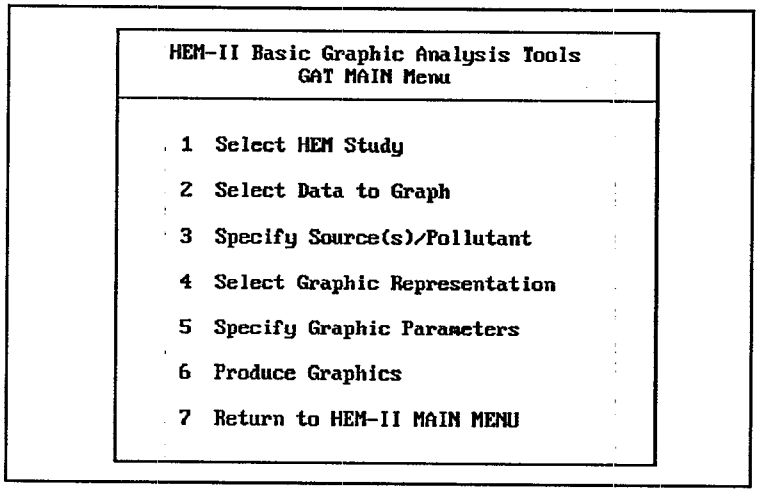
NOTE: The default state is for graphics outputs to be disabled. To activate the graphics, highlight 'enabled.'

```
                    Output Options Selection Screen

Source-Specific Graphics Data  :  Disabled   Enabled
Study-Wide Graphics Data       :  Disabled   Enabled
```

Producing Graphics from Graphics Data Sets

The HEM-II user enters the GAT Menu subsystem by selecting **'Reports and Graphics'** from the main menu and then **'GRAPHICS Analysis Tools'** from

the **HEM-II REPORTS/GRAPHICS MENU**. The **GAT MAIN MENU** (below) will then appear. The user will then select the type of data for graphing and the format of the graphical output by using a set of hierarchically structured control menus.



The **GAT MAIN MENU** options should be selected in the order listed. Therefore, the sequence of events associated with graphics production is as follows:

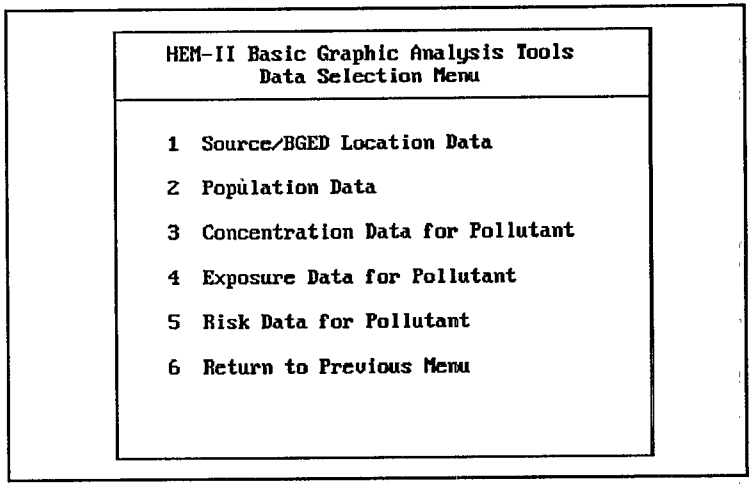
1. Select the HEM-II study to use for graphics.
2. Select data to graph.
3. Specify emissions source(s) and pollutant (if applicable).
4. Select type of graphic (predetermined for some data).
5. Specify graphic viewing parameters (defaults are provided if the user skips this selection).
6. Generate preliminary view of the graphic.
7. Adjust graphic viewing parameters.
8. Generate final view of the graphic.

9. Save graphic in metafile form.

10. Send the metafile to a hard-copy plotter.

The user controls this sequence of events using the **GAT MAIN MENU SCREEN**, which is the central point of orientation for the user to specify and produce graphics.

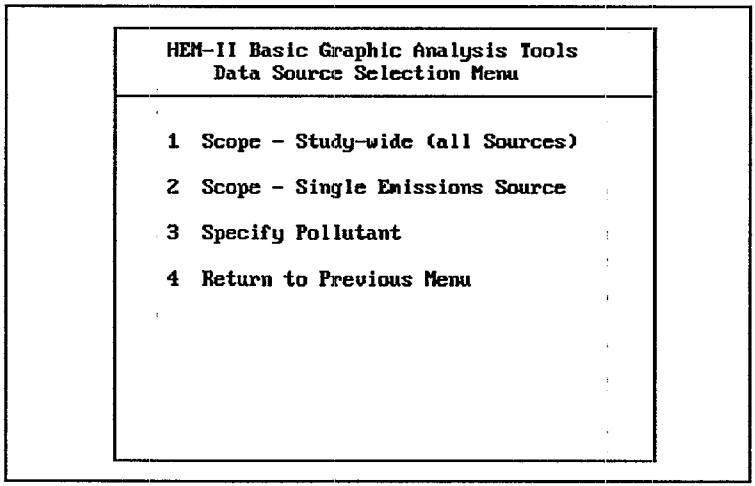
After naming the HEM study to use for producing graphics (the default is the study most recently defined in this session), the user selects the type of HEM-II data for graphical display. As shown in the **DATA SELECTION MENU** below, the options are as follows:



- Population Centroid (BGED) Locations with Emissions Source Locations,
- Population Density,
- Pollutant Concentration,
- Pollutant Exposure, and
- Health Risk Attributed to a Pollutant.

Source and pollutant information is not necessary for source or BGED location graphs. However, if the graph data are pollutant- or source-related data,

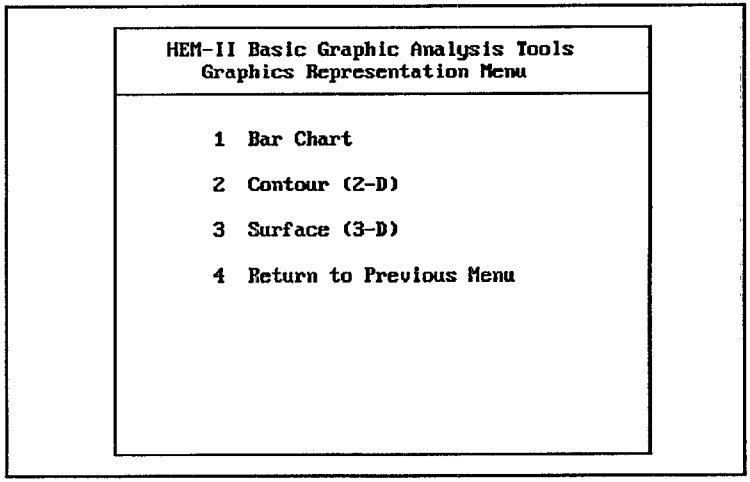
the user will provide input to specify these criteria using the **DATA SOURCE SELECTION MENU** (below). The user must specify a single pollutant if the type of graph chosen is specific to a particular pollutant (e.g., concentration, exposure, or risk).



The user is presented with a list of all pollutant names defined in the named study for selection. Next, the user selects whether to use studywide data (including all emissions sources), or, alternatively, to use data only for a single emissions source. Select either option 1 or 2 to accomplish this. If the user selects a single source, a computer display of all source names in the specified study is presented for selection.

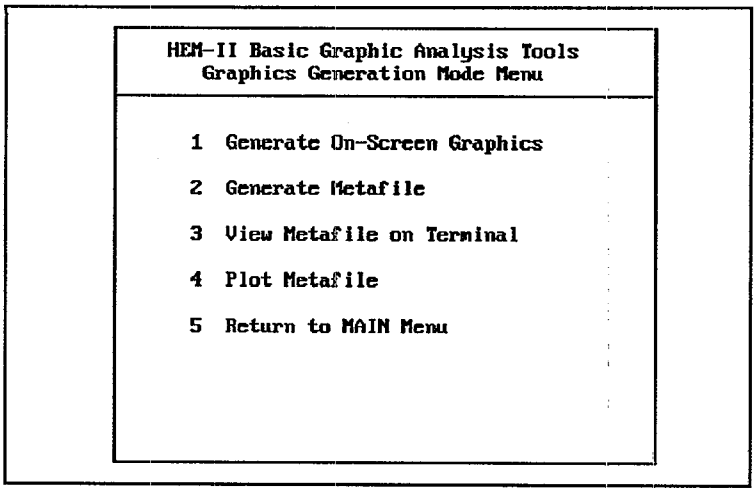
After the user selects the HEM-II study, the data to graph, and applicable source(s)/pollutant details, the user proceeds to the **GRAPHICS REPRESENTATION MENU** to select the type of graphic to generate: '**Bar Chart**,' '**Contour (2-D)**,' or '**Surface (3-D)**.' Some graphic representations are determined by the graph data, and the user will be informed regarding the applicable graph type instead of using the **GRAPHICS REPRESENTATION MENU**. For example, if the user selects BGED locations as the graph data, the

only graphic representation for this graph data is a Plan View Graphic; this will be automatically detected by the software. For this reason, the Plan View Graphic does not appear on this screen.



At this time, the user may specify certain display parameters, such as the title of the graphic, using the Display Parameters Screen (item 5 from the **GAT MAIN MENU** shown previously. Defaults are provided for unspecified values. Alternatively, the user may want to wait until after viewing the graphic to specify graphic labels, titles, and specific viewing parameters all at once. The user may change some specific values but accept the default values provided for other parameters. The Graphics Parameters Entry Screen has not been designed at this time. It will be designed during the phase of developing details for interfacing and controlling the GRAFkit® routines when they are better defined. Such values as graphic title, axis labels, captions, and viewing angles are expected to be incorporated in this data entry screen.

The **GRAPHICS GENERATION MODE MENU** is used for all subsequent steps of graphics production.



