
for the

Total Human Exposure Model (THEM)

Version 1.0

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ABSTRACT

The details of a Total Human Exposure Model (THEM) that calculates 24-hour exposure profiles using real human activity patterns and indoor air models derived from actual measurements of Respirable Suspended Particles (RSP) are described from both the user’s and the programmer’s perspectives. Included are descriptions of: (1) the mathematical basis for THEM, (2) the user interface, files, and options in THEM, (3) an example calculation for the San Francisco Bay Area, (4) the flow of the THEM program, (5) the subprograms and variables contained in the THEM source code, and (6) methods of adding custom subprograms to THEM. The source code for version 1.0 of the THEM software (included in an Appendix) was written in Microsoft™ Professional BASIC version 7.1 for implementation on IBM-compatible personal computers. [Currently, the model uses the California Activity Pattern (CAP) database obtained from the Air Resources Board. These data include diaries of over 1700 adults and children that contain coded information on microenvironments, which consist of locations and activities. The diary codes correspond to locations in factories, offices, restaurants and homes (room specific), and whether or not an individual is in the presence of a smoker. THEM determines RSP exposure by taking the microenvironmental information from the CAP data and assigning RSP levels for (1) Environmental Tobacco Smoke (ETS) and (2) ambient levels (from motor vehicles and wood smoke). For ambient data, actual hourly diurnal particulate measurements are obtained from a continuous monitoring instrument. THEM computes RSP exposures from ETS using validated models based on the mass balance equation. Source strengths, smoking rates, room air exchange rates, and room volumes are incorporated into the model by randomly sampling from actual distributions of data. An execution of THEM for 381 people on a 33 MHz 486 computer for both microenvironmental and ambient exposures took approximately 20 minutes.
PREFACE

This document is part of a series of Stanford University reports on the exposure of Californians to Environmental Tobacco Smoke (ETS) supported in part by the Tobacco Related Disease Research Program (TRDRP), Grant No. 2RT0274. The previous reports consisted of detailed analyses of the California Activity Pattern (CAP) Survey conducted by the California Air Resources Board (CARB). This report is a user’s and programmer’s manual that describes the Total Human Exposure Model (THEM), which was developed, in part, to study the proportion that ETS contributes to overall exposure to Respirable Suspended Particles (RSP). THEM is part of a new class of human activity pattern-exposure models that integrate activity pattern data and measurements of pollutant concentration for different sources and in different locations to produce frequency distributions of exposure for entire populations.
INTRODUCTION

The Total Human Exposure Model (THEM) described in this user's and programmer's manual was developed at Stanford University to compute the frequency distribution of human exposures to Respirable Suspended Particles (RSP) from Environmental Tobacco Smoke (ETS) and ambient sources for the populations of California. The California Activity Pattern (CAP) data from the California Air Resources Board (ARB) was used to supply diary data and codes for the locations and the presence of a smoker. Microenvironmental concentrations of RSP were generated using a Sequential Cigarette Exposure Model (SCEM) also developed at Stanford University and validated in field experiments. Parameter inputs for SCEM were either estimated by the authors or came from actual data on air exchange rates and house footage. Other estimates of microenvironmental concentrations were based on field studies conducted at Stanford University as part of the California Environmental Tobacco Smoke Field Survey (CETFS) supported by the Tobacco Related Disease Research Program (TRDRP). Ambient concentrations came from the air monitoring network operated by the Bay Area Air Quality Management District (BAAQMD). An example exposure calculation from THEM for the subpopulation of the San Francisco Bay Area is given in Part 7 of Section IV of this manual. The basis for much of THEM is the Simulation of Human Activity and Pollutant Exposure (SHAPE) Model. A complete description of the THEM methodology is available in another paper. Although THEM has been designed and applied primarily to air pollutants, the theoretical framework in THEM can be extended in the future to dermal exposure and to other exposure media.

Although THEM was first written for a specific pollutant (RSP) with microenvironmental and activity pattern data for a specific population (California), it was designed to be expandable to compute exposures for any population and any pollutant. The modular design allows for both the facile addition of procedures containing any number of mass balance or chemical microenvironmental models, and the simple alteration of the control structure in a single module that determines what models are incorporated into a THEM calculation. THEM reads external text files containing activity pattern data, ambient data, activity and location code groupings, frequency distributions of physical parameters for models, and physical distributions of microenvironmental concentrations. These files are all specified by the user, allowing for the inclusion of data pertinent to the populations and pollutants of interest.

The manual is divided into three major sections. The basis and mathematical structure of THEM is outlined in Sections I and II. Section III contains instructions and information for the users of THEM. Programmers who wish to modify the THEM program can find the information they need in Section IV.
Notice to Users: This document is intended for scientists in the field of exposure or risk analysis who wish to conduct calculations of population exposure using the THEM program. THEM should be used by individuals who have a clear understanding of the scope of human exposure analysis and the structure of human activity pattern data.

Technical Notice to Users: THEM is a group of stand-alone computer programs for use with the DOS operating system on IBM-compatible XT, AT, 386, 486, etc., personal computers. THEM is capable of being executed with any monitor configuration and does not require a math coprocessor. It requires no additional files and uses no special non-text file formats. On a 33 MHz 486 IBM-compatible computer, THEM takes about 20 minutes to calculate total human exposure for every 400 people.

Notice to Programmers: THEM was written in Microsoft Extended QuickBASIC version 7.1. The QuickBASIC programming language is completely modular and structured. It is possible with QuickBASIC to produce understandable code very quickly. A brief description of the structure used in THEM is available in Part 1 of Section IV of this manual. For more information on the language please consult the QuickBASIC manual\textsuperscript{13} or contact Microsoft.
This research was supported by funds provided by the Cigarette and Tobacco Surtax Fund of the State of California through the Tobacco Related Disease Research Program of the University of California, Grant No. 2RT0274. Grateful appreciation is extended to Wayne Ott for his constructive criticisms and to Paul Switzer for his helpful insights. Appreciation is given to the U.S. Environmental Protection Agency (EPA) for its support in developing some of the models and collecting some of the data used in this program. Thanks are extended to John P. Robinson for his help with the CAP data base and to Elena Tracy for her assistance with the CAP data base and BASIC computer programming. Appreciation is given to Peggy Jenkins and Tom Phillips of the California Air Resources Board for conducting the California Activity Pattern (CAP) Survey and making the data available to us.
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BACKGROUND

The frequency distribution of exposures across a population is crucial for conducting risk analyses. However, the task of measuring exposures for all people, including daily, weekly, and seasonal variations, even just for one pollutant, is quite a difficult and expensive proposition; and since exposures for different pollutants can vary widely between people, studies involving small numbers of people can be very misleading. There are two major methods for arriving at exposures across a population: a "direct" and an "indirect" method\textsuperscript{14,15}.

The direct method involves the simultaneous sampling of real exposures and activity patterns from a defined population, and creating exposure statistics from these data. Exposure data are collected with personal monitors attached to individuals as they conduct and record their daily routines. This method is fairly massive since it requires a day-long commitment of many persons and careful quality control for small, rugged instruments, often followed by chemical analysis.

The indirect method, as exemplified by THEM, combines information on human activity patterns with information on the pollutants likely to be found there. Activity pattern information consists of samples of the daily locations and activities of a defined population. Microenvironmental concentrations are measured separately for the population, and used to develop mass balance models or frequency distributions of typical exposures in each microenvironment. The indirect method allows the problem of exposure estimation to be broken down into smaller segments. Activity patterns for a population can be obtained from fairly short random phone interviews, and microenvironmental concentrations can be obtained from short visits to various places individuals in the population typically visit or from intensive studies of pollutant flow in real locations or in laboratories. Measurements are still required, but instead of instruments worn by people, scientists measure and model the concentrations in the microenvironments that people visit.
THE STRUCTURE OF THE TOTAL HUMAN EXPOSURE MODEL (THEM)

THEM generates location, activity, and exposure “profiles” that consist of 1440-minute arrays containing location and activity codes (Figure 1), or RSP concentrations (Figure 2).

Figure 1. Example of location profile. Minutes run vertically and hours run horizontally over grid containing location codes for person #5 of Bay Area activity file.
### Figure 2. Example exposure profile. Minutes run vertically and hours run horizontally over grid containing average microenvironmental RSP concentrations (µg/m³) for person #5 of Bay Area activity file.
The exposure for person $i$ at minute $j$ can be represented by

\begin{equation}
E_{\text{M}}(i,j) = f[L(i,j), A(i,j), S(i,j)]
\end{equation}

where

- $E_{\text{M}}(i,j)$ = Microenvironmental exposure for person $i$ at minute $j$
- $L(i,j)$ = Location for person $i$ at minute $j$
- $A(i,j)$ = Activity for person $i$ at minute $j$
- $S(i,j)$ = Presence of smoker for person $i$ at minute $j$

Microenvironmental exposures, $E_{\text{M}}(i,j)$, are measured in concentration units such as $\mu$g/m$^3$ or ppm. Locations, $L(i,j)$, are places such as home, bar, restaurant, work, car, bingo game, etc. Activities, $A(i,j)$, include taking a shower, sleeping, vacuuming, cooking dinner, driving to work, refinishing furniture, etc. The presence of a smoker, $S(i,j)$, is also taken into account.

THEM calculates microenvironmental exposures $E_{\text{M}}(i,j)$ for each person by inputting locations, activities and the presence of a smoker and calling a subprogram -- called an $\text{M}$-subprogram-- that fills in the minutes with appropriate pollutant concentrations. THEM uses the Monte-Carlo inverse transform method\textsuperscript{16,17} to sample from frequency distributions of physical parameters and/or frequency distributions of microenvironmental concentrations.

**Note:** The current version of THEM uses the Sequential Cigarette Exposure Model (SCEM) to calculate microenvironmental particle exposures due to Environmental Tobacco Smoke (ETS)\textsuperscript{3}. SCEM comprises an $\text{M}$-subprogram that is called whenever a single smoker is present in any location. It fills in each minute of the exposure array with an average particle concentration.

The ambient exposures are added to microenvironmental exposures to obtain total exposures

\begin{equation}
E_{\text{T}}(i,j) = E_{\text{M}}(i,j) + E_{\text{A}}(i,j)
\end{equation}

where

- $E_{\text{T}}(i,j)$ = Total exposure for person $i$ at minute $j$
- $E_{\text{M}}(i,j)$ = Microenvironmental exposure for person $i$ at minute $j$
- $E_{\text{A}}(i,j)$ = Ambient exposure for person $i$ at minute $j$
Ambient exposures are obtained from one or more fixed station monitors operating in the regional area where THEM is applied. The ambient data include the seasonal and daily fluctuations in exposure from outside sources such as vehicles or wood smoke.

As THEM cycles through each person, it calculates 24-hour microenvironmental and ambient average exposures, maximum minute-by-minute micronenvironmental exposures, and maximum hourly total exposures. It also outputs the age and sex of each person obtained from the original activity pattern diaries and optionally outputs the amount of time each person was exposed in each location. More detailed discussion of the structure of THEM is available in another paper\textsuperscript{12}. 
USER'S SECTION

This section describes the aspects of THEM that a user must be familiar with so that he/she can: (1) Calculate Population Exposures, (2) Specify Input and Output Files, (3) Modify Location and Activity Groupings, (4) Set Calculation Options, (5) Set Display Options, (6) Specify Frequency Distributions for Microenvironmental Model Parameters, (7) Specify Frequency Distributions for Microenvironmental Concentrations, (8) Create Histograms and Statistics for Human Exposures. Through (6) and (7) above, the user can easily improve the accuracy of THEM calculations by using more reliable input data based on field studies and experiments.

Note: All executable programs are written in capital letters (e.g., THEMMAIN) in the following discussions.

The THEM Suite of Programs

The methodology for computing frequency distributions of exposure is split into several different computer program modules: THEMMAIN, THEMHIST, CALCHIST, and VIEWHIST. This was done for three primary reasons: (1) memory considerations, (2) to simplify the programming, and (3) to clarify the step-wise progress of calculations for users. The first program (THEMMAIN) is the actual engine for producing exposure data from activity patterns, microenvironmental surveys, and indoor models. This program can be used alone to tabulate lists of exposure, demographic data, and exposure times for each person in the population. The output of THEMMAIN can then be used with a statistical package for analyzing the data. Alternatively, the second THEM program (THEMHIST) can be used easily to calculate histograms, averages, standard deviations, medians, number of exposed people, percent of exposures over a certain threshold, and other statistics relevant to exposure analysis. The remaining two THEM programs produce histograms of the frequency distributions for the physical parameters and microenvironmental concentrations that are used as input to THEMMAIN (CALCHIST), and display graphical representations of histograms produced by any of the THEM programs (VIEWHIST). Most of the discussion in the next few parts centers around the THEMMAIN program.

User Interface

The user interface in all of the THEM programs consists of key-controlled menus. Each menu contains a title, a list of tasks or options, and instructions. The user selects a choice from the lists of tasks or options by pressing a letter or number. To exit a menu, the user usually presses either the "Return" or "Escape" key.
During calculations in the THEMMAIN program, the user is presented with a screen displaying information about the calculation-in-progress. The person number, identification number, last microenvironmental exposure, current task, etc., are all updated as THEM processes each person. Depending on the options the user has chosen, THEM may save, display on the screen, or print information on each person. Instructions are displayed in a window at the bottom of the screen.

**Main Calculation Choices.** With THEMMAIN, the first screen the user sees is the title screen. After pressing any key, the user sees the "Main Title" screen containing all the major calculation options. The first section of the "Main Title" screen has options for: (1) carrying out a "detailed" calculation for the next person, (2) calculating exposures for everyone in the activity pattern input file (APIF), and (3) calculating exposures for the next N persons in the APIF. The detailed calculation for (1) displays for the user the location, activity, exposure, and hourly summary profiles as the program conducts a calculation for only the next person in the APIF. The second section of the "Main Title" screen allows for the control of position in the APIF. The third section contains options leading the user to menus for changing display options, input and output filenames, and calculation options.

**Input and Output Files**

The user can change the name of all input and output filenames (Table 1) by pressing "O" at the "Main Menu". He/she is then presented with a list of the current filenames that are altered by pressing the appropriate letter and entering the new name. All names must also contain the desired path, otherwise THEM assumes they are in the same as the directory where the THEMMAIN program was started.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>APIF</td>
<td>Activity Pattern Input File</td>
</tr>
<tr>
<td>AIF</td>
<td>Ambient Input File</td>
</tr>
<tr>
<td>PEOF</td>
<td>Population Exposure Output File</td>
</tr>
<tr>
<td>TOF</td>
<td>Output File for Tally of Exposure Time in Each Location</td>
</tr>
<tr>
<td>LOF</td>
<td>Output File for All Location Profiles</td>
</tr>
<tr>
<td>AOF</td>
<td>Output File for All Activity Profiles</td>
</tr>
<tr>
<td>SOF</td>
<td>Output File for All Smoker Present Profiles</td>
</tr>
<tr>
<td>EOF</td>
<td>Output File for All Exposure Profiles</td>
</tr>
<tr>
<td>HOF</td>
<td>Output File for All Hourly Exposure Summaries</td>
</tr>
<tr>
<td>MOF</td>
<td>Output File for All Exposure Episode Model Parameters</td>
</tr>
</tbody>
</table>

The APIF, AIF, and PEOF filenames cannot be null since they are required in any calculations of exposure. Exposures are automatically written to the PEOF for every person cycled through the THEMMAIN program. If the other output file names are null, then none of the corresponding information will be written to a file. Information is appended to these files for
each cycle. The user is required to erase the files manually to erase unwanted data from previous calculations.

**THEM Data Files**

THEM requires two data files to carry out its calculations: (1) THEMLOC.DAT, and (2) THEMDIST.DAT. THEMLOC.DAT contains the location names, old codes, and calculation method for each of the new regrouped location codes. The old codes are the standard codes used during the collection of actual activity pattern data (Table 2). The calculation method involves either a mass balance model or sampling from a distribution of actual microenvironmental data. The four-character code corresponding to the calculation method must be recognized by the THEMMAIN program. Currently, the only method codes recognized are "SCEM" for the Sequential Cigarette Exposure Model and "MICR" for the sampling of micronvironmental concentration data. THEMDIST.DAT contains the frequency distributions for the mass balance model parameters and for microenvironmental concentrations. Examples of both files -- with instructions for their use -- are included in Appendices B and C. To help the user check the input distribution, CALCHIST reads the frequency distributions in the THEMDIST.DAT data file and displays histograms of sampled values.

Although adding a new microenvironmental model requires the user to program a new BASIC subprogram, adding new microenvironmental exposure data obtained from real monitoring studies involves only the modification of the THEMDIST.DAT text file. The number of locations is input into THEMMAIN from the THEMLOC.DAT text file and THEMMAIN expects to find distributions corresponding to each of these locations at the end of the THEMDIST.DAT text file. THEMMAIN requires a "99,99" flag at the end of each distribution data line. The format is described in the file itself (Appendix B).

**Calculation Options**

THEMMAIN allows for the exclusion of specific microenvironmental locations from population exposure calculations. It also is possible from within THEMMAIN to change the calculation method used to determine exposures in each microenvironment.

The utility of exposure models such as THEM lies in their ability to predict the effect of specific control strategies on population exposure as long as other exposure factors remain the same. For example, if smoking tobacco were prohibited in bars and restaurants, what would be the resulting reduction in 24-hour ETS exposures for the defined population? If no other human behavior had been changed due to this policy decision, the analyst could use the same activity pattern and exposure data as before and simply set all exposures in bars and restaurants to zero.
To conduct such a calculation in THEMMAIN is very simple. From the “Options, Filenames” menu, the user should press “1” for “Exclude Locations”. Next, the user should enter the number of the location you wish to exclude. For calculations that include the exposures for only one microenvironment, just exclude all locations except for the one desired.

The calculation method for each location can be changed by pressing “2” at the “Options, Filenames” menu. When the number of the appropriate location is entered, the program cycles through the available calculation methods (e.g., SCEM or MICR). The algorithm corresponding to each calculation method must be present in a subprogram of the THEMMAIN program module (see the “Programmer's Section” of this manual). Frequency distributions for the parameters required by any models and frequency distributions for microenvironmental concentrations must both be present in the THEMDIST.DAT text file.

**Display & Printout Options**

The THEM user has access to the following data: (a) location and activity profiles, (b) exposure files, (c) hourly summaries, (d) graphical representation of daily profiles, and (e) exposure episode parameter list for every person cycled during a calculation. This data is available through: (1) display on monitor screen, (2) printouts, or (3) files on a computer disk. The user also can have THEMMAIN pause between the calculation of each person, or pause when a new exposure episode is encountered. These options are accessed by pressing "C" at the "Main Menu" and toggling each option by pressing the appropriate number.

**Example Calculation**

This part of the manual presents an “example calculation” of 24-hour average Respirable Suspended Particles (RSP) exposures from Environmental Tobacco Smoke (ETS) and ambient levels for the San Francisco Bay Area. The activity pattern file used as input is part of the California Activity Pattern (CAP) Survey[1,2,3,4]. In this example, the PM-10 RSP ambient data was obtained from a BAAQMD fixed-station monitoring site in San Jose, CA[8]. The SCEM cigarette exposure model was used to calculated PM-3.5 microenvironmental exposures for all the reduced locations in Table 3; that is, no frequency distributions of actual microenvironmental concentrations were used in this example. All model parameters were estimated by the author except for the residential air exchange rates[6], and residential areas (footages) and number of rooms[7]. The frequency distributions estimated by the author in THEMDIST.DAT are for vehicle volumes, vehicle window-open/window-closed air exchanges, sources strengths, and smoking rates. The THEMLOC.DAT and THEMDIST.DAT files used for this calculation are given in Appendices A and B. The conversion factor from PM-10 ambient concentrations to PM-3.5 concentrations was chosen as 0.6[18] in the subprogram that read the BAAQMD file. All parties involved in this research realize that use of a single conversion factor for PM 3.5/PM 10 is an oversimplification.
However, a special real-time monitoring field study conducted and analyzed at Stanford University compared PM 2.5 reading with the BAAQMD values of PM 10. Although the results of this unpublished research showed that the ratio varied from day to day, its range was between 0.4 and 0.8. Use of 0.6 is an approximation.