The user may now generate the graphic on the computer terminal using selection 1 from the **GRAPHICS GENERATION MODE MENU**. The GRAFkit® support software will construct the graphical image for the type and content specified in the GAT Menu subsystem. If, for example, BGED Location was selected as the graph data, a graphic like the one shown in Figure 5-1 would be created. On the other hand, if Studywide Concentration was selected as the graph data, graphics like Figures 5-2, 5-3, and 5-4 will be created. Figure 5-2 shows an example of what is produced if '**Bar Chart**' was chosen as the graphics representation. Figure 5-3 shows the type of two-dimensional isopleth produced if '**Contour**' was chosen as the graphics representation. Figure 5-4 gives an example of a three-dimensional isopleth that is created if '**Surface**' was chosen as the graphics representation.

After viewing the graphic with default display parameters, the user may desire to modify these display parameters to tailor the appearance of the graphic, then to regenerate the display.

When the appearance of the graphic is as desired (scale, perspective, etc.) the graphic may be permanently saved as a Computer Graphics Metafile (CGM). The CGM produced by GRAFkit® conforms to the ISO-CGM (International Standards

Organization) standard. This CGM may be directly recalled for display or for generating hard copy on a plotter at a later time. The metafile is retained as a permanent file in the user's directory of the VAX computer. This file may be downloaded from the VAX to a PC by using the Kermit file transfer utility between the VAX and the PC. Note that you must use the binary transfer mode of Kermit. These metafiles may be used with PC-based graphics and desktop publishing systems that support the CGM standard.

SECTION 6
REFERENCES

Federal Register. Preamble to the Proposed National Emission Standards for Hazardous Air Pollutants (NESHAP) for Benzene, Volume 53, p. 28496, July 28, 1988.

Federal Register. Preamble to the Final National Emission Standards for Hazardous Air Pollutants (NESHAP) for Benzene, Volume 54, p. 38044, September 14, 1989.

U.S. Environmental Protection Agency. Guideline on Air Quality Models (Revised) (Includes Supplement A, July 1987). EPA-450/2-78-027R, U.S. EPA Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1986a.

U.S. Environmental Protection Agency. User's Manual For the Human Exposure Model (HEM). EPA-450/5-86-001, U.S. EPA Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1986b.

U.S. Environmental Protection Agency. Industrial Source Complex (ISC) Dispersion Model User's Guide-Second Edition (Revised) Volume I (Includes June 1988 updates). EPA 450/4-88-002a, U.S. EPA Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1987.

U.S. Environmental Protection Agency. VAX Cluster Ready Reference. In: Guide to NCC Services. U.S. EPA Office of Administration and Resources Management/National Data Processing Division, Research Triangle Park, North Carolina, 1989.

APPENDIX A
HEM-II DISK FILE DIRECTORIES

NOTE: This list has been updated for Version 15. File names may vary for subsequent versions.

DIRECTORY NAME	CONTENTS	FILES
User Inputs	Study Data	HEMSTUDY_U*.DAT
User Outputs	HEM-II Results Files	<for future use>
USR Exe	Programs	HEM.EXE
HEM Supervisor Exe	Programs	HEM_SYS_COORD.EXE SRCGRP_MAIN.EXE
POP Exe	Programs	HEM_POP_COORD.EXE
BAC Exe	Programs	AREAMOD_INPGEN.EXE AREA_MODEL.EXE HEM_ISCLT.EXE ISCLT_SETUP.EXE
EXP Exe	Programs	HEM_EXP_COORD.EXE HEM_RPT_COORD.EXE
GAT Exe	Programs	GAT.EXE
Supervisor Data 1	Permanent Data	FILE_P32.DAT FILE_P32_41.DAT FILE_P32_121.DAT FILE_P32_122.DAT
Supervisor Data 2	Study Data	HEMSTUDY_I02.DAT HEMSTUDY_I03.DAT
POP Data 1	Permanent Data	POLYGON_NAMES.DAT BGED80.DAT
POP Data 2	Study Data	HEMSTUDY_I04.DAT HEMSTUDY_I14.DAT HEMSTUDY_I18.DAT HEMSTUDY_I111A.DAT HEMSTUDY_I111P.DAT HEMSTUDY_I113.DAT HEMSTUDY_I115.DAT HEMSTUDY_I116.DAT

DIRECTORY NAME	CONTENTS	FILES
BAC Data 1	Permanent Data	STAR####.DAT AUGAUX####.DAT ISCLT_DEFAULTS.DAT
BAC Data 2	Study Data	HEMSTUDY_I26.DAT HEMSTUDY_I29.DAT HEMSTUDY_I211.DAT HEMSTUDY_I212.DAT HEMSTUDY_I215.DAT
EXP Data 2*	Output Reports and Study Data	HEMSTUDY_RPT1.DAT HEMSTUDY_RPT2.DAT HEMSTUDY_RPT3.DAT HEMSTUDY_RPT4.DAT

* *The "Data 1" designation is reserved for permanent data files. Currently, there are no permanent EXP data files.*

APPENDIX B
HEM-II VERSION 1.3 SPECIFICATIONS

POLLUTANT PROCESSING

Point Sources:	
Maximum Number of Standard Point Sources	100
Maximum Number of Emission Points per Source	20
Maximum Polar Grid Receptor Rings	15
Maximum Number of Source Groups	100
Area Sources:	
Maximum Number of Area Sources	100
Maximum Number of Cells in Area Source Grid	10,000
Maximum Number of Exclusion Cells per Area Source	25
Maximum Number of Cells in a Master Grid	10,000
Prototype Sources:	
Maximum Number of Prototype Point Sources	0
Other:	
Maximum Number of Pollutants	10
Maximum Number of Wind Directions	16

POPULATION PROCESSING

Maximum Number of BGEDs per Source Group or Single-Source Area	10,000
Maximum Number of Population Cohorts (Total Population)	1
Maximum Number of Growth Areas	10
Maximum Number of Race Groups	10
Maximum Number of States (USA)	52
Maximum Number of Counties (USA)	3,224
Maximum Number of Counties (State)	260
Maximum Number of Microenvironments	10
Maximum Number of Microenvironment Growth Areas	10

APPENDIX C
HEM-II POINT SOURCE MODULE

INTRODUCTION

The Point Source Module of HEM-II (Version 1.3) produces estimates of ambient air pollutant concentrations based upon user-specified emission source characteristics and meteorological data. Ground-level concentrations predicted by this module are based on point, area, or line sources that may exist within a given industrial or commercial facility. Ambient concentrations are determined internally by a single air quality dispersion model. This model is the Industrial Source Complex Long-Term (ISCLT) model.[1] Cited in the EPA Guideline on Air Quality Models (Revised), it is an air quality model that has been approved by the EPA for regulatory application.[2] It is a steady-state, Gaussian plume model commonly used for modeling single or multiple sources in flat or rolling terrain.

Such EPA-approved models are part of the User's Network for Applied Modeling of Air Pollution (UNAMAP). UNAMAP models are changed periodically, and the version number identifies the latest version recommended for use. The version of ISCLT that is used within HEM-II is the version dated 86324. This version reflects the changes made to the model as described in UNAMAP Version 6, Change Letter 2, dated December 2, 1986. Furthermore, the version used in HEM-II has been modified to default to a 10-kilometer mixing height for atmospheric stability classes E and F when operated in the urban mode. This change is consistent with versions of the model that have been issued since version 86324 was installed within HEM-II. The ISCLT version used in HEM-II differs from the 89319 version that is currently available through EPA in the following:

- Above-ground (flagpole) receptors are not incorporated, and

- Direction-specific building downwash with a linear decay adjustment to plume height (according to the method of Schulman and Scire) is not incorporated.[1]

The building wake effect algorithm used by ISCLT within HEM-II is the wake effect algorithm of Huber and Snyder.[1]

The user is referred to the Guideline on Air Quality Models (Revised)[2] and the ISC Dispersion Model User's Guide[1] for guidance in developing the source characteristics to be input to the Point Source Module.

METEOROLOGICAL DATA

The ISCLT uses National Weather Service (NWS) meteorological data in the form of STAR (STability ARray) summaries. STAR data sets are statistical tabulations of the joint frequency of occurrence of wind speed and wind direction categories classified according to Pasquill stability categories. The user may specify a STAR site to be used in ISCLT. If no STAR site is selected by the user, the Point Source Module defaults to the STAR site closest to the source from among the 392 STAR sites listed in Appendix G. The module checks each source to ensure that the STAR site closest to the source is used.

If the user selects a specific STAR site, that STAR site will be assigned to all sources of the particular study in question. User selection of a STAR site allows utilization of meteorological data from a more distant NWS station that may be more climatologically representative of the source location.

MODEL OPTIONS

Certain ISCLT model options are held fixed in HEM-II. These options are listed below.

- Polar coordinate receptor grid,
- No terrain elevations,
- Annual average concentrations,
- Concentrations from all sources combined,
- Rural or Urban Mode 3,
- Final plume rise,
- Briggs stack-tip downwash correction,
- Buoyancy-induced dispersion,
- Regulatory default mode, and
- No pollutant decay.

As described in Appendix F, output from dispersion models other than ISCLT may be used within HEM-II.

The user may find the source identification nomenclature within HEM-II to be different from that which is commonly associated with independent use of ISCLT. An example illustrating the source hierarchy within HEM-II is illustrated in Figure C-1. Only two source groups are shown in this figure. However, a study could have a single source group or as many as 100 source groups.