**Input Files.** The text files BAY.DAT and PART.DAT contain the Bay Area Activity Pattern and ambient data, respectively (Figures 3 and 4).

```
31,3,1,230,150,150,2,5,91,10,17,87,7
31,0,426,707,838,0,2,101887,1,1,1,1,5,2,0,0,0,0,0,0,0
31,5,0,0,0,0,0,0,0,0,0,0,1,1,1,7,720,720,5,0,5,5,5,5,5
31,0,1,1,5,5,5,5,5,5,40,6,0,5,95492,49,1,1,1,1,5,1,0,0,0,1,5,3,1,5
31,0,0,0,0,0,0,0,1,5,0,5,0,0,0,0,0,0,0,0,0,0,5,5,5,5,5,5
31,1,1,1,1,1,1,9,5,1,01887,0,1,53,24,3,0,3,2,24,39,5,1,1,10,17,87
31,7,10,17,87,7,0,10,17,87,7,10,17,87,7,0,10,643,.5895,.9258,.541
31,3,1,230,400,90,240,4,5,474,10,17,87,7
31,3,1,400,1100,420,660,2,5,101887,1,1,1,1,5,2,0,0,0,0,0,0,0,0,0
31,3,1,1100,1115,675,4,5,40,10,17,87,7
31,3,1,1115,1215,60,735,1,5,43,10,17,87,7
31,3,1,1215,1400,105,840,1,5,43,10,17,87,7
31,3,1,1400,1500,60,900,1,5,43,10,17,87,7
31,3,1,1500,1700,120,1020,5,5,10,17,87,7
31,3,1,1700,1800,60,735,4,5,40,10,17,87,7
31,3,1,1800,2300,300,1380,2,5,91,10,17,87,7
31,3,1,2300,30,1410,1,5,43,10,17,87,7
31,3,1,2330,2400,30,1440,2,5,43,10,17,87,7
33,3,3,0,1000,600,600,5,0,45,10,17,87,7
33,0,426,707,838,0,2,101887,1,1,1,1,5,2,0,0,0,0,0,0,0,0
33,5,0,0,0,0,5,0,0,0,0,0,0,0,1,1,1,1,7,720,720,5,0,5,5,5,5,5
33,0,1,1,5,5,5,5,5,5,40,6,0,5,95492,49,1,1,1,1,5,1,0,0,0,1,5,3,1,5
33,0,0,0,0,0,0,0,1,5,0,5,0,0,5,0,0,0,0,0,0,0,5,5,5,5,5,5
33,1,1,1,1,5,14,9,5,101887,0,1,53,24,3,0,3,2,24,39,5,5,1,1,10,17,87
33,7,10,17,87,7,0,10,17,87,7,10,17,87,7,0,10,643,.5895,.9258,.541
33,3,1,1000,1045,45,645,5,5,96,10,17,87,7
33,3,1,1045,1115,30,675,4,5,40,10,17,87,7
33,3,1,1115,1145,30,705,5,5,47,10,17,87,7
33,3,1,1145,1230,45,750,4,5,40,10,17,87,7
33,3,1,1230,1300,30,780,2,5,91,10,17,87,7
33,3,1,1300,120,20,800,51,5,39,10,17,87,7
33,3,1,1320,1845,325,1125,24,5,31,10,17,87,7
33,3,1,1845,1900,15,1140,51,5,39,10,17,87,7
33,3,1,1900,1915,15,1155,5,1,5,10,17,87,7
33,3,1,1915,2000,45,1200,5,5,80,10,17,87,7
33,3,1,2000,2030,30,1230,2,5,43,10,17,87,7
33,3,1,2030,2200,90,1320,2,5,91,10,17,87,7
33,3,1,2200,2300,30,1350,5,5,96,10,17,87,7
33,3,1,2300,30,1380,4,5,40,10,17,87,7
33,3,1,2320,2300,20,1400,51,5,79,10,17,87,7
33,3,1,2320,2400,40,1440,31,5,86,10,17,87,7
```

Figure 3. The entries for the first two people in the BAY.DAT activity pattern data file for the San Francisco Bay Area consist of demographic and diary data. Each diary line (the shorter ones) contains: the personal identification number, adult vs. youth code, beginning time, ending time, cumulative time, location code, presence of a smoker code, activity code, month, day, year, and day of week. The demographic data (longer lines) contains various information on sex, age, education, housing, etc.
Figure 4. The ambient data file PART.DAT consists of lines corresponding to each day in 1987 (the first 20 days are shown). Each line contains the Julian date (number of days after first of the year) and the average concentration of PM-10 RSP (in \( \mu g/m^3 \)) for each hour measured at the BAAQMD site in San Jose, CA.

**Location Regroupings.** For this example, the standard locations codes used in the CAP data base were regrouped into six new location codes (Table 2): (1) Home, (2) Office-Factory, (3) Other Indoor, (4) Bar-Restaurant, (5) Outdoors, and (6) Vehicle.

<table>
<thead>
<tr>
<th>Standard Location Codes</th>
<th>Regrouped Location Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Location</td>
</tr>
<tr>
<td>1</td>
<td>IN KITCHEN</td>
</tr>
<tr>
<td>2</td>
<td>IN LIVING ROOM</td>
</tr>
<tr>
<td>3</td>
<td>IN DINNING ROOM</td>
</tr>
<tr>
<td>4</td>
<td>IN BATHROOM</td>
</tr>
<tr>
<td>5</td>
<td>IN BEDROOM IN GARAGE</td>
</tr>
<tr>
<td>6</td>
<td>IN STUDY</td>
</tr>
<tr>
<td>7</td>
<td>IN GARAGE</td>
</tr>
<tr>
<td>8</td>
<td>IN BASEMENT</td>
</tr>
<tr>
<td>9</td>
<td>IN UTILITY ROOM</td>
</tr>
<tr>
<td>10</td>
<td>POOL, SPA</td>
</tr>
<tr>
<td>11</td>
<td>IN YARD</td>
</tr>
<tr>
<td>12</td>
<td>ROOM TO ROOM</td>
</tr>
<tr>
<td>13</td>
<td>OTHER HOUSEHOLD ROOM</td>
</tr>
<tr>
<td>21</td>
<td>AT OFFICE</td>
</tr>
<tr>
<td>22</td>
<td>AT PLANT</td>
</tr>
<tr>
<td>23</td>
<td>AT GROCERY STORE</td>
</tr>
<tr>
<td>24</td>
<td>AT SHOPPING MALL</td>
</tr>
<tr>
<td>25</td>
<td>AT SCHOOL</td>
</tr>
<tr>
<td>26</td>
<td>OTHER PUBLIC PLACE</td>
</tr>
<tr>
<td>27</td>
<td>AT HOSPITAL</td>
</tr>
<tr>
<td>28</td>
<td>AT RESTAURANT</td>
</tr>
</tbody>
</table>

11
Execution of THEM. The procedure for executing a THEM calculation involves setting calculation options, filenames, display-save-print options, etc. (Table 3).

Table 3. Checklist for Execution of an Exposure Calculation Using THEM

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Activity, ambient input files are in the correct format</td>
<td></td>
</tr>
<tr>
<td>2. THEMLOC.DAT file contains the correct location categories and old location codes with corresponding calculation method</td>
<td></td>
</tr>
<tr>
<td>3. THEMDIST.DAT file contains the correct frequency distributions for mass balance parameters and for microenvironmental concentrations (VIEWHIST may be used)</td>
<td></td>
</tr>
<tr>
<td>4. Start THEMMAIN program</td>
<td></td>
</tr>
<tr>
<td>5. Input and output filenames are correct (Choose &quot;O&quot; from main menu for &quot;Options, Filenames&quot; menu)</td>
<td></td>
</tr>
<tr>
<td>6. Options for excluding microenvironments are correct</td>
<td></td>
</tr>
<tr>
<td>7. Options for calculation method in each microenvironment are correct</td>
<td></td>
</tr>
<tr>
<td>8. Option to include ambient data is correct</td>
<td></td>
</tr>
<tr>
<td>9. Options for printing and displaying calculation results/progress are correct (Choose &quot;C&quot; from main menu for &quot;Print, Display options&quot; menu)</td>
<td></td>
</tr>
</tbody>
</table>
10. Choose "D", "A", or "N" from main menu for "detailed", "all", or "n-person" exposure calculation

11. View the calculation screen while exposures and, if opted, exposure times, location, activity, smoker, and hourly profiles, and episode parameters are tabulated in the appropriate files; this information may be displayed on the screen or printed if appropriate options were set

12. Output files do not contain any obvious errors

13. Repeat above checklist for any additional exposure calculations

14. Quit THEMMAIN program

15. Start THEMHIST program

17. Proper path and filename are set for file containing exposures outputed from THEMMAIN

18. Input desired number of people from tabulated list of exposures (Choose "R" for "read in file" from "Action Menu")

19. Select desired population subdivisions for histograms (Choose "V" for "view" under the "Action Menu" and set options)

20. Produce desired histograms ("O" on the "View Summaries" menu allows modification of histogram options such as barwidth, number of bars, start, end etc.)

21. Save histograms and statistics (Choose "H" from "View Summaries" menu)

THEM was run with no locations excluded and the SCEM method was selected for each location. All 381 people in the BAY.DAT file were processed in THEMMAIN with the "All" calculation option (see Main Menu Choices under User Interface above). The population exposure output file produced from THEMMAIN included the 24-hour average and hourly maximum RSP exposures for each person (Figure 5). Exposure times were also tallied and output for each person (Figure 6).
### SUMMARY OF 24-HOUR AVERAGE HUMAN RSP EXPOSURES (ug/m3)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
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<th></th>
</tr>
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<td>0.00</td>
<td>24.97</td>
<td>62.40</td>
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<tr>
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<td>33</td>
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<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>24.97</td>
<td>62.40</td>
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<td>41</td>
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<td>24.97</td>
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<td>23.30</td>
<td>35.40</td>
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<td>101</td>
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<td>1</td>
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<td>0.00</td>
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<td>62.40</td>
<td></td>
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<tr>
<td>7</td>
<td>143</td>
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<td>24.97</td>
<td>62.40</td>
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<tr>
<td>8</td>
<td>171</td>
<td>49</td>
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<td>280.58</td>
<td>841.73</td>
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<td>9</td>
<td>201</td>
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<td>62.40</td>
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<td>10</td>
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<td>24.97</td>
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<tr>
<td>11</td>
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<td>1</td>
<td>10.92</td>
<td>184.97</td>
<td>14.54</td>
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<td>149.11</td>
<td>23.30</td>
<td>166.51</td>
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</tr>
</tbody>
</table>

**Figure 5.** The first twenty people in the exposure output file for the Bay Area (381 persons total). The last line of the file contains, in parentheses: the name of the activity pattern input file, a string containing O’s for each microenvironment included and X’s for each microenvironment not included, a string containing the calculation method for each microenvironment (separated by periods), and the calculation type (“N”, “All”, or “detailed”).

### TALLY OF MINUTES OF EXPOSURE FOR EACH PERSON

**IN EACH OF 6 LOCATIONS**

<table>
<thead>
<tr>
<th>#</th>
<th>PID</th>
<th>AT</th>
<th>H</th>
<th>OFFI</th>
<th>OTHE</th>
<th>BAR,</th>
<th>OUTD</th>
<th>VEHI</th>
<th>TOT</th>
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<td>0</td>
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<td>0</td>
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<td>615</td>
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<tr>
<td>18</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>601</td>
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<td>0</td>
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<td>0</td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>120</td>
</tr>
</tbody>
</table>

**Figure 6.** The first twenty people in the output file containing tally of exposure times in each microenvironment for the Bay Area (381 persons total). The last line is explained in the caption for
Next, the THEMHIST program was used to generate a histogram of 24-hour average microenvironmental exposures for the population from which the mean, median, standard deviation, number of people exposed, percent over state standard, and percent over the federal standard were obtained (Table 4). THEMHIST can also be used to generate statistics involving any of the other variables.