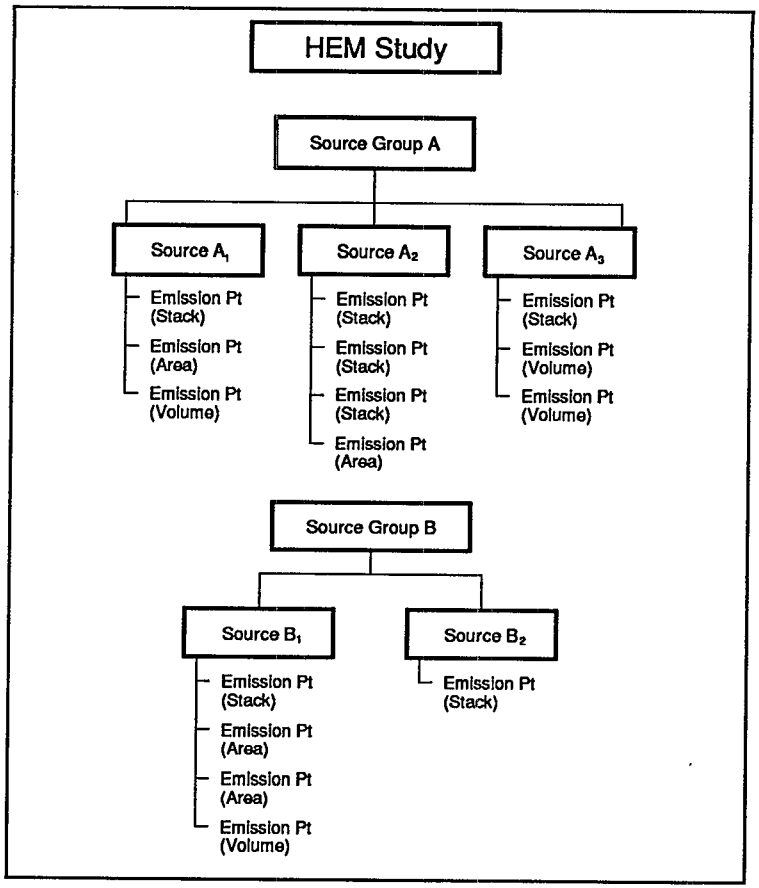


Figure C-1. Example Schematic of Source Hierarchy within HEM-II (1.3).

Each time a user runs HEM-II, a "HEM Study" is defined. The exposure and risk estimates associated with the HEM Study reflect the exposure and risk estimates determined for each source group of the study. As illustrated, source groups within HEM-II are composed of one or more sources. Specifically, a source group is made up of sources whose impact areas overlap. The maximum source impact area is generally 50 kilometers. Any given source is composed of one or more emission points. These emission points are what are generally referred to as sources within ISCLT and may be point (stack), area, or volume sources.

REFERENCES

1. U.S. Environmental Protection Agency. Industrial Source Complex (ISC) Dispersion Model User's Guide - Second Edition (Revised) Volume I (Includes June 1988 updates). EPA 450/4-88-002a, U.S. EPA Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1987.

2. U.S. Environmental Protection Agency. Guideline On Air Quality Models (Revised) (Includes Supplement A, July 1987). EPA 450/2-78-027R, U.S. EPA Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1986.

APPENDIX D
HEM-II AREA SOURCE MODULE

The Area Module is appropriate for sources that are widely dispersed over a region and that can be modeled as a function of population. For example, automobile emissions can be modeled as area sources.

Pollutant concentrations in urban areas often have been estimated through the use of box models. The common box model evaluation is based on three simplifying assumptions: steady-state conditions (no change in concentration or mixed-layer height with time), constant wind speed with height, and a uniform distribution of pollutant concentration in the vertical and horizontal dimensions.

HEM-II is equipped with two box models: Hanna-Gifford and TOXBOX. Concentrations within the Hanna-Gifford model[1] are calculated as:

$$X = \frac{CQ_o}{U}$$

where

- X = air pollutant concentration,
- Q_o = pollutant emission rate per unit area,
- C = a dimensionless parameter dependent on city size and atmospheric diffusion conditions, set equal to a constant value in HEM-II, and
- U = wind speed.

A mean value for C of 225, based on estimates of air pollution for 44 U.S. cities, is used in the HEM-II Hanna-Gifford area source model. This limits the use of Hanna-Gifford for HEM-II implementation to urban areas.

The version of TOXBOX used in HEM-II was adapted from the TOXBOX area source model implemented by EPA's Office of Toxic Substances (OTS). TOXBOX calculates air pollutant concentrations as:

$$X = \frac{Q_0\,(\Delta x/U)[1/(\sqrt{\pi/2}\,\sigma_z)]}{1+(\Delta x/U)[V_d/(\sqrt{\pi/2}\,\sigma_z)] + [\Delta x/U(\Lambda)] + [\Delta x/U(1/T_c)]}$$

where

Q_0 = pollutant emission rate per unit area,
Δx = width of the grid cell,
V_d = deposition velocity (m/s),
Λ = precipitation scavenging (s^{-1}),
T_c = time constant (s), and
U = wind speed.

This equation essentially expands the Hanna-Gifford equation, incorporating the removal processes of dry deposition, precipitation scavenging, and chemical decay. Note that in this version of HEM-II, the time constant (T_c) is set equal to zero, indicating no chemical decay of the pollutant. Here the coefficient C is replaced by the term

$$\Delta x/(\sigma_z\sqrt{\pi/2})$$

that represents the height adjustment of the box, according to the size of the source area and the vertical diffusion depth, σ_z.

Both Hanna-Gifford and TOXBOX require that the emission rate be expressed on a per area basis. Because the emission rate is input as grams per second per person, the area associated with each BGED is needed in order to convert the emission rate to grams per second per square kilometer. This information is not available, so HEM-II must estimate the area per BGED.

The estimation procedure is based on the user-defined Cartesian grid that overlies the modeling area. Each BGED is assigned to the cell

whose centroid is closest to the latitude and longitude of the BGED. More than one BGED may be assigned to any given cell. The model then associates empty cells with the closest BGED (or group of BGEDs). The first BGED number assigned to any cell (whether it has one BGED or many) is designated as the "initial" BGED for that cell. The program proceeds to assign a BGED number to empty cells based on the latitude and longitude coordinates of these initial BGEDs.

Figure D-1 shows an example 10 x 10 grid for Morgan County, CO; each cell is 25 km^2. The shaded cells have BGEDs actually located within their boundaries (the numbers in the shaded cells represent the 31 BGEDs found in the modeled region). The numbers in the unshaded cells show the BGED with which that cell has been grouped; when more than one BGED has been assigned to a

1	1	1	1	1	1	3	3	2	2
5	5	4	4	4	3	3	3	2	2
5	5	5	4	4	3	3	6	27	2
5	5	5	28	28	26	26	6-10 12-16 18-25	27	11 17
5	5	5	30	30	29	29	31	27	11
5	30	30	30	30	29	31	31	31	31
30	30	30	30	30	31	31	31	31	31
30	30	30	30	30	31	31	31	31	31
30	30	30	30	30	31	31	31	31	31
30	30	30	30	30	31	31	31	31	31

Figure D-1. 10 x 10 Grid Encompassing Most of Morgan County, CO.

cell, only one BGED number (the initial one assigned to the group) is shown.

The area per initial BGED is then calculated as a function of the number of BGEDs co-occurring with that initial BGED and of the number of cells assigned to it. The area of BGED 31 is calculated as follows:

$$\frac{(25 \text{ cells})\ (25 \text{ km}^2/\text{cell})}{1 \text{ BGED} + 1} = 312.5 \text{ km}^2/\text{BGED}$$

Where 25 cells is the number of cells associated with this initial BGED, 25 km^2 is the physical area per cell, and 1 BGED is the number of BGEDs associated with this initial BGED. Similarly, the area of BGED 6 is calculated as follows:

$$\frac{(2 \text{ cells})\ (25 \text{ km}^2)}{18 \text{ BGEDs} + 1} = 2.6 \text{ km}^2/\text{BGED}$$

Each cell within the modeling grid is then assigned the weighted area calculated for the initial BGED with which it is associated.

The user needs to be aware of how the BGED area is calculated in HEM-II because it can affect model results significantly. A grid should be defined as precisely as possible; ideally, grid resolution should be fine enough that only one BGED is located in any given cell. In practice, this is often difficult. Also, because the model will assign ***all*** cells to a BGED, the user needs to be careful when defining the modeling region. Areas such as lakes or uninhabited land regions should be excluded (either by using the EXCLUDE CELLS feature or by carefully setting region boundaries). If these precautions are not used, the concentrations may be underestimated.

The user should experiment with the Area Module, changing cell sizes and excluding cells to determine how the results are affected. The Area Module should not be employed unless the user has a good understanding of the region to be modeled and the module's limitations.

REFERENCE

1. Gifford, F.A., and S.R. Hanna. Modeling Urban Air Pollution. Atmos. Environ. 7:131-136, 1973.

APPENDIX E
CALCULATION OF EXPOSURE AND RISK

INTRODUCTION

The HEM-II produces estimates of maximum individual and aggregate exposure and risk. These risk estimates are provided at the source, source group, and study levels of analysis. Certain simplifying assumptions are incorporated into the current version of the model as a result of data limitations and to facilitate its general use. Some of these assumptions are listed below:

- Exposure is assumed to occur at population-weighted centers (centroids) of Block Group/ Enumeration Districts (BGEDs), because actual residence location information does not exist in available data bases. HEM-II relies on 1980 population data from the U.S. Bureau of the Census.

- People are assumed to reside at these centroid locations for their entire lifetimes (assumed to be 70 years in the calculation of cancer risk).

- Pollutants are assumed to be emitted at a constant emission rate for 70 years.

- The only source of exposure is assumed to be the ambient air.

- Pollutant concentrations are predicted assuming a homogeneous, flat terrain over the study area.

Subsequent sections discuss how model output is generated for a HEM-II study involving only point sources, output for only studywide area sources, and results for both point and studywide area sources combined.

POINT SOURCES

Source Grid

For a HEM-II study involving only point sources and a source-specific grid, values for each pollutant of maximum exposure and risk and of total maximum exposure and risk are derived as follows:

- Annual pollutant concentrations are predicted for each receptor of the user-specified polar grid.

- Pollutant concentrations are then interpolated for each BGED centroid location. Concentrations are interpolated linearly between direction radials and exponentially along them (see Figure E-1).

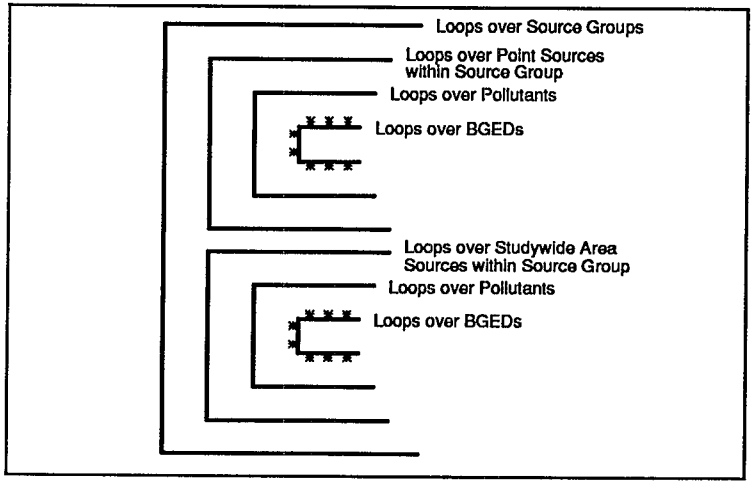


Figure E-1. Interpolation of Pollutant Concentrations.

- The highest of all BGED concentrations is determined. This concentration defines the maximum exposure and provides the basis for calculating all maximum individual exposure and risk estimates.

- With the highest BGED concentration, HEM-II also reports the highest predicted concentration within the receptor grid.

Master Grid

The master grid is a rectangular array of grid cells that represents a geographic region. Processing exposure and risk estimates under the master grid option involves the following steps:

- BGED populations are allocated to the particular grid cell in which they reside.
- Each master grid cell becomes a pseudo-BGED, with coordinates the same as the center of the grid cell and with a population that is the total of all BGEDs located within the grid cell.
- Master grid cell boundaries (min_xcell and min_ycell; max_xcell and max_ycell) are then determined for each source. Each cell within these boundaries is marked as a BGED within the source impact area.
- Annual pollutant concentrations are predicted for each receptor of the user-specified polar grid and calculations proceed as for the source-specific grid.

STUDYWIDE AREA SOURCES

Source Grid

As described in Appendix D, studywide area source concentrations are calculated using a box model approach. Initially, concentrations (in units of micrograms per cubic meter per person) are determined for each cell in the user-specified, area source domain. BGEDs located within this domain are indexed according to the grid cell in which they reside. Concentrations at individual BGEDs are then determined as:

$$\text{BGED concentration} = \text{Concentration associated with grid cell in which the BGED is located} \times \text{BGED population}$$

Estimates of exposure and risk are then calculated as described for point sources above.

Master Grid

Estimates of exposure and risk, in the case of a studywide area source with a master grid, follow the same general procedures identified above for area sources with a source-specific grid. Processing area sources with the master grid option follows the same logic as for point sources.

- BGED populations are allocated to the particular grid cell in which they reside.

- Each master grid cell becomes a pseudo-BGED, with coordinates the same as the center of the grid cell and with a population that is the total of all BGEDs located within the grid cell.

- Master grid cell boundaries (min_xcell and min_ycell; max_xcell and max_ycell) are then determined for each source. Each cell within these boundaries is marked as a BGED within the source impact area. If the domain of the studywide area source extends beyond the limits of the master grid, then the area source domain is modified to encompass only those BGEDs within the master grid.

POINT SOURCES AND STUDYWIDE AREA SOURCES COMBINED

HEM-II processes estimates of exposure and risk from point and studywide area sources by using the same procedures outlined above. The processing logic is illustrated in Figure E-1.

At the source group level, a total concentration for each BGED is determined by summing the interpolated concentrations at each BGED over all sources. The highest of all the total BGED concentrations is determined, and it is this

concentration that defines the maximum exposure concentration in the Source Group Exposure/Risk Report 3 discussed in Section 5. At the study level, the maximum individual risk and exposure estimates are the highest of those reported at the source group level.

APPENDIX F
USER-SUPPLIED POINT SOURCE CONCENTRATION DATA FROM EXTERNAL DISPERSION MODELS

Although HEM-II provides internal modeling capabilities (see Appendices D and E), users of HEM-II may want to use alternative air dispersion models or climatological data. To address these needs, HEM-II allows the option of using Externally Modeled Point Sources. This feature is provided for use by experienced dispersion modelers who have the programming expertise to create a standardized format data file that may be used by the HEM-II as a source of Breathing Air Component (BAC) data.

Figure F-1 shows the format used for HEM-II external model data. This file has three components: x-coordinates, y-coordinates, and concentration data.

The first and second components must be identical to the example format for use in the current version of HEM-II. They describe the HEM-II default polar receptor grid for modeling point sources. This default corresponds to the standard polar grid used at the EPA Pollutant Assessment Branch (PAB). The first line of the file contains the x-coordinates; these are the radii of the 10 concentric polar rings, ranging from 200 meters to 50 kilometers. The next two lines contain the y-coordinates, the 16 wind direction angles in degrees from 0 to 337.5 degrees. These components are required for internal software verification during execution of the model.

The remainder of the file contains a listing of 16 rows of concentration data, corresponding to the 16 wind directions. Each row contains ten concentration values, one for each of the ten radii.

The FORTRAN code that is used in HEM-II to write concentration data in this format is shown in Figure F-2. A call to this subroutine is inserted at the very end of the ISCLT dispersion model immediately before the FORTRAN STOP statement. At this point, ISCLT has completed a dispersion model run, and the receptor grid dimension and concentration data array reside in memory in the CORE array of ISCLT.

```
2.0000E+02 5.0000E+02 1.0000E+03 2.0000E+03 5.0000E+03 1.0000E+04 2.0000E+04 3.0000E+04 4.0000E+04 5.0000E+04
0.0000E+00 2.2500E+01 4.5000E+01 6.7500E+01 9.0000E+01 1.1250E+02 1.3500E+02 1.5750E+02 1.8000E+02 2.0250E+02
2.2500E+02 2.4750E+02 2.7000E+02 2.9250E+02 3.1500E+02 3.3750E+02
6.4992E-01 8.1029E-01 4.2333E-01 1.8403E-01 1.0609E-01 7.0630E-02 5.1222E-02 3.9346E-02 3.1497E-02 2.6007E-02
3.4814E-01 4.3955E-01 2.4008E-01 1.0813E-01 6.3087E-02 4.2248E-02 3.0749E-02 2.3677E-02 1.8985E-02 1.5693E-02
3.3559E-01 3.9800E-01 2.0889E-01 9.1713E-02 5.3141E-02 3.5517E-02 2.5836E-02 1.9902E-02 1.5975E-02 1.3221E-02
2.9087E-01 3.4964E-01 1.8729E-01 8.3380E-02 4.8492E-02 3.2439E-02 2.3601E-02 1.8172E-02 1.4561E-02 1.2050E-02
3.5911E-01 4.5456E-01 2.3929E-01 1.0428E-01 6.0197E-02 4.0133E-02 2.9141E-02 2.2408E-02 1.7956E-02 1.4840E-02
2.0163E-01 2.6631E-01 1.4481E-01 6.4635E-02 3.7574E-02 2.5107E-02 1.8245E-02 1.4030E-02 1.1237E-02 9.2799E-03
2.1872E-01 2.9228E-01 1.5421E-01 6.6895E-02 3.8523E-02 2.5644E-02 1.8600E-02 1.4290E-02 1.1441E-02 9.4495E-03
1.3721E-01 1.8366E-01 9.3139E-02 3.8999E-02 2.2157E-02 1.4638E-02 1.0566E-02 8.0901E-03 6.4623E-03 5.3287E-03
2.5577E-01 3.2219E-01 1.5315E-01 6.0424E-02 3.3559E-02 2.1919E-02 1.5717E-02 1.1986E-02 9.5530E-03 7.8688E-03
1.5233E-01 1.7465E-01 8.2564E-02 3.3055E-02 1.8496E-02 1.2132E-02 8.7220E-03 6.6613E-03 5.3123E-03 4.3762E-03
2.4699E-01 2.7572E-01 1.2547E-01 4.8195E-02 2.6534E-02 1.7275E-02 1.2369E-02 9.4305E-03 7.5127E-03 6.1987E-03
2.0141E-01 2.5033E-01 1.2562E-01 5.2529E-02 2.9861E-02 1.9748E-02 1.4271E-02 1.0946E-02 8.7612E-03 7.2384E-03
2.3933E-01 3.1592E-01 1.6443E-01 7.0519E-02 4.0483E-02 2.6928E-02 1.9533E-02 1.5020E-02 1.2044E-02 9.9633E-03
6.7962E-02 1.1813E-01 7.0593E-02 3.2950E-02 1.9432E-02 1.3086E-02 9.5561E-03 7.3738E-03 5.9210E-03 4.8991E-03
1.3115E-01 2.1573E-01 1.2028E-01 5.3365E-02 3.0929E-02 2.0648E-02 1.5000E-02 1.1534E-02 9.2400E-03 7.6334E-03
1.3072E-01 1.8863E-01 9.9046E-02 4.2522E-02 2.4384E-02 1.6187E-02 1.1718E-02 8.9909E-03 7.1857E-03 5.9362E-03
```