Table 4. Overall statistics for the 24-hour average RSP microenvironmental exposures from ETS (µg/m³) for the San Francisco Bay Area (381 people total)

<table>
<thead>
<tr>
<th>Median</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>No. of people exposed at least 1 min.</th>
<th>% over 50 µg/m³ (California 24-hour Standard)</th>
<th>% over 100 µg/m³ (U.S. 24-hour Standard)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-20</td>
<td>68</td>
<td>128</td>
<td>184</td>
<td>32</td>
<td>13</td>
</tr>
</tbody>
</table>
PROGRAMMER'S SECTION

This section provides the information necessary to modify THEM. While user's are able to change the population activities, location codes, typical mass balance model parameters, and typical microenvironmental concentrations, all without writing any new BASIC code, scientists interested in studying exposures with new models must write a new M-subprogram to calculate minute-by-minute exposures. Changes must also be made in THEM so it will input the proper distributions and properly branch to new subprograms when new models are added for a specific locations. Thus, THEM can be constantly expanded so as to produce more sophisticated and accurate results.

If activity pattern or ambient data files of non-ASCII formats are desired, then a subroutine must be written to read them in. Only the sections in the ProcessPerson subprogram involving input must be changed.

Microsoft QuickBASIC

THEM was written in Microsoft Extended Professional QuickBASIC version 7.1. QuickBASIC supports the use of separate modules which must be loaded prior to execution of the program. Each of these modules contains independent procedures (subprograms or functions), and/or variable and type declarations. They are linked together by the use of INCLUDE files containing procedure, global variable, and type declarations. Each module has an INCLUDE file associated with it. The procedures in a module may be accessed if the calling module has "included" the corresponding INCLUDE file and the variables can be accessed if they have been preceded in the INCLUDE file by the COMMON SHARED statement. For THEM, the file THEMDECS.BI contains all global variable and type declarations (preceded by COMMON SHARED), and procedure declarations for the Main Module (THEMMAIN.BAS). Each other module (THEMIO.BAS, THEMSTAT.BAS) "includes" THEMDECS.BI if it needs to access its procedures, variables, or types. Please see the Microsoft QuickBASIC Manual for detailed information on programming with modules and procedures.

Style Conventions

All filenames in THEM are written in capital letters (e.g., THEMMAIN.BAS, THEMDECS.BI). Variables are also written in capital letters (e.g., NUMRECORDS%, INPUTFILE$; ending with the appropriate type identifier, %=Integer, &=Long Integer, %=String, none=Single Precision Real). Procedures (subprograms and functions) are written with initial capital letters (e.g., CalculateExposure, ShowParamsMenu, GetFromTimeStringS).
The Subprograms

There are over 70 procedures (subprograms and functions) used by THEM. They are divided into four program modules and five other separate modules. The four programs (Table 5) are: (1) Main Module (THEMMAIN.BAS), (2) Histogram Calculating Module (THEMHIST.BAS), (3) Distribution Checking Module (CALCHIST.BAS), and (4) Histogram Viewing Module (VIEWHIST.BAS). THEMMAIN contains the main THEM logic loop and subprograms that carry out tasks peculiar to THEM. These include: (1) reading input files, menus, array handling, (2) algorithms for the calculation of exposure, and (3) exposure profile output (Table 6). THEMHIST is used for calculating histograms of the exposures output by THEMMAIN. CALCHIST is used for checking the parameter and microenvironmental concentration frequency distributions contained in the THEMDIST.DAT file. VIEWHIST actually displays a histogram on the screen using BASIC's presentation graphics routines. Each of the four program modules contains procedures specific to themselves.

Table 5. Modules Comprising the THEM Suite of Programs

<table>
<thead>
<tr>
<th>Program Module</th>
<th>Sub-Modules Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>THEMMAIN</td>
<td>GENIO, GENSTAT</td>
</tr>
<tr>
<td>* Calculates population exposures from activities, and parameter or concentration frequency distributions*</td>
<td></td>
</tr>
<tr>
<td>THEMHIST</td>
<td>GENIO, THEMIO, GENSTAT, THEMSTAT</td>
</tr>
<tr>
<td>* Creates histograms from THEM population exposures*</td>
<td></td>
</tr>
<tr>
<td>CALCHIST</td>
<td>THEMGRX, THEMSTAT, GENIO</td>
</tr>
<tr>
<td>* Calculates and displays histograms for model parameters or microenvironmental concentration frequency distributions used in THEM*</td>
<td></td>
</tr>
<tr>
<td>VIEWHIST</td>
<td>THEMGRX, GENIO</td>
</tr>
<tr>
<td>* Displays histograms that have been saved to a file by other programs (THEMMAIN, THEMHIST)*</td>
<td></td>
</tr>
</tbody>
</table>

Each module has its own, separate "include" file (*.BI) containing all its procedure, type, and variable declarations.
<table>
<thead>
<tr>
<th>Module</th>
<th>Subprogram</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>THEMMAIN <em>Main module containing procedures for calculating population exposures</em></td>
<td>AmbExp</td>
<td>Gets ambient hourly average exposure data from D. Fairley, BAAQMD file.</td>
</tr>
<tr>
<td></td>
<td>CalculatePerson</td>
<td>Handles calculation of exposure for each person</td>
</tr>
<tr>
<td></td>
<td>Calender</td>
<td>Translates CAP date to Julian format</td>
</tr>
<tr>
<td></td>
<td>ClearProfile</td>
<td>Erases profiles (location/smoking)</td>
</tr>
<tr>
<td></td>
<td>ClearVector</td>
<td>Erases vector profiles (exposure)</td>
</tr>
<tr>
<td></td>
<td>ConstantExposure</td>
<td>Determines constant exposures based on location, smoking, and activity</td>
</tr>
<tr>
<td></td>
<td>ConstMenu</td>
<td>Displays menu for user to change constant exposure values</td>
</tr>
<tr>
<td></td>
<td>Diary</td>
<td>Processes the CAP diary information for each person</td>
</tr>
<tr>
<td></td>
<td>DoTitle</td>
<td>Displays title on the screen</td>
</tr>
<tr>
<td></td>
<td>EnterDist</td>
<td>Enters the parameters for arbitrary user-specified distributions (range + cum. frequ.)</td>
</tr>
<tr>
<td></td>
<td>EnterLNorm</td>
<td>Enters log normal or normal distribution parameters specified by the user</td>
</tr>
<tr>
<td></td>
<td>Fill</td>
<td>Fills in the 1440 minutes of location, activity, smoker and exposure grids</td>
</tr>
<tr>
<td></td>
<td>FindPersonID</td>
<td>Search input file for a specific PID#</td>
</tr>
<tr>
<td></td>
<td>HistMenu</td>
<td>Displays the menu for user-specified histogram options</td>
</tr>
<tr>
<td></td>
<td>Initialize</td>
<td>Initializes global variables, sets options etc...</td>
</tr>
<tr>
<td></td>
<td>MainMenu</td>
<td>Displays the main menu</td>
</tr>
<tr>
<td></td>
<td>NewPerson</td>
<td>Resets global parameters to prepare for processing of next person</td>
</tr>
<tr>
<td></td>
<td>OptionsMenu</td>
<td>Displays the options menu for filenames and calculation type</td>
</tr>
<tr>
<td></td>
<td>PrintOutOptions</td>
<td>Displays menu for options to print calculation results or calculation progress to screen or line printer</td>
</tr>
<tr>
<td></td>
<td>ProcessPerson</td>
<td>Control subprogram for the processing of each person</td>
</tr>
<tr>
<td></td>
<td>ReadDistParams</td>
<td>Actually reads in the parameters from the file THEMDIST.DAT; called by EnterDist and EnterLNorm subprograms</td>
</tr>
<tr>
<td>Function</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>RegroupLoc</td>
<td>Regroups locations into any new locations specified by the user in THEMLOC.DAT</td>
<td></td>
</tr>
<tr>
<td>RestartCalc</td>
<td>Reinitializes files pointers and global variables to restart calculation</td>
<td></td>
</tr>
<tr>
<td>RetrieveOptions</td>
<td>Retrieves program options from THEM.OPT file</td>
<td></td>
</tr>
<tr>
<td>SaveOptions</td>
<td>Saves program options into THEM.OPT file</td>
<td></td>
</tr>
<tr>
<td>SCEM2</td>
<td>Calculates RSP exposure from ETS based on SCEM model</td>
<td></td>
</tr>
<tr>
<td>SCEMExp</td>
<td>&quot;</td>
<td></td>
</tr>
<tr>
<td>ShowGroupLoc</td>
<td>Displays regrouped locations</td>
<td></td>
</tr>
<tr>
<td>ShowLocations</td>
<td>Displays original locations</td>
<td></td>
</tr>
<tr>
<td>ShowParamsMenu</td>
<td>Displays menu for viewing distribution parameters as specified by the user in THEMDIST.DAT</td>
<td></td>
</tr>
<tr>
<td>StorePerson</td>
<td>Saves 24-hour average microenvironmental, ambient, total, and hourly maximum total exposures for each person</td>
<td></td>
</tr>
<tr>
<td>PrintHist</td>
<td>Prints a histogram to the printer</td>
<td></td>
</tr>
<tr>
<td>PrintHourlySum</td>
<td>Prints the hourly summary of microenvironmental and ambient exposure to the line printer</td>
<td></td>
</tr>
<tr>
<td>PrintProfile</td>
<td>Prints location and activity profiles to the line printer (integer number elements)</td>
<td></td>
</tr>
<tr>
<td>PrintSCEM</td>
<td>Prints a list of all sets of SCEM parameters for one person to the printer</td>
<td></td>
</tr>
<tr>
<td>PrintSummary</td>
<td>Prints a summary of all 24-hour average microenvironmental and ambient exposures to printer</td>
<td></td>
</tr>
<tr>
<td>PrintVector</td>
<td>Prints exposure profile to the printer (real number elements)</td>
<td></td>
</tr>
<tr>
<td>ReadAmbient</td>
<td>Reads hourly ambient data from a file for a specified Julian date</td>
<td></td>
</tr>
<tr>
<td>SaveHourlySum</td>
<td>Saves the hourly of microenvironmental and ambient exposure for each person to file</td>
<td></td>
</tr>
<tr>
<td>SaveProfile</td>
<td>Saves a location or activity profile (integer elements) to a file</td>
<td></td>
</tr>
<tr>
<td>SaveSCEM</td>
<td>Saves all sets of SCEM model parameters for one person to a file</td>
<td></td>
</tr>
<tr>
<td>SaveVector</td>
<td>Saves exposure profile to a file (real number elements)</td>
<td></td>
</tr>
<tr>
<td>UpdateScreen</td>
<td>Updates screen during calculation of exposures</td>
<td></td>
</tr>
</tbody>
</table>
### Write Dist
- **WriteDist** Writes a frequency distribution to the screen

### Write Hourly Sum
- **WriteHourlySum** Writes summary of hourly exposures for one person to the screen

### Write Profile
- **WriteProfile** Writes a location or activity profile (integer elements) to the screen

### Write Vector
- **WriteVector** Writes exposure profile to file (real number elements)

The five other modules contain general procedures that are independent of the three major applications, but can be used by any of them (Tables 7 and 8): (1) General Input and Output (GENIO.BAS), (2) General Statistics (GENSTAT.BAS), (3) Statistics for THEM (THEMSTAT.BAS), (4) Input and Output for THEM (THEMIO.BAS), and (5) Graphics for THEM (THEMGRX.BAS). The Input and Output Modules contain routines for sending data to the screen, file, or printer; receiving user input from the keyboard, and string-handling. The Statistical Modules contain statistical functions (average, standard deviation, etc.), functions for sampling from distributions, and a subprogram for calculating histograms.