Figure F-1. File Format for HEM-II External Mode Data.

```
!*****************************************************************************!
! CONTRACTOR : Radian Corporation                                             !
! SYSTEM     : HEM                  SUB-SYSTEM  : BAC                         !
! PROGRAM    : APPEND_CORE_DATA     PROGRAMMER  : GF Laniak                   !
!                                                                             !
! FUNCTION   : Appends receptor locations and concentration array from        !
!              ISCLT CORE array to HEM Point source output file (i26)         !
!                                                                             !
! CALLS      : n/a                                                            !
! CALLED BY  : ISCLT MODEL immediately before FORTRAN STOP.                   !
!                                                                             !
! CALLING SYNTAX : CALL APPEND_CORE_DATA( datfile, nx, ny)                    !
!                                                                             !
!   datfile         name of file to append data to (File I26)                 !
!   nx              number of x points in source receptor grid                !
!   ny              number of y points in source receptor grid                !
!                                                                             !
! REVISION HISTORY :                                                          !
!  Date      Init    Remarks                                                  !
! 10/22/87   GFL     Initial Implementation                                   !
!*****************************************************************************!

      SUBROUTINE Append_CORE_Data(i26_filename, nx, ny)

      include 'hem$common:dirpaths.blk/list'

      COMMON CORE(40000)

      character*80  message, filename
      character*20  i26_filename, routine_name/ 'APPEND_CORE_DATA' /

      ! Make filespec, including directory path, for file to be opened

      filename = BACdata2
      CALL CONCAT(filename, i26_filename)

      CALL OPEN_WR_APPEND(lun, filename, ios)
         if(ios .ne. 0) then
            write(message,10) i26_filename
            CALL IO_ERR(ios, routine_name, message)
            STOP 'Program Terminated'
         end if

      ! Compute total number of data points to be extracted from
      ! CORE array .

      num_pts = nx + ny + (nx*ny) - 1

      ! write x point location data to output

      write(lun,20,iostat=ios,err=100) (core(i),i=1,nx)
100      if(ios. ne. 0) then
            write(message,30)
            CALL IO_ERR(ios, routine_name, message)
            STOP 'Program Terminated'
         end if

      ! write y point location data to output
```

Figure F-2. FORTRAN Code from HEM-II for Writing External File.

```
      j = nx + 1
      k = nx + ny
      write(lun,20,iostat=ios,err=200) (core(i),i=j,k)
200      if(ios. ne. 0) then
            write(message,40)
            CALL IO_ERR(ios, routine_name, message)
            STOP 'Program Terminated'
         end if

      inc = nx - 1
      index = nx + ny + 1
      num_y = 1

      ! write concentration data

      do while(num_y .le. ny)
         j = index
         k = index + inc
300      write(lun,20,iostat=ios,err=300) (core(i),i=j,k)
         if(ios. ne. 0) then
            write(message,50)
            CALL IO_ERR(ios, routine_name, message)
            STOP 'Program Terminated'
         end if
         index = index + nx
         num_y = num_y + 1
      end do

      CLOSE(unit=lun,status='keep')
      CALL FREE_LUN(lun)

      RETURN

      !-----------------------------------------------------------------!
      !-----------------FORMAT STATEMENTS-------------------------------!
      !-----------------------------------------------------------------!
10    format(' error opening point source output file :')
20    format(10(1x,1pe10.4))
30    format(' error appending x location data to point source output')
40    format(' error appending y location data to point source output')
50    format(' error appending conc data to point source output')

      END
```

Figure F-2. (continued).

APPENDIX G
HEM-II PERMANENT SUPPORT DATA FILES

HEM-II uses two permanent data files containing meteorological data and population data. The data in both files were obtained from the U.S. Environmental Protection Agency.

The population data are in the form of Block Group/ Enumeration Districts (BGEDs) from 1980 and 1983 U.S. census data. The latitude, longitude, and population size of each BGED are stored in this file. The 1980 data used in HEM-II are a subset of a census data base created internally at EPA's Pollutant Assessment Branch. The 1983 data are in a proprietary data base.

The meteorological data are from STAR (STability ARray) sites in the United States; a list of the STAR sites included follows in this section. Two indexed FORTRAN files hold all of the STAR site data. HEMII_STAR.DAT contains wind speed frequencies for each STAR site. STAR_AUGAUX.DAT contains other meteorological data including average temperature, maximum and minimum temperatures, mixing heights, and stability categories. The STAR data in HEM-II come from the Graphical Exposure Modeling System (GEMS) at EPA's Office of Toxic Substances (OTS). A list of STAR sites follows.

NOTE: This list is current as of the date of publication. Additional STAR sites may be available in the future.

0001	ASHEVILLE NC	0057	NEW ORLEANS/MOISA LA
0003	MACON/LEWIS B WIL GA	0062	HOUSTON/HOBBY 129 TX
0005	CORBIN KY	0064	SAN ANTONIO TX
0009	AUGUSTA/BUSH GA	0065	GALVESTON/SCHOLES TX
0013	SAVANNAH/TRAVIS GA	0068	CORPUS CHRISTI TX
0017	FT RUCKER/CAIRNES AL	0074	GOLDSBORO/SEYMOUR NC
0018	PENSACOLA/FORST S FL	0075	FT BRAGG/POPE/FAY NC
0033	BELMAR/EVANS LAB NJ	0082	RALEIGH/RALEIGH-D NC
0035	BRADFORD/REGIONAL PA	0084	GREENSBORO/GSO-HI NC
0042	TAMPA/MACDILL FL	0085	NORFOLK REG VA
0056	LAREDO TX	0104	WILMINGTON/NEW HA NC

0106	CHERRY POINT NC	0284	FARMINGTON NM
0109	FT CAMPBELL/CAMPB KY	0289	VICTORVILLE/GEORG CA
0110	FT KNOX/GODMAN KY	0290	BURBANK/HOLLYWOOD CA
0111	ALBANY GA	0291	ELY/YELLAND NV
0113	PANAMA CITY/TYNDA FL	0292	BAKERSFIELD/MEADO CA
0114	SELMA/CRAIG AL	0293	BLYTHE/RIVERSIDE CA
0115	MERIDIAN/KEY MS	0294	BRYCE CANYON UT
0117	PARKERSBURG WV	0295	TUCSON AZ
0118	ANNISTON/CALHOUN AL	0300	DAGGETT/SAN BERNA CA
0120	ATLANTA GA	0301	DELTA UT
0127	BRISTOL/TRI CITY TN	0302	HANKSVILLE UT
0129	CHARLESTON SC	0308	NEEDLES CA
0132	CHARLOTTE/DOUGLAS NC	0309	PHOENIX/SKY HARBO AZ
0134	CHATTANOOGA/LOVEL TN	0311	PRESCOTT AZ
0143	MEMPHIS TN	0314	WINSLOW AZ
0149	NASHVILLE/MET TN	0315	YUMA AZ
0152	OKLAHOMA CITY/TIN OK	0316	FAIRFIELD/TRAVIS CA
0153	GREENVILLE MS	0317	SAN RAFAEL/HAMILT CA
0154	JACKSON MS	0320	SACRAMENTO/EXECUT CA
0161	DALLAS/LOVE TX	0321	SAN FRANCISCO CA
0166	BATON ROUGE/RYAN LA	0322	ALAMEDA CA
0170	COLUMBIA 03945 MO	0324	BISMARK ND
0178	SPRINGFIELD MO	0327	PIERRE SD
0179	CARIBOU ME	0329	ROCKSPRINGS WY
0180	BRUNSWICK ME	0330	SHERIDAN CO WY
0181	BEDFORD/L G HANSC MA	0331	BILLINGS/LOGAN MT
0182	CHICOPEE FALL/WES MA	0333	MILES CITY MT
0185	NEWBURGH/STEWART NY	0335	CASPER WY
0189	NEW YORK/LAGUARDI NY	0336	RAPID CITY SD
0195	NEWARK NJ	0337	OGDEN/HILL UT
0207	ALTOONA/BLAIR CO/ PA	0355	SALT LAKE CITY UT
0217	POUGHKEEPSIE/DUTC NY	0357	BUTTE/SILVER BOW MT
0218	PHILIPSBURG/MID-S PA	0360	SPOKANE WA
0220	PORTLAND ME	0363	PORT ANGELES WA
0240	CLEVELAND/HOPKINS OH	0364	PORTLAND OR
0243	COLUMBUS/PORT COL OH	0365	SEATTLE/TACOMA WA
0244	FINDLAY OH	0370	BIG DELTA/ALLEN 2 AK
0251	MUSKEGON CO MI	0371	GULKANA/INTERM AK
0254	SAGINAW/TRI CITY MI	0372	ANCHORAGE AK
0257	SOUTH BEND/ST JOE IN	0376	DOUGLAS/BISBEE-DG AZ
0260	YOUNGSTOWN OH	0378	ZUNI/INTERMEDIATE NM
0263	DULUTH MN	0380	SAN DIEGO/NORTH I CA
0266	LA CROSSE WI	0392	CAPE HATTERAS NC
0269	MOLINE/QUADCITY IL	0398	WASHINGTON DC/DUL VA
0270	BURLINGTON IA	0402	BOWLING GREEN/CIT KY
0273	HILO/LYMAN HI	0403	COVINGTON/GTR CIN KY
0276	MAUI HI	0404	DAYTON/JM COX DAY OH
0278	MIDLAND/SLOAN TX	0408	HUNTINGTON/CHESAP WV
0280	SAN ANGELO/MATHIS TX	0410	LOUISVILLE/STANDI KY

0415	SPRINGFIELD/CAPIT IL	0543	KALISPELL/GLACIER MT
0417	BRUNSWICK/GLYNCO GA	0544	HUNTSVILLE/HSV-MA AL
0421	ANDERSON/COUNTY SC	0546	EVANSVILLE/DRESS IN
0422	QUINCY/BALDWIN IL	0547	ELDORADO/GOODWIN AR
0423	ASTORIA/CLATSOP C OR	0554	MINNEAPOLIS/ST PA MN
0424	KLAMATH FALLS/KIN OR	0558	BRIDGEPORT CT
0428	TETERBORO NJ	0561	FT LEAVENWORTH/SH KS
0429	WHITE PL/WESTCHES NY	0563	ST LOUIS/LAMBERT MO
0435	NEW YORK/FT TOTTE NY	0573	COLO SPRINGS/PETE CO
0438	ROCKFORD/GRTR ROC IL	0584	GLENVIEW IL
0452	CHICAGO/OHARE IL	0585	PENDLETON/PENDLET OR
0469	LUFKIN/ANGELINA C TX	0586	REDMON/ROBERTS OR
0470	EUGENE/MAHLON SWE OR	0587	LOS ANGELES CA
0471	SALEM/MCNARY OR	0590	SALISBURY/WICOMIC MD
0474	RANTOUL/CHANUTE IL	0598	ROCHESTER/MONROE NY
0476	GRAND JUNCTION/WA CO	0599	SCOTTSBLUFF NB
0479	PADUCAH/BARKLEY KY	0600	FLORENCE/GILBERT SC
0484	YAKIMA WA	0604	WICHITA KS
0485	WALLA WALLA/CY-CO WA	0609	BUFFALO/GRTR BUFF NY
0486	MOSES LAKE/GRANT WA	0610	ERIE/PORT ERIE PA
0487	HOQUIAM/BOWERMAN WA	0611	PROVIDENCE/FRANCI RI
0488	TOLEDO/WINLOCK WA	0616	CUTBANK MT
0489	EL PASO TX	0617	CHEYENNE WY
0491	MILTON/WHITING FL	0618	DENVER/STAPLETON CO
0494	GREENVILLE-SPARTA SC	0621	AMARILLO/ENGLISH TX
0507	HAVRE CITY-COUNTY MT	0630	CHICAGO/MIDWAY IL
0508	LEWISTOWN MT	0641	TALLAHASSEE FL
0509	DICKINSON ND	0642	FALMOUTH/OTIS MA
0510	MINOT ND	0653	BOISE ID
0511	WILLISTON/SLOULIN ND	0654	MOUNTAIN HOME ID
0516	LITTLE ROCK/ADAMS AR	0658	LAS VEGAS/NELLIS NV
0518	ELLENSBURG 94239 WA	0659	RENO/STEAD NV
0519	SEATTLE/BOEING WA	0667	AKRON/WASHINGTON CO
0520	OLYMPIA WA	0670	COLUMBUS MS
0521	EPHRATA WA	0672	DETROIT CITY 1485 MI
0522	MISSOULA/JOHNSON MT	0673	LANSING/CAPITAL C MI
0523	ALBANY/CO NY	0674	DETROIT/WILLOW RU MI
0524	ABILENE TX	0683	CONCORD NH
0525	BINGHAMTON/BROOME NY	0684	MONROE/SELMAN LA
0526	ROANOKE VA	0685	DOVER DE
0527	SIOUX FALLS/FOSS SD	0687	WALLOPS IS VA
0530	SPARTANBURG MEM SC	0699	COTULLA TX
0531	WINSTON SALEM/S R NC	0700	BEEVILLE/CHASE TX
0534	TOPEKA/BILLARD KS	0704	OXNARD CA
0536	FAIRBANKS/EIELSON AK	0705	POINT MUGU CA
0537	FAIRBANKS AK	0706	RICHMOND/BYRD VA
0541	DAYTONA BEACH FL	0709	WRIGHTSTOWN/MCGUI NJ
0542	WASHINGTON DC/AND DC	0710	BARBERS POINT HI

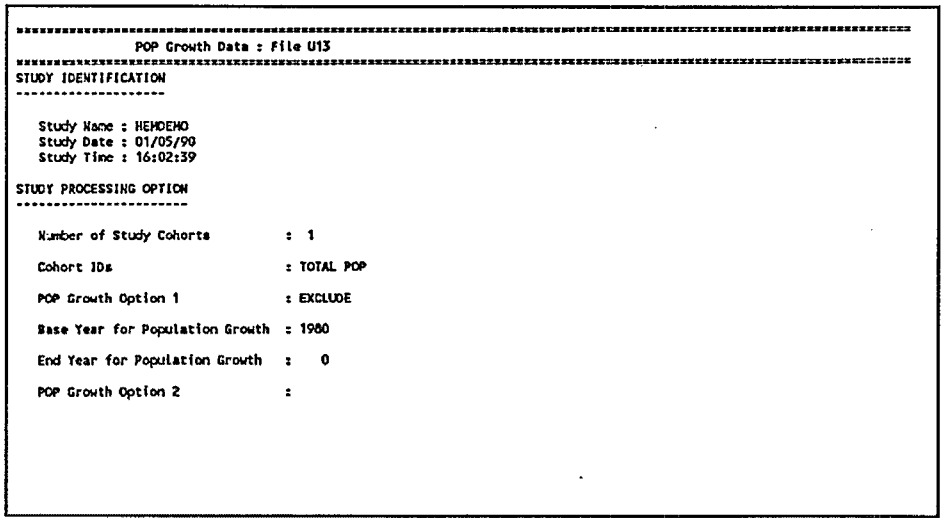
0715	EAU CLAIRE WI	0898	WILKES-BARRE-SCRA PA
0729	WATERLOO IA	0901	WILLIAMSPORT/LYCO PA
0742	AKRON/AKRON CANTO OH	0905	NIAGARA FALLS/MIS NY
0744	FT MYERS/PAGE FL	0906	ELMIRA/CHEMUNG CO NY
0750	SANTA MARIA CA	0907	GLENS FALLS/WARRE NY
0755	LAFAYETTE LA	0908	UTICA/ONEIDA CO NY
0760	GOODLAND/RENNER KS	0909	MALAD CITY ID
0761	NORTH PLATTE/LEE NB	0910	IDAHO FALLS/FANNI ID
0763	ATHENS/BEN EPPS GA	0912	POCATELLO ID
0770	SAVANNAH/HUNTER GA	0915	TAMPA FL
0771	ALMA/BACON CO GA	0917	ALEXANDRIA/ESLER LA
0773	MADISON/TRUAX WI	0921	SAN DIEGO/LINDBER CA
0774	MILWAUKEE/MITCHEL WI	0922	TYLER/POUNDS TX
0775	PEORIA/GREATER PE IL	0925	WHIDBEY IS WA
0776	GREEN BAY/AUSTIN WI	0926	OMAHA/OFFUTT NB
0789	ROME/GRIFFISS NY	0930	RIVERSIDE/MARCH CA
0790	WATERTOWN NY	0931	OMAHA/EPPLEY NB
0795	AUGUSTA/STATE ME	0970	LUBBOCK/WEST AIR TX
0796	LAKE CHARLES LA	0974	GLASGOW MT
0797	MORGANTOWN WV	0975	EL CENTRO CA
0798	PUEBLO/MEMORIAL CO	0979	MIAMI FL
0806	HELENA MT	0988	BILOXI/KEESLER MS
0807	GWINN/K I SAWYER MI	0990	TOLEDO OH
0809	OLD TOWN/DEWITT 1 ME	0992	WEST PALM BEACH FL
0818	GARDEN CITY KS	0995	ST CLOUD/WHITNEY MN
0824	GORDONSVILLE VA	0996	INTERNATIONAL FAL MN
0825	DANVILLE VA	0999	FALLON NV
0826	BELLEVILLE/SCOTT IL	1003	WORCESTER MA
0830	MCCOMB/PIKE CO MS	1008	SHREVEPORT LA
0831	WINNEMUCCA NV	1011	DUNKIRK NY
0832	LOVELOCK/DERBY NV	1012	PLATTSBURG NY
0833	ELKO NV	1027	MYRTLE BEACH SC
0838	ORLANDO/JETPORT FL	1037	JACKSONVILLE FL
0839	ROCHESTER MN	1042	FARGO/HECTOR ND
0852	EDWARDS CA	1043	TEXARKANA/WEBB AR
0862	WACO TX	1047	WASHINGTON DC/NAT DC
0867	BURLINGTON VT	1049	MASON CITY IA
0869	AUSTIN/MUELLER TX	1050	SIOUX CITY IA
0871	ANCHORAGE/ELMENDO AK	1053	LOS ALAMITOS CA
0873	LONG BEACH CA	1054	OAKLAND CA
0874	VANDENBERG/SURF CA	1055	SANTA BARBARA CA
0875	KENAI AK	1056	SUNNYVALE/MOFFETT CA
0878	SYRACUSE/C E HANC NY	1057	HARTFORD/BRAINARD CT
0880	PITTSBURG/GRT PI PA	1058	WILMINGTON/GREATE DE
0883	HARRISBURG/STATE PA	1059	BALTIMORE/FRIENDS MD
0888	PONCA CITY OK	1067	MARTINSBURG WV
0891	OKLAHOMA CITY/WIL OK	1078	FT SMITH AR
0895	ALLENTOWN PA	1079	TULSA OK

1080	INDIANAPOLIS/WEIR IN	1328	KNOXVILLE TN
1081	KIRKSVILLE/CANNON MO	1344	SAN BERNARDINO/NO CA
1083	TUSCALOOSA/VAN DE AL	1364	BAKER OR
1086	FT WAYNE/BAER IN	1371	COLUMBIA/MET SC
1092	MANSFIELD/LAHM OH	1374	NORFOLK VA
1100	LANDER/HUNT WY	1379	NEW ORLEANS/CALLE LA
1117	PULASKI/NEW RIVER VA	1410	HOUSTON/ELLINGTON TX
1123	BOSTON/LOGAN MA	1412	HAMPTON/LANGLEY VA
1139	ATLANTIC CITY/NAF NJ	1413	ALPEN/PHELPS
1141	MOBILE/BATES AL	1414	SHERMAN TX
1142	LINCOLN NB	1417	HONOLULU/JOHN ROG HI
1144	SOUTH WEYMOUTH MA	1425	MT CLEMENS/SELFRI MI
1147	SANTA MARIA/PUBLI CA	1443	ARCATA CA
1163	MEDFORD/JACKSON C OR	1448	MULLAN PASS ID
1169	JACKSON/THOMPSON MS	1454	LARAMIE/GEN BREES WY
1173	CAPE CANAVERAL FL	1456	MONTEREY CA
1180	RENO NV	1460	BATTLE CREEK/KELL MI
1182	VICTORIA/FOSTER TX	1462	ALAMOSA CO
1183	LAS CRUCES/WHITE NM	1464	RED BLUFF CA
1184	SANTA FE NM	1465	STOCKTON/MET CA
1199	HOBBS/LEA CO NM	1466	UKIAH CA
1200	KANSAS CITY 13988 MO	1467	SANTA ANA CA
1207	FT MEADE/TIPTON MD	1470	KINGSVILLE TX
1213	FRESNO SIR TERM/H CA	1474	ALBUQUERQUE/SUNPT NM
1215	FLINT/BISHOP MI	1478	SUMMIT AK
1217	FT WORTH/REGIONAL TX	1479	NENANA AK
1240	JACKSON/MCKELLAR TN	1480	ROSWELL/WALKER/IN NM
1241	TERRE HAUTE/HULMA IN	1497	ELKINS/RANDOLPH C WV
1261	RAWLINS WY	1503	BELLINGHAM WA
1262	HARTFORD/BRADLEY CT	1506	EVERETT/PAINE WA
1263	PHILADELPHIA PA	1508	CORPUS CHRISTI/CL TX
1291	ROSWELL NM	1510	BIRMINGHAM AL
1311	FT BRIDGER WY	1524	MASSENA/RICHARDS NY
1319	PATUXENT RIVER MD	1583	HOMER AK
1320	MONTGOMERY/DANNEL AL	1683	TRUTH OR CONSEQUE NM
1322	GREAT FALLS MT	1689	BANGOR/DOW ME
1323	KANSAS CITY 03947 MO	1702	PRT ARTHUR/JEFFER TX
1325	HOUSTON/INTCONT 1 TX	1703	SALINAS CA
1326	FT SILL/POST OK	1707	COLUMBIA REG/FRM MO
1327	LEXINGTON/BLUE GR KY	1709	HUNTINGTON/TRI ST WV