### Table 7. Procedures in THEM-Specific Modules

<table>
<thead>
<tr>
<th>THEMIO</th>
<th>SaveHist</th>
<th>Saves a histogram to file</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input and Output procedures specific to THEM</strong></td>
<td>SaveSummary</td>
<td>Saves summary of all 24-hour average microenvironmental and ambient exposures to file</td>
</tr>
<tr>
<td></td>
<td>ViewSummaries</td>
<td>Displays menu for viewing and saving summaries/histograms of population data</td>
</tr>
<tr>
<td></td>
<td>WriteHist</td>
<td>Writes a histogram to the screen</td>
</tr>
<tr>
<td></td>
<td>WriteSummary</td>
<td>Writes the summary of exposures across the population to the screen</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THEMSTAT</th>
<th>CalculateHist</th>
<th>Returns the histogram for a data array</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statistical Routines specific to THEM</strong></td>
<td>DisplayBarChart</td>
<td>Displays a bar chart on the screen; Used by THEM for drawing histograms</td>
</tr>
<tr>
<td></td>
<td>SetUpPresGRX</td>
<td>Sets up the screen and initializes variables for drawing a chart</td>
</tr>
</tbody>
</table>

---

20
Table 8. List of Procedures in "General" Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Procedures</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENIO General Input and Output procedures</td>
<td>ColorOn</td>
<td>Specifies color for screen text</td>
</tr>
<tr>
<td></td>
<td>FillString</td>
<td>Enters a string of specified length with another string derived from numeric data</td>
</tr>
<tr>
<td></td>
<td>GetAKey</td>
<td>Reads a key in from the keyboard; used for input from user during menu routines</td>
</tr>
<tr>
<td></td>
<td>GetFromHexStringN</td>
<td>Gets a number from a string, <em>3_43_3.43</em>, with specified position: 1 2 3</td>
</tr>
<tr>
<td></td>
<td>GetFromHexStringS</td>
<td>Gets a string from a string, <em>hello_there</em>, with specified position: 1 2</td>
</tr>
<tr>
<td></td>
<td>LookAtFile</td>
<td>Displays contents of any text file on the screen with scrolling control</td>
</tr>
<tr>
<td></td>
<td>OpenFile</td>
<td>Opens a file with error checking</td>
</tr>
<tr>
<td></td>
<td>PlaceText</td>
<td>Positions color text on the screen</td>
</tr>
<tr>
<td></td>
<td>PrinterControl</td>
<td>Sends commands to line printer</td>
</tr>
<tr>
<td></td>
<td>RepeatCH</td>
<td>Displays a character repeatedly over a line on the screen</td>
</tr>
<tr>
<td></td>
<td>SetPrintFont</td>
<td>Sets font for the attached printer</td>
</tr>
<tr>
<td></td>
<td>SetPrintStyle</td>
<td>Sets print style for the attached printer</td>
</tr>
<tr>
<td>GENSTAT General Statistical routines</td>
<td>Average</td>
<td>Returns the average of a data array</td>
</tr>
<tr>
<td></td>
<td>Die</td>
<td>Simulates the rolling of a die with a user-defined number of sides</td>
</tr>
<tr>
<td></td>
<td>DistSample</td>
<td>Samples a real number from a distribution</td>
</tr>
<tr>
<td></td>
<td>InvGausCDF</td>
<td>Returns a value for the inverse Gaussian cumulative distribution function</td>
</tr>
<tr>
<td></td>
<td>LNORMSample</td>
<td>Samples a value from a log normal distribution</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>Returns the maximum of a data array</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td>Returns the minimum of a data array</td>
</tr>
<tr>
<td></td>
<td>NormSample</td>
<td>Samples a value from a normal distribution</td>
</tr>
<tr>
<td></td>
<td>StandardDeviation</td>
<td>Returns the standard deviation of a data array</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>Returns the sum of a data array</td>
</tr>
</tbody>
</table>

*THEM is written in Microsoft Professional QuickBASIC v.7.1*

**Bold** procedures are functions that return values depending on the parameters passed to them.

"Write" refers to displaying data on the screen

"Save" refers to saving data to a file on disk

"Print" refers to printing data to the attached line printer

"Vector" refers to arrays with real valued elements (exposures)

"Profile" refers to array with integer valued elements (location/activity codes)
The Flow of THEMMAIN

The Main Module contains the THEM control loop. This loop branches to procedures for: (1) Calculating Exposure, (2) Viewing Input Data, and (3) Changing Options. All subprograms that only display menus contain the word "Menu" at the end of their names (Table 6). The following subprograms work together to calculate exposure based on the location and smoking profiles: NewPerson, ProcessPerson, CalculatePerson, StorePerson. The CalculatePerson subprogram calls the $M$-subprograms MicroExp or SCEMExp that, in turn, calculate specific exposures based on constant exposures obtained from real microenvironmental measurements or from the Sequential Cigarette Exposure Model (SCEM), respectively.

Variables and Types

All global types, variables, and constants are declared in THEMDECS.BI (Tables 9, 10 and 11). All other variables are locally declared. The largest arrays used in THEM are the 1440-minute long location, activity, smoker, and exposure profiles, but these are declared locally in the ProcessPerson subprogram.

Table 9. Global types declared in THEMDECS.BI for THEMMAIN.BAS

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE SMPARAMS</td>
<td>Parameters for mass balance smoking models (e.g. SCEM): air exchange rate, volume, smoking rate, source strength, smoking location, average concentration and number of rooms. The model uses the other parameters to find a value for AVECONC.</td>
</tr>
<tr>
<td>ACH AS SINGLE</td>
<td></td>
</tr>
<tr>
<td>VOLUME AS SINGLE</td>
<td></td>
</tr>
<tr>
<td>SMRATE AS SINGLE</td>
<td></td>
</tr>
<tr>
<td>SOURCE AS SINGLE</td>
<td></td>
</tr>
<tr>
<td>SMLOC AS SINGLE</td>
<td></td>
</tr>
<tr>
<td>AVECONC AS SINGLE</td>
<td></td>
</tr>
<tr>
<td>NUMROOMS AS SINGLE</td>
<td></td>
</tr>
<tr>
<td>END TYPE</td>
<td></td>
</tr>
</tbody>
</table>
**TYPE LOCCODES**

<table>
<thead>
<tr>
<th>CODE AS INTEGER</th>
<th>NAME AS STRING * 15</th>
<th>REGROUP(1 TO 100) AS INTEGER</th>
</tr>
</thead>
<tbody>
<tr>
<td>NGROUP AS INTEGER</td>
<td>ETSDIST(2, 25) AS SINGLE</td>
<td>EXCLUDE AS STRING * 1</td>
</tr>
<tr>
<td>SAMPLE AS SINGLE</td>
<td>METHOD AS STRING * 4</td>
<td>TALLY AS INTEGER</td>
</tr>
</tbody>
</table>

End Type

New code, name, standard codes used, number of codes to regroup, distribution of microenvironmental concentrations, exclude flag, sampled value of concentration data, calculation method, exposure time tally for each location.

Typically, THEM's method of calculation involves either sampling a value from a distribution OR it calculates a concentration using a model as specified by the 4-character METHOD variable.

**TYPE DEMOG**

| AGE AS INTEGER | SEX AS INTEGER | PID AS LONG | EXPOS AS INTEGER |

End Type

Demographic data for each person: age, sex, personal identification number, and exposed flag (0 = unexposed; 1 = exposed)