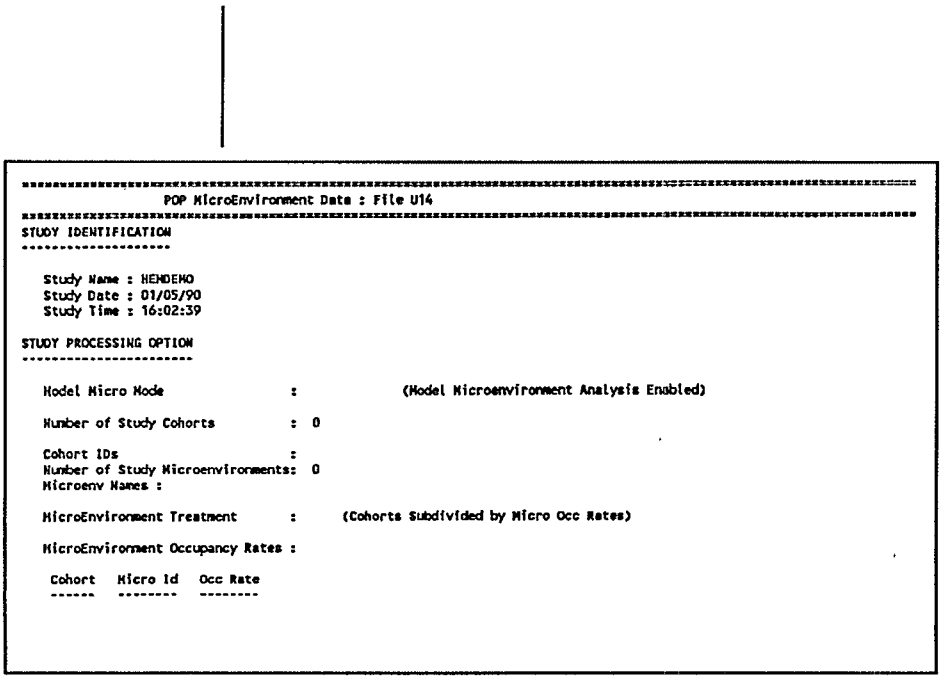
APPENDIX H
STUDY DEFINITION REPORTS

```
HEM Study Definition Data : File U01

Study Name : hemdemo
Study Date : 01/05/90
Study Time : 16:02:39


Model Math Mode :      Model Grid Mode : SRC SPEC     Model Time Mode :
Model Risk Mode :      Model Micro Mode : EXCLUDE


  HEM Study Master Grid Definition : File U01a
Master Grid Name  : HEM-II Demo #2 using Master Grid

                  DDMMSS                          DDMMSS
                  ------                          ------
Grid Ctr Latitude : 413650     Grid Ctr Longitude :  874100

Number for East-West Grid Cells   :   40     East-West Cell Size   :     10.0000
Number for North-South Grid Cells :   40     North-South Cell Size :     10.0000


   HEM Study Microenvironments : File U01b
Microenvironment Definition      : MCODEF
Number of Study Microenvironments :          3
Microenv Names :      Outdoor
                      Indoor
                      Office Bldg
```

```
                POP MicroEnvironment Options : File U10
STUDY IDENTIFICATION
--------------------

   Study Name : hemdemo
   Study Date :
   Study Time :

STUDY PROCESSING OPTION
-----------------------

                                Option Selected
                                ---------------

   Population Cohort Specification  : TOT_POP      (Population Cohort Option)

   Population Microenvironment Mode : STOCHAS      (Population Microenvironment Option)

   Population Growth                : INCLUDE      (Population Growth Option)
```



```
POP Growth Data : File U13

STUDY IDENTIFICATION
--------------------

   Study Name : HEMDEMO
   Study Date : 01/05/90
   Study Time : 16:02:39

STUDY PROCESSING OPTION
-----------------------

   Number of Study Cohorts          : 1

   Cohort IDs                       : TOTAL POP

   POP Growth Option 1              : EXCLUDE

   Base Year for Population Growth  : 1980

   End Year for Population Growth   :    0

   POP Growth Option 2              :
```



```
POP MicroEnvironment Data : File U14

STUDY IDENTIFICATION
--------------------

   Study Name : HEMDEMO
   Study Date : 01/05/90
   Study Time : 16:02:39

STUDY PROCESSING OPTION
-----------------------

   Model Micro Mode                 :              (Model Microenvironment Analysis Enabled)

   Number of Study Cohorts          : 0

   Cohort IDs                       :
   Number of Study Microenvironments: 0
   Microenv Names :

   MicroEnvironment Treatment       :      (Cohorts Subdivided by Micro Occ Rates)

   MicroEnvironment Occupancy Rates :

    Cohort   Micro Id   Occ Rate
    ------   --------   --------
```

```
BAC Options/Pollutant Data : File U20

   Study Name :HEMDEMO
   Study Date :01/05/90
   Study Time :16:02:39

Internal models included are:
        Area Sources
        Standard Point Sources

Microenvironments are modeled deterministically.

Total Number of Pollutants   :          3

Pollutant Name              Decay rate :
--------------              ----------

chloroform                    0.0000

benzene                       0.0000

styrene                       0.0000
```

```
BAC Area-Source Data : File U22

Total Number of Area Sources :          1
Total Number of Pollutants   :          3

Pollutant Name List :
     chloroform
     benzene
     styrene
```

```
RAC Standard Point-Source Data : File U23
-----------------------------------------------------------------------------

Total Standard Point Sources :          2
Total Number of Pollutants   :          3

Pollutant Name List :
     CHLOROFORM
     BENZENE
     STYRENE

Source Id  : Demo Point Source #1
Latitude   :     414121     Longitude  :     873349
Geo Class  : URBAN          Polar Grid : DEFAULT
No Emis Pts:          1     Max Radius :     50.0000
No Rings   :         10
Ring Radii :
                  0.2000
                  0.5000
                  1.0000
                  2.0000
                  5.0000
                 10.0000
                 20.0000
                 30.0000
                 40.0000
                 50.0000
-----------------------------------------------------------------------------
Emiss Pt Id       : Main Smokestack
X Location        :     0.0000      Y Location       :     0.0000
Emiss Pt Type     : STACK
Emiss Pt Hgt      :    35.0000      Ground Hgt       :     0.0000
STACK Int diameter:     1.3400
STACK temperature :   400.0000
STACK velocity    :     0.1120
STACK bldg hgt    :     0.0000      STACK bldg wid   :     0.0000
STACK wake flag   :          0
-----------------------------------------------------------------------------
```

Report U23 continued.

```
Pollutant            Emission Rate
---------            -------------
chloroform              1.2000
benzene                 2.3000
styrene                 3.4000
=============================================================================
Source Id  : HEM Demo Plant #2
Latitude   :     412150     Longitude  :     875451
Geo Class  : URBAN          Polar Grid : USERSPEC
No Emis Pts:          2     Max Radius :     40.0000
No Rings   :         10
Ring Radii :
                  0.1000
                  0.2500
                  0.5000
                  1.0000
                  2.0000
                  5.0000
                 10.0000
                 20.0000
                 30.0000
                 40.0000
-----------------------------------------------------------------------------
Emiss Pt Id       : Big Stack
X Location        :  -100.0000      Y Location       :  -100.0000
Emiss Pt Type     : STACK
Emiss Pt Hgt      :   600.0000      Ground Hgt       :     0.0000
STACK Int diameter:     1.4800
STACK temperature :   383.0000
STACK velocity    :     0.4100
STACK bldg hgt    :     0.0000      STACK bldg wid   :     0.0000
STACK wake flag   :          0
-----------------------------------------------------------------------------
```

Report U23 continued.