---

**Table 10. Global variables declared in THEMDECS.BI for THEMMAIN.BAS**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.y, tbeg, tend, etim, ctim, where, DSMOKE, act, dirm, dird, diry, dirwkday</td>
<td>Single</td>
<td>All parameters for each diary line: adult or youth code, beginning time, ending time, cumulative time, location code, smoking code, activity code, month, day, year, day of week</td>
</tr>
<tr>
<td>ACTFILE$</td>
<td>String</td>
<td>Activity profile output file</td>
</tr>
<tr>
<td>ALLSTOP%</td>
<td>Integer</td>
<td>Flag for exiting &quot;all&quot; calculation loop when interrupted by user</td>
</tr>
<tr>
<td>AMBFILE$</td>
<td>String</td>
<td>Ambient input file</td>
</tr>
<tr>
<td>AMBOPT$</td>
<td>String</td>
<td>Option to read in ambient or not</td>
</tr>
<tr>
<td>AVEAMB</td>
<td>Single</td>
<td>Current 24-hour average ambient exposure</td>
</tr>
<tr>
<td>AVEEXP</td>
<td>Single</td>
<td>Current 24-hour average microenvironmental exposure</td>
</tr>
<tr>
<td>CALCMODE$</td>
<td>String</td>
<td>Current Calculation Method (e.g., SCEM or MICR)</td>
</tr>
<tr>
<td>Variable</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------</td>
<td>-------------------------------------------------------------------</td>
</tr>
<tr>
<td>CALCOPT$</td>
<td>String</td>
<td>Option for &quot;all&quot;, &quot;N&quot;, or &quot;detailed&quot; calculation</td>
</tr>
<tr>
<td>CURRENTACT%</td>
<td>Integer</td>
<td>Current activity</td>
</tr>
<tr>
<td>CURRENTLOC%</td>
<td>Integer</td>
<td>Current location</td>
</tr>
<tr>
<td>CURRENTSMOK%</td>
<td>Integer</td>
<td>Current smoking presence (0 = no smoker present)</td>
</tr>
<tr>
<td>DATE</td>
<td>Single</td>
<td>Current date in Julian format</td>
</tr>
<tr>
<td>EXCHANGE()</td>
<td>Array</td>
<td>Distribution parameters for air exchanges</td>
</tr>
<tr>
<td>EXPFILE$</td>
<td>String</td>
<td>Exposure profile output file</td>
</tr>
<tr>
<td>FOOTAGE()</td>
<td>Array</td>
<td>Distribution parameters for house footages</td>
</tr>
<tr>
<td>GROUPOPT$</td>
<td>String</td>
<td>Option to regroup or not regroup locations into LOCAT() codes</td>
</tr>
<tr>
<td>HOURFILE$</td>
<td>String</td>
<td>Hourly exposure summary output file</td>
</tr>
<tr>
<td>INFILE$</td>
<td>String</td>
<td>Activity pattern input file</td>
</tr>
<tr>
<td>LASTPID&amp;</td>
<td>Long</td>
<td>Last Personal Identification Number (set to PID&amp; after first diary line is read)</td>
</tr>
<tr>
<td>LOCAT() AS LOCCODES</td>
<td>Array</td>
<td>Array for location information (see type declaration above)</td>
</tr>
<tr>
<td>MAXEXP</td>
<td>Single</td>
<td>Current maximum minutely microenvironmental exposure</td>
</tr>
<tr>
<td>NSMRATE()</td>
<td>Array</td>
<td>Distribution parameters for smoking rate</td>
</tr>
<tr>
<td>NSOURCE()</td>
<td>Array</td>
<td>Distribution parameters for source strength</td>
</tr>
<tr>
<td>NUMBER%</td>
<td>Integer</td>
<td>Number of people chosen to process</td>
</tr>
<tr>
<td>NUMGROUPS%</td>
<td>Integer</td>
<td>Number of regrouped location categories; see LOCAT() dimension</td>
</tr>
<tr>
<td>NUMROOMS()</td>
<td>Array</td>
<td>Distribution parameters for number of rooms</td>
</tr>
<tr>
<td>NVEHEXCHC()</td>
<td>Array</td>
<td>Distribution parameters for vehicle exchange rate with windows closed</td>
</tr>
<tr>
<td>NVEHEXCHO()</td>
<td>Array</td>
<td>Distribution parameters for vehicle exchange rate with windows open</td>
</tr>
<tr>
<td>NVEHVOL()</td>
<td>Array</td>
<td>Distribution parameters for vehicle volumes</td>
</tr>
<tr>
<td><strong>OMITOUT</strong></td>
<td>Single</td>
<td>Threshold for omission of outliers</td>
</tr>
<tr>
<td><strong>PATH$</strong></td>
<td>String</td>
<td>Path for BASIC modules (used during compilation)</td>
</tr>
<tr>
<td><strong>PEOPLE%</strong></td>
<td>Integer</td>
<td>Number of people processed</td>
</tr>
<tr>
<td><strong>PERSONDATA AS DEMOG</strong></td>
<td></td>
<td>Current demographic information</td>
</tr>
<tr>
<td><strong>PID&amp;</strong></td>
<td>Long</td>
<td>Personal Identification Number (PID #)</td>
</tr>
<tr>
<td><strong>POPFILE$</strong></td>
<td>String</td>
<td>Population exposure output file</td>
</tr>
<tr>
<td><strong>RECPERSON&amp;</strong></td>
<td>Long</td>
<td>Current number of records read in from INFILE$</td>
</tr>
<tr>
<td><strong>RECTOTAL&amp;</strong></td>
<td>Long</td>
<td>Total number of records read in from INFILE$</td>
</tr>
<tr>
<td><strong>RT1$</strong></td>
<td>Single</td>
<td>Run Time option 1</td>
</tr>
<tr>
<td><strong>RT10$</strong></td>
<td>String</td>
<td>Run Time option 10</td>
</tr>
<tr>
<td><strong>RT2$</strong></td>
<td>String</td>
<td>Run Time option 2</td>
</tr>
<tr>
<td><strong>RT3$</strong></td>
<td>String</td>
<td>Run Time option 3</td>
</tr>
<tr>
<td><strong>RT4$</strong></td>
<td>String</td>
<td>Run Time option 4</td>
</tr>
<tr>
<td><strong>RT5$</strong></td>
<td>String</td>
<td>Run Time option 5</td>
</tr>
<tr>
<td><strong>RT6$</strong></td>
<td>Single</td>
<td>Run Time option 6</td>
</tr>
<tr>
<td><strong>RT7$</strong></td>
<td>String</td>
<td>Run Time option 7</td>
</tr>
<tr>
<td><strong>RT8$</strong></td>
<td>String</td>
<td>Run Time option 8</td>
</tr>
<tr>
<td><strong>RT9$</strong></td>
<td>String</td>
<td>Run Time option 9</td>
</tr>
<tr>
<td><strong>SCEMFILE$</strong></td>
<td>String</td>
<td>SCEM parameter output file</td>
</tr>
<tr>
<td><strong>TALLYFILE$</strong></td>
<td>String</td>
<td>Exposure time tally output file</td>
</tr>
<tr>
<td><strong>TIMES%</strong></td>
<td>Integer</td>
<td>Times UPDATESCREEN subprogram has been called during a calculation</td>
</tr>
<tr>
<td><strong>TOTMAX</strong></td>
<td>Single</td>
<td>Current 24-hour average total maximum hourly exposure</td>
</tr>
</tbody>
</table>

Single = Single Precision Real  
Long = Long Integer  
Blank types are custom-typed variables  
"Current" means for current person
Table 11. Global constants declared in THEMDECS.BI for THEM BASIC.BAS

<table>
<thead>
<tr>
<th>Constant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back = 9</td>
<td>blue for background</td>
</tr>
<tr>
<td>Inst = 15</td>
<td>white for instructions</td>
</tr>
<tr>
<td>Lin = 13</td>
<td>magenta for separating lines</td>
</tr>
<tr>
<td>Quit = 14</td>
<td>yellow for quit instruction</td>
</tr>
<tr>
<td>SubT = 9</td>
<td>blue for subtitles</td>
</tr>
<tr>
<td>Text = 11</td>
<td>cyan for text</td>
</tr>
<tr>
<td>Title = 10</td>
<td>light green for titles</td>
</tr>
</tbody>
</table>

Adding a New \( \mathcal{M} \)-Subprogram

Adding a new \( \mathcal{M} \)-subprogram to THEM for calculating micronenvironmental exposures requires creating a new BASIC subprogram, changing a logic structure, changing data structures, adding code to read in new model parameters, and adding parameter frequency distributions to THEMDIST.DAT (Table 12). The new subprogram can be anything from a simple constant value model to a complex mass balance algorithm.

Table 12. Checklist for Adding a New Microenvironmental Exposure Model to THEM

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Write a QuickBASIC subprogram that inputs the 1440-minute long LOCATION%( ), ACTIVITY%( ), and SMOKERS%( ) arrays and assigns exposures for every minute.</td>
</tr>
<tr>
<td>2.</td>
<td>Change logic statement in THEMMAIN (RSPFill subprogram) to branch to a new subprogram when the calculation option matches</td>
</tr>
<tr>
<td>3.</td>
<td>Declare new subprogram and global parameter distribution arrays (useCOMMON SHARED statement) in THEMDECS.BI include file for THEMMAIN.BAS.</td>
</tr>
<tr>
<td>4.</td>
<td>Modify ReadDistParams QuickBASIC subprogram to read in appropriate model parameter distributions from the THEMDIST.DAT text file into parameter distribution arrays</td>
</tr>
<tr>
<td>5.</td>
<td>Dimension parameter distribution arrays in THEMMAIN.BAS program module</td>
</tr>
<tr>
<td>6.</td>
<td>Enter model parameter frequency distributions into THEMDIST.DAT</td>
</tr>
</tbody>
</table>
REFERENCES


Appendix A: Location Data (THEMLOC.DAT)

This is the file: THEMLOC.DAT. It contains the possible locations in which people are present for the THEM model as tabulated in the California Activity Pattern (CAP) database.

The number of the location is on the left, followed by the location name. Next are the location codes in CAP that are being regrouped into these new locations. Calculation method is listed last.

For Example:

<table>
<thead>
<tr>
<th># old codes</th>
<th>new code</th>
<th>location name</th>
<th>Calculation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>_<em>1_Home_9_1_2_3_4_34_24_56_67_78_SCEM</em></td>
<td>_<em>1_AT HOME_13_1_2_3_4_5_6_7_8_9_12_13_32_99_SCEM</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>_<em>2_OFFICE-FACTORY_3_21_22_38_SCEM</em></td>
<td>_<em>2_OFFICE-FACTORY_3_21_22_38_SCEM</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>_<em>4_BAR, RESTAURANT_2_28_29_SCEM</em></td>
<td>_<em>4_BAR, RESTAURANT_2_28_29_SCEM</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>_<em>5_OUTDOORS_7_10_11_34_40_53_54_59_SCEM</em></td>
<td>_<em>5_OUTDOORS_7_10_11_34_40_53_54_59_SCEM</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>_<em>6_VEHICLE_8_51_52_55_56_57_58_60_61_SCEM</em></td>
<td>_<em>6_VEHICLE_8_51_52_55_56_57_58_60_61_SCEM</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix B: Distribution Data (THEMDIST.DAT)

| REAL--------------Footage, square feet |
|-------------------------|-----------------|
| 200, 0.0000001         | 400, 0.014      |
| 599, 0.040             | 999, 0.14       |
| 1499, 0.488            | 1999, 0.782     |
| 2699, 0.937            | 3499, 0.980     |
| 5000, 1.000            | 99, 99          |

| REAL--------------Air Exchange, air changes per hour (ach) |
|-------------------------|-----------------|
| 0.31, 0.05              | 0.76, 0.25      |
| 2.12, 0.40              | 4.15, 0.75      |
| 10.59, 0.95             | 15.00, 1.000    |
| 99, 99                  |                 |

| REAL--------------Rooms in a House |
|-------------------------|-----------------|
| 1, 0.002                | 2, 0.007        |
| 3, 0.033               | 4, 0.132       |
| 5, 0.396               | 6, 0.680       |
| 7, 0.840               | 8, 0.933       |
| 9, 0.969               | 10, 0.986      |
| 15, 1.000              | 99, 99         |

| NORMAL-----------Vehicle Volumes, cubic feet |
|-------------------------|-----------------|
| 150, 20                 |                 |

| NORMAL-----------Vehicle Air Exchange Rate (Windows Open), ach |
|-------------------------|-----------------|
| 75, 20                  |                 |

| NORMAL-----------Vehicle Air Exchange Rate (Windows Closed), ach |
|-------------------------|-----------------|
| 5, 1.1                  |                 |

| NORMAL-----------Source Strength, ug/cigarette |
|-------------------------|-----------------|
| 12100, 1000             |                 |

| NORMAL-----------Smoking Rate, cigarettes/hour |
|-------------------------|-----------------|
| 2.0, 0.3                |                 |

<p>| REAL-------------Home Microenvironmental Concentrations, ug/m3 |
|-------------------------|-----------------|
| 60, 0.5                 | 107, 1.000     |
| 99, 99                  |                 |</p>
<table>
<thead>
<tr>
<th>Microenvironmental Concentrations, ug/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>REAL--Bar-Restaurant</td>
</tr>
<tr>
<td>REAL--Office-Factory</td>
</tr>
<tr>
<td>REAL--Other Indoor</td>
</tr>
<tr>
<td>REAL--Outdoor (not incl. ambient)</td>
</tr>
<tr>
<td>REAL--Vehicle</td>
</tr>
</tbody>
</table>
Appendix C: THEMDECS.BI Source Code Listing