Pollutant	Emission Rate
chloroform	0.0000
benzene	5.0000
styrene	6.0000

Emiss Pt Id	: Little Stack			
X Location	: 50.0000	Y Location	:	50.0000
Emiss Pt Type	: STACK			
Emiss Pt Hgt	: 25.0000	Ground Hgt	:	0.0000
STACK Int diameter	: 0.5000			
STACK temperature	: 397.5000			
STACK velocity	: 0.1500			
STACK bldg hgt	: 0.0000	STACK bldg wid	:	0.0000
STACK wake flag	: 0			

Pollutant	Emission Rate
chloroform	7.2000
benzene	0.0000
styrene	0.0000

BAC MicroEnvironment Data : File U26

STUDY IDENTIFICATION

Study Name : MEMDEMO
Study Date : 01/05/90
Study Time : 16:02:39

STUDY PROCESSING OPTION

Model Micro Mode : (Model Microenvironment Analysis Enabled)

Number of Pollutants : 0

Poll IDs :
Number of Study Microenvironments: 0
Microenv Names :

MicroEnvironment Treatment : (Microenvironment Option Selected)

MicroEnvironment Correlation Coefficients :

Pollutant	Micro Id	Coef

RISK Data : File U40

STUDY IDENTIFICATION

Study Name : hemdemo
Study Date :
Study Time :

Number of Pollutants : 3

Pollutant Name	Pollutant UD	Pollutant URF
chloroform	U	0.0000
benzene	U	0.0000
styrene	U	0.0000

APPENDIX I
ISCLT MODEL DEFAULTS REPORTS

```
Card Group 1 : TITLE -- No Defaults

Card Group 2 : ISC Option Switches
               1 2 2 0 0 3 2 2 3 0 0 0 0 0 0 0 0 1 0 1 0 0 1 1

Card Group 3 : General Source/Met Data
               NSOURC       : No Default
               NGROUP       :  0
               NXPNTS       : No Default
               NYPNTS       : 16
               NXWYPT       :  0
               NSEASN       :  1
               NSPEED       :  6
               NSTBLE       : No Default
               NSCTOR       : 16
               NOFILE       :  0

Card Group 4 :  No Defaults

Card Group 5 : Concentration/Emission Rate Units
               MICROGRAMS PER CUBIC METER                GRAMS PER SECOND

Card Group 6 : X-pt Receptor Grid -- No Default

Card Group 7 : Y-pt Receptor Grid
                   0.00   22.50

Card Group 8 : Terrain Elevations -- Not Used

Card Group 9 : Freq_of_Occurence Data Format
               (7X,6F7.5)

Card Group 10 : Ambient Air Temp -- No Defaults

Card Group 11 : Mixing Layer Hts -- No Defaults

Card Group 12 : Vert Grad of Potential Temp
                Stability Class 1 (All Wind Speed Cat) :    0.000
                Stability Class 2 (All Wind Speed Cat) :    0.000
                Stability Class 3 (All Wind Speed Cat) :    0.000
                Stability Class 4 (All Wind Speed Cat) :    0.000
                Stability Class 5 (All Wind Speed Cat) :    0.020
                Stability Class 6 (All Wind Speed Cat) :    0.035
```

```
Card Group 1 : TITLE -- No Defaults

Card Group 2 : ISC Option Switches
               1 2 2 0 0 3 2 2 3 0 0 0 0 0 0 0 0 1 0 1 0 0 1 1

Card Group 3 : General Source/Met Data
               NSOURC       : No Default
               NGROUP       :  0
               NXPNTS       : No Default
               NYPNTS       : 16
               NXWYPT       :  0
               NSEASN       :  1
               NSPEED       :  6
               NSTBLE       : No Default
               NSCTOR       : 16
               NOFILE       :  0

Card Group 4 :  No Defaults

Card Group 5 : Concentration/Emission Rate Units
               MICROGRAMS PER CUBIC METER              GRAMS PER SECOND

Card Group 6 : X-pt Receptor Grid -- No Default

Card Group 7 : Y-pt Receptor Grid
                   0.00   22.50

Card Group 8 : Terrain Elevations -- Not Used

Card Group 9 : Freq_of_Occurence Data Format
               (7X,6F7.5)

Card Group 10 : Ambient Air Temp -- No Defaults

Card Group 11 : Mixing Layer Hts -- No Defaults

Card Group 12 : Vert Grad of Potential Temp
               Stability Class 1 (All Wind Speed Cat) :    0.000
               Stability Class 2 (All Wind Speed Cat) :    0.000
               Stability Class 3 (All Wind Speed Cat) :    0.000
               Stability Class 4 (All Wind Speed Cat) :    0.000
               Stability Class 5 (All Wind Speed Cat) :    0.020
               Stability Class 6 (All Wind Speed Cat) :    0.035
```

APPENDIX J
MICROENVIRONMENTS

Microenvironments are defined as locations (either indoor or outdoor) where pollutant concentrations cannot be assumed to be equal to those existing in the ambient air. The ability to estimate pollutant concentration for a variety of microenvironments eliminates the assumption that indoor concentrations are equal to outdoor concentrations. The technique uses a correlation relationship for particular pollutant and microenvironment types (e.g., building types such as office buildings, schools, and residences). The technique is mechanistically applicable to both long- and short-term averages, but most of the research supporting these correlation relationships has provided data more representative of long-term averages.

Recent research has shown that representing concentrations to which people are exposed by using the ambient concentration can produce results that are substantially different from actual measured exposures. Microenvironment pollutant concentrations are a function of three factors: exchange rates between indoor and outdoor air, indoor sources of the pollutant, and indoor sinks for the pollutant. The relative importance of these factors varies from pollutant to pollutant. Yocum[1] has grouped pollutants according to the location of the predominant source of the pollutant: predominantly outdoor, indoor and outdoor, and predominantly indoor.

Estimating microenvironmental pollutant concentrations based on indoor/outdoor correlation factors is currently the preferred approach. In the past 15 years, researchers[2,3] have collected data using both fixed-site and personal exposure monitors. Studies have focused on quantifying personal exposure to pollutants. The majority of monitoring data collected has focused on criteria pollutants, those for which National Ambient Air

Quality Standards (NAAQS) have been established under the Clean Air Act. Indoor/outdoor pollutant concentration relationships, however, have also been established for a number of trace metal and organic compounds.

The NAAQS Exposure Model (NEM)[4] contains a methodology for calculating microenvironmental concentrations based on indoor/outdoor concentration ratios. The microenvironmental concentration at time, t, is expressed as:

$$X_{m,t} = a_{m,t} + b_m x_t$$

where

$X_{m,t}$ = microenvironment concentration; m is the specific microenvironment and t is a specific time interval,
$a_{m,t}$ = pollutant concentration generated by an indoor source,
b_m = indoor/outdoor concentration ratio for microenvironment m, and
x_t = ambient air concentration estimate (from outdoor fixed site monitor) for time interval t.

The indoor/outdoor concentration ratio at time, t, is based on independent experimental data fit to the following expression:

$$b_m = \frac{(x_{m,t} - \bar{a}_{m,t})}{x_{a,t}}$$

where

b_m = average indoor/outdoor concentration ratio for microenvironment m,
$x_{m,t}$ = microenvironmental concentration for microenvironment m during time period t,
$\bar{a}_{m,t}$ = average pollutant concentration generated by a source contained in microenvironment m during time period t, and
$x_{a,t}$ = ambient pollutant concentrations during time period t.

The above equations introduce an important concept to estimating microenvironmental

concentrations: time dependence. *Outdoor* ambient air concentrations and indoor source pollutant levels are not static. Indoor pollutant "sinks" are a subject of current research[5] and information has not yet been developed for use in operational models. Another time-related concern is that these relationships are generally not valid for short-term intervals because there may be a substantial lag between outdoor concentration values and consequent indoor concentrations.

Microenvironment pollutant concentrations generated from sources within that microenvironment have been estimated using compartmental models. Outdoor air quality, indoor generation of pollutants, pollutant removal mechanisms, meteorological factors, and structural permeability and ventilation rates are incorporated into the theoretical framework of the model. Both single- and multicompartment models have been developed and tested for a few pollutants. However, compartmental models are in the developmental stage. They have not yet been applied to a broad range of pollutants and are not considered to be operational for use in exposure/risk modeling.

HEM-II does not currently calculate pollutant concentrations generated by microenvironment (e.g., indoor sources). Therefore, the expression for calculating long-term microenvironment concentrations reduces to:

$$x_m = b_m x_i$$

The overall individual exposure is expressed as follows:

$$X = \Sigma[(b_m x_i)c_m]$$

where

X = total exposure for an individual,
b_m = indoor/outdoor concentration rate for microenvironment m,
x_i = ambient air concentration at location of the individual, and

c_m = fraction of time individual spends in microenvironment m.

The term b_m is described in the HEM-II User Interface as the Pollutant Correlation Coefficient. The mechanism of specifying these coefficients is described in Section 4, **BAC MICROENVIRONMENTS POLLUTION COEFFICIENTS MENU**. The user will supply a single value for each of the microenvironments named in the **'HEM Study Scenario.'**

The term c_m is described in the HEM-II User Interface as the Microenvironment Occupancy Rate. The details for specifying these values are also described in Section 4 of this User's Guide, under the **POP MICROENVIRONMENTS MENU**. The user will supply a single value for each of the microenvironments included in the study definition.

HEM-II uses these values in the above expression by evaluating the ambient air concentration at the location of the individual, normally a population BGED, and then evaluating all microenvironments present at that location. The contributing microenvironment concentrations are then integrated to provide the overall concentration to which an individual at that location is exposed.

REFERENCES

1. Yocum, J. E. Indoor-Outdoor Air Quality Relationships, A Critical Review. J. Air Pollut. Control Assoc., 32(5):500-520, 1982.

2. Freed, J. R., S. N. Nacht, L. Thompson, W. N. Christie, and C. E. Carpenter. Methods for Assessing Exposure to Chemical Substances, Volume 2 (Draft). U. S. Environmental Protection Agency, Washington, DC, 1985.

3. Spengler, J. D., and M. L. Soczek. Evidence for Improved Ambient Air Quality and the Need for Personal Exposure Research. Environ. Sci. Technol. 18(9):268A-280A, 1984.

4. Johnson, T., and R. A. Paul. NAAQS (National Ambient Air Quality Standards) Exposure Model (NEM) Applied to Carbon Monoxide, EPA Publication No. EPA-450/5-83-003. U. S. EPA Office of Air Quality Planning and Standards, Research Triangle Park, NC, 1983.

5. National Research Council. Indoor Pollutants. EPA-600/6-82-001, U.S. EPA Office of Research and Development, Washington, DC, 1982.