**********************************************************************
** THEMDECS.BI
**
** BASIC INCLUDE file containing all
** sub program declarations and global
** type and variable declarations for
** main THEM program.
**
** Main Module: THEMMAIN.BAS
**********************************************************************
DECLARE SUB GraphProfile (LOCATION%, SMOKERS%, RSP!())
DECLARE SUB AmbientArray (AMBIENT!, date2!, date1!, AMBDATA() AS STRING * 78)
DECLARE SUB ReadAmbient ()
DECLARE SUB AmbientFile (AMBIENT!, date2!, date1!, AMBFILE$)
DECLARE SUB InitializeHead ()
DECLARE SUB GoToPerson (N%)
DECLARE SUB SetUpScreen ()
DECLARE SUB SaveWriteActivity (LOCATION%, ACTIVITY%, SMOKERS%, RSP(), AMBIENT!) 
DECLARE SUB SaveWriteExposure (LOCATION%, ACTIVITY%, SMOKERS%, RSP(), AMBIENT!)
DECLARE SUB PrintEpisode (HEAD$)
DECLARE SUB RSPFill (LOCATION%, ACTIVITY%, SMOKERS%, RSP!)()
DECLARE FUNCTION SCEMExp (LOCATION%)
DECLARE SUB ReadNextPerson (LOCATION%, ACTIVITY%, SMOKERS%, RSP(), AMBIENT())
DECLARE SUB ExcludeMenu ()
DECLARE SUB AssignMenu ()
DECLARE SUB AddSummary ()
DECLARE SUB Initialize ()
DECLARE SUB ReadDistParams ()
DECLARE SUB CalculatePerson (LOCATION%, ACTIVITY%, SMOKERS%, RSP(), AMBIENT())
DECLARE SUB ProcessPerson ()
DECLARE SUB StorePerson (AMBIENT!, RSP!())
DECLARE SUB Calender (date1!, M!, d!, y!)
DECLARE SUB ClearProfile (N%, PROFILE%())
DECLARE SUB ClearVector (N%, VECTOR!())
DECLARE FUNCTION MicroExp (LOCATION%, ACTIVITY%, SMOKERS%)
DECLARE SUB Diary (WH%, LOCATION%, SMOKERS%, ACTIVITY%)()
DECLARE SUB EnterDist (VECTOR!())
DECLARE SUB EnterLNorm (VECTOR!())
DECLARE SUB Fill (PROFILE%(), N%)
DECLARE SUB FindPersonID (PID&, FILENAME$)
DECLARE SUB GroupMenu ()
DECLARE SUB RegroupLoc (WH%)
DECLARE SUB RetrieveOptions ()
DECLARE SUB SaveOptions ()
DECLARE SUB MainMenu (CHOICE$)
DECLARE SUB DoTitle ()
DECLARE SUB OptionsMenu ()
DECLARE SUB PrintOutOptions ()
DECLARE SUB ShowLocations ()
DECLARE SUB GetLoc ()
DECLARE SUB RestartCalc ()
DECLARE SUB ShowConstExp ()
DECLARE SUB ShowGroupLoc ()
DECLARE SUB UpdateScreen (STATUS$)
DECLARE SUB WriteDist (VECTOR!())
DECLARE SUB WriteHourlySum (HEAD$, N%, RSP!(), AMBIENT!)()
DECLARE SUB WriteProfile (HEAD$, VECTOR%())
DECLARE SUB WriteVector (HEAD$, VECTOR%())
DECLARE SUB SaveProfile (FILENAME$, HEADING$, VECTOR%(), N%)
DECLARE SUB WriteVector (HEAD$, VECTOR%(), N%)

**********************************************************************
** TYPES
**********************************************************************
'Type for SCEM parameters

TYPE SMPARAMS
ACH AS SINGLE  'air exchange rate ach
VOLUME AS SINGLE  'volume m3
SMRATE AS SINGLE  'smoking rate #/min
SOURCE AS SINGLE  'source strength ug/min
SMLOC AS SINGLE  'location code
AVECONC AS SINGLE  'average concentration ug/m3
NUMROOMS AS SINGLE  'number of rooms in house
END TYPE

'Type for location codes

TYPE LOCCODES
    CODE AS INTEGER              'new code number
    NAME AS STRING * 15          'name of new code
    REGROUP(1 TO 100) AS INTEGER 'regrouped codes
    NGROUP AS INTEGER            'number of regrouped codes
    ETSDIST(2, 25) AS SINGLE     'ETS exposure distribution for location
    EXCLUDE AS STRING * 1       'X = zero contrib. from this loc; O = include
    SAMPLE AS SINGLE             'exposure sampled from distribution
    METHOD AS STRING * 4         'SCEM OR MICR
    TALLY AS INTEGER             'number of minutes exposed in each location
END TYPE

'Type for demographic information

TYPE DEMOG
    AGE AS INTEGER
    SEX AS INTEGER
    PID AS LONG
    EXPOS AS INTEGER
END TYPE

'omit outliers over
COMMON SHARED OMITOUT

' General Statistical Routines are in the GENSTAT.BAS module
' included in THEMMAIN.BAS. Histograms are created using the
' CALCHIST.BAS program which includes the THEMSTAT.BAS module.

'*DATA FOR CREATING EXPOSURE HISTOGRAMS**
'............................................................................
COMMON SHARED /ExposureData/ MAXEXP, AVEEXP, AVEAMB, TOTMAX
'............................................................................
' Array for Fairley ambient data
'............................................................................
COMMON SHARED AMBDATA() AS STRING * 78
'............................................................................
' file names including paths
COMMON SHARED /pop/ POPFILE$ 'file for population exposure data
COMMON SHARED /fil1/ INFIL$, AMBFILE$, HOURFILE$, SCENFILE$
COMMON SHARED /fil2/ ACTFILE$, LOCFILE$, SMOKFILE$, EXPFILE$
COMMON SHARED /fil3/ TALLYFILE$  'file for tally of "exp. time" in each loc.
' path for options, input & include files; used during program compilation
COMMON SHARED /pat/ PATH$
'*............................................................................
COMMON SHARED TIMES%  'Times there has been a call to UpdateScreen
COMMON SHARED /SCEM/ SCEM AS SMPARAMS           'Parameters for SCEM Model
COMMON SHARED /LOCATIONS/ LOCAT() AS LOCCODES   'Parameters for Location Codes
COMMON SHARED /DEMOGRAPH/ PERSONDATA AS DEMOG   'Demographic data
COMMON SHARED /NUMS/ NUMGROUPS%                 'Number of reduced locations
COMMON SHARED CURRENTLOC%, CURRENTACT%, CURRENTSMOK% 'Current location, activity, smoker?
COMMON SHARED /ALOOP/ ALLSTOP%              'Control Variable for "All"-type calculation
' personal diary information
COMMON SHARED /a/ PID&, LASTPID&, PEOPLE%, NUMBER%, RECPERSON&, RECTOTAL&
COMMON SHARED /b/ DATE, CALCLOPT$, CALCMODE$, AMBOPT$, GROUPOPT$
COMMON SHARED /c/ RT16, RT25, RT35, RT45, RT55, RT65, RT75, RT85, RT95, RT105
COMMON SHARED /d/ ID, a.y, tbeg, tend, etim, ctim, where, DSMOKE
COMMON SHARED /e/ act, dirm, dird, diry, dirwday
' distribution arrays
COMMON SHARED /dist/ FOOTAGE(), EXCHANGE(), NUMROOMS()
' normal mean and stdev arrays
COMMON SHARED /dist2/ NVEHEXCHO(), NVEHEXCHC(), NVEHVOL(), NSMRATE(), NSOURCE()

"personal data" fields:
COMMON SHARED /f/ RN01&, RSEL&, YSEL&, TPAC&, PRFX&, CLST&, STUM&, ACDT&, HHAT&, HHA&, HOU$, PARK&, PRK2&, WKJB&, WKHR&, VRH&, NJOB&, WP1&, WP2&, WP3&, WP4&, WP5&, WP6&
COMMON SHARED /g/ SMOK&, SMKY&, SMK2&, SMY2&, CLC4&, CLC6&, PGAR&, PGYS&, PGS&, GSTV&, NSTV&, MS1&, MST&, MS2&, GPFR&, GSTM4, PLOT&, HTYS$, HTFL4, HEAT$, OPE4, OPN1$, OPN2$, PAN1$, PAN2$, AIRC4, ACTP4, GLUE4, PNT1$, PNT2$, SOLV$, PEST$
COMMON SHARED /h/ PST2$, SOAP$, OCLN$, AERO$, SHR$, BATH$, MOTH$, DEOD$, RMR$, AGE$, EDUC$, GDGR$, MRTL$, ZIP4$, CNTY4$, AREA4$, HHT4$, BG15$, BG16$, BG17$, RSE4$, INCM4$, INCA4$, INC4$, INCD4$, INCE4$, INC4$, ISUM4$, HHTT$, YTB$
COMMON SHARED /i/ YWHR$, YVHR$, YNJB$, YWP1$, YWP2$, YWP3$, YWP4$, YWP5$, YWP6$, YSTU$, YSMK$, YSMY$, YSM2$, YSY2$, YCC6$, YCC8$, YPG4$, YPGS$, YSTV4$, YSTV5$, YNST$, YMS1$, YMSM$, YMS2$, YGSP$, YGTM$, YPLT$, YGLU$, YPT1$, YPT2$, YSLV$, YPS$, YPS$
COMMON SHARED /j/ YSP4$, YCLN$, YARO$, YSHR$, YBH$, YAGE$, YEDU$, YSEX$, YCDT$, AOUT$, YOUT$, TTIM$, INUM$, TCNT4$, RCNT4$, RANS$, ANYO$, CSUM$, ANUM$, ZST$, ADIFF$, YDIFF$, NPHONE$, YINT$, di$, dir$, dir$, dirty$
COMMON SHARED /k/ ADWKDAY$, CMPMM$, CMPDD$, CMPYY$, ACKWDAY$, OCC$, YDIRMM$, YDIRD$, YDIRY$, YDFKDAY$, YCMPPM$, YCMPPD$, YCMPPY$, YCMPPDAY$, YCC$, SMOK$3$, SMOKE$, SAMPW$, TIMEW$, YSAMPW$, YTIm$

Histogram bar widths
COMMON SHARED /bwa/ BarWidthAve 'Bar width for Average Indoor
COMMON SHARED /bwa2/ BarWidthAmb 'Bar width for ambient exp.
COMMON SHARED /bwm/ BarWidthMax 'Bar width for Maximum exp.
COMMON SHARED /hop/ HOPT% 'Specify Barwidth or Start, Stop, # Bars

'Screen foreground and background colors
CONST Back = 9 'blue
CONST Title = 10 'light green
CONST Text = 11 'cyan
CONST Lin = 13 'magenta
CONST Inst = 15 'white
CONST Quit = 14 'yellow
CONST SubT = 9 'blue

******************************************************************************************
Appendix D: THEMMAIN.BAS Source Code Listing

'****************************************************
'*                 THEMMAIN.BAS                     *
'*                 "Main Module"                    *
'*                    For                         *
'*                  Total Human Exposure Model    *
'*              (THEM)                           *
'*                ***                             *
'*              -using California Activity Pattern *
'*                (CAP) data from the Air          *
'*                Resources Board (ARB)          *
'*                ***                             *
'*                -and data from real RSP exposure *
'*                measurements                    *
'*                                                  *
'****************************************************

Written in Microsoft (R) QuickBASIC Extended v7.1

Development Funded by the Tobacco Related Disease Research Program (TDRP) of the State of California, grant no. ?????

Other Modules: THEMIO.BAS, THEMSTAT.BAS, THEMGRX.BAS

Include Files: THEMIO.BI, THEMSTAT.BI, THEMGRX.BI, THEMDECS.BI

Data Files: THEM.OPT, THEMDIST.DAT, THEMLOC.DAT

THEMDECS.BI ====== All procedure/type declarations and common shared variables/constants for main program

THEMSTAT.BAS ===== Statistical Routines

THEMIO.BAS ======= Input/Output Routines

THEMGRX.BAS ====== Invocation of QuickBASIC Presentation Graphics Toolbox

*********.BI  ==== QuickBASIC INCLUDE files for each module's declarations

Last Modified: 10/19/93 nk

Programming History & Personnel:

Program written by Wayne Ott, Stanford University, beginning July 1991
Program was extended by Elena Tracy and Wayne Ott, beginning February 1993
Program rewritten by Neil Klepeis, beginning August 1993
Program modularized, menu driven 9/16/93 nk
Program modularized into: THEMMAIN, THEMIO, THEMSTAT, THEMGRX nk
All subsequent modifications: nk

Description of Program:

The current form of the program is as follows: ***

1. Program reads the California Activity Pattern (CAP) data file
2. Program generates "uniform diaries" 1440 min. long from actual diaries
3. Program creates location & smoker-present vectors for each person automatically regrouping locations into six subgroups
4. Program assigns CONSTANT EXPOSURES for each min. for each person
5. OR uses the SCEM Model to assign ETS exposures.(see SCEM2 sub for details)
6. Program calculates 1440 minutes of exposure per person
7. Program has user-definable run-time options and default settings.
   These are accessible via the user-accessible menu system
8. a.Options, b.Distribution Parameters, c.Regrouped Location Codes and Constant Microenvironmental RSP exposures for ETS are user-definable through external text files: THEM.OPT, THEMDIST.DAT, THEMLOC.DAT, respectively. 10/94 nk
9. Saves and produces exposure histograms for different demographic groups:
   age, sex, education, employment status, marital status, housing type.
10. Separates exposed people from unexposed people. 1/94 nk
11. Program separated in THEM and THEMHIST programs. THEM only determines 24-hour exposures and hourly maximums for each person and saves them to a list. THEM acts like a needle with data flowing through it like a thread; the summary arrays are NOT stored in the computer but on file. THEMHIST take the summary file and calculates histograms from it: exposed vs. unexposed and all demographics. 2/94 nk

*******************************************************************************
INCLUDE Files containing all sub program/function declarations.
INCLUDE types and shared variables

SINCLUDE: 'd:\\thém\basic\THEMDECS.BI'
SINCLUDE: 'd:\\thém\basic\GENIO.BI'
SINCLUDE: 'd:\\THEM\BASIC\GENSTAT.BI'

End of Include File Section

***************************************************************************
*****************     Dimension Arrays and Variables    *******************
***************************************************************************

'COMMON SHARED HIST AS HISTOGRAM' 'Parameters for Histograms
'COMMON SHARED PERSONDATA AS DEMOG' 'variable for all demographic data
'Note: other "COMMON SHARED" statements are in THEMDECS.BAS
'The "COMMON SHARED HIST AS HISTOGRAM" statement is in
'all modules that call the CalculateHist routine. This
'declaration is in the THEMSTAT.BAS module.
'The following variables contain data compiled for each person,
saved in a file and used to create statistics on the whole pool
'of people analyzed.

'MAXEXP: MAXIMUM MINUTELY EXPOSURE FOR EACH PERSON OVER 1 DAY
'AVEEXP: AVERAGE 24-HOUR MICR. EXPOSURE FOR EACH PERSON OVER 1 DAY
'TOTMAX: TOTAL HOURLY MAXIMUM EXPOSURE FOR EACH PERSON OVER 1 DAY
'AVEAMB: AVERAGE AMBIENT EXPOSURE FOR EACH PERSON OVER 1 DAY
'Demographics variables are defined in THEMDECS.BI
'PERSONDATA = CODES FOR DEMOGRAPHIC GROUP: age,sex,ed.,emp.,mar,hous.

********************************************************************************
'note: THEM calculations will produce exposure statistics for everyone. This
data can then be subdivided into demographic groups and/or the exposed group.
'Demographic data for each person is in array PERSONDATA and exposed vs.
'non-exposed data is simply obtained from the exposures themselves:
'0.0 ug/m3 = unexposed.
********************************************************************************

'Arrays for distribution data to be randomly sampled for use as parameters
' in sub models
',
DIM FOOTAGE(2, 25)  'dist. of sq. footages for a house -hunds. of sq. ft.-
DIM EXCHANGE(2, 25) 'dist. of air exchange rates-ach- for a house
'DIM VEHEXCH(2, 25) 'dist. of vehicle air exchange rate-ach
'DIM NUMBER(2, 25)  'dist. of smoking rates-cig. per hour
'DIM VEHVOL(2, 25)  'dist. of vehicle volumes--square feet
DIM NUMROOMS(2, 25) 'dist. of number of rooms in a house
'DIM SOURCE(2, 25)  'dist. of source strengths (ug/cigarette)
'normal mean and stdev arrays
DIM NVHEXCHNO(2), NVHEXCHC(2), NVHVOL(2) 'vehicle ach win cl;win op, vehicle volume
DIM NSIRATE(2), NSOURCE(2) 'smoking rate, source strength
',
'array to hold location codes and RSP levels corresp. to locations (ug/m3)
'LOCAT is "redim'ed" in GetLoc subprogram
'NUMGROUPS% = 6: CURRENTLOC% = 1: LAST% = 2
'REDIM LOCAT(1 TO NUMGROUPS%) AS LOCCODES
',
'omit outliers in averages and st. dev.
OMITOUT = 1E+10

DIM AMBDATA(731) AS STRING * 78  'array for fairly ambient data (unused)
',
'PRINT FRE(AMBDATA(1))
'SLEEP

********************************************************************************
End Of Array Dimensioning********************************************************************************

******************************************************************************
$$$$$$$$$$$$$$   Pre-Title-Screen Initializing Routines $$$$$$$$$$$$$$$
#########################################################################

CLS
ON KEY(15) GOSUB ExitAll:
ALLSTOP% = 0
WHILE ALLSTOP% = 0
    CALL ProcessPerson
contA:
    WEND
    KEY(15) OFF
    AddSummary
    CALL UpdateScreen("Press Any Key to Return to Main Menu...")
SLEEP
END IF
CASE "v", "V": LookAtFile POPFILE$
CASE "e", "E":
    CLS
    PRINT "This will erase the exposure data file: " + POPFILE$
    PRINT "The exposure file is normally appended between all THEM calculations."
    ANS$ = GetAKey("Press <RET> to ERASE or <ESC> to CANCEL...")
    IF ANS$ = CHR$(13) THEN KILL POPFILE$
    CASE "r", "R":   'Restarts Calculation by Initializing files pointers
        RestartCalc
    CASE "g", "G": Initialize
        INPUT "Enter the Person Number:"; N%
        GoToPerson N%
    CASE "f", "F": Initialize
        INPUT "Enter the PID: "; PID$
        FindPersonID PID$, INFILE$
    CASE "c", "C": PrintOutOptions
    CASE "s", "S": ShowParamaMenu
    CASE "l", "L":
        PRINT "This will restart calc. at beginning of file."
        PRINT "Press ESC to CANCEL, RET to continue..."
        ANS$ = GetAKey("")
        IF ANS$ = CHR$(13) THEN
            CLOSE #1
            LookAtFile INFILE$
            OpenFile INFILE$, 1, 1
        END IF
    CASE "": CLS
        INPUT "Name of file: ", FIL$
        LookAtFile FIL$
        CASE "q", "Q": CONT% = 1
    CASE ELSE
        END SELECT
    CLS
    WEND
    'close activity input file
    'others opened & closed in sub prog.
    SaveOptions 'Save Options to file, THEM.OPT
    'SCREEN 0: COLOR 7, 0: CLS 'Restore Screen to Text (0), white foreground
END
'(((((((((((((((((||||||||||||||||||||||||||||||)))))))))))))))))))))))))))))))))))))))))
'************************************************ END OF MAIN LOOP: QUIT PROGRAM ********************
'@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
 SetDefaults:
CLS : BEEP
PRINT "Errors in reading options file or null INPUT file name";
PRINT "both require the setting of internal default parameters.";
PRINT "Press any key to assign internal defaults.";
PRINT
'activity pattern data file
INFILE$ = "d:\californ\BAY.DAT"
'ambient level data file
AMBFILE$ = "c:\californ\PART.DAT"
'output file for activity codes; if 'none' then no codes written
ACTFILE$ = ""
'output file for exposure vectors; if 'none' then no vectors written
EXPFILE$ = ""
'output file for hourly summaries of each person
HOURFILE$ = ""
'output file for SCEM parameters
SCEMFILE$ = ""
'regrouping of locations
GROUPOPT$ = "Yes"
'
'** CALCULATION OPTIONS **
CALCOPT$ = "CONST" 'use SCEM routine or CONST RSP values
AMBOPT$ = "No" 'reading in of ambient data
'
'** Run time screen options
RT1$ = "No" 'print out personal data to screen
RT2$ = "No" 'print out location/activity/smoking profiles to screen
RT3$ = "No" 'print out exposure vectors to screen
RT4$ = "No" 'pause between person calculations
RT5$ = "No" 'print out hourly summary for each person
'
'** printer options
RT6$ = "No" 'print loc/act/smok profiles to printer
RT7$ = "No" 'print indoor/ambient exposures to printer
RT8$ = "No" 'print hourly summary of each person to printer
RT9$ = "No" 'pause between SCEM/CONST parameter changes
RT10$ = "No" 'print SCEM parameters out to line printer
'
RETURN
'
ProcessErrors:
BEEP
LOCATE 24, 1
COLOR 14 'yellow error message
SELECT CASE ERR
CASE 6: PRINT "OVERFLOW ERROR.";
CASE 7: PRINT "OUT OF MEMORY ERROR.";
CASE 52: PRINT "FILENAME ERROR.";
CASE 53: PRINT "FILE NOT FOUND.";
CASE 54, 55: PRINT "FILE ACCESS ERROR.";
CASE 57: PRINT "CAN'T ACCESS FILE.";
CASE 58: PRINT "FILE EXISTS ERROR.";
CASE 61: PRINT "DISK IS FULL.";
CASE 68: PRINT "CAN'T ACCESS DEVICE.";
CASE 71: PRINT "DISK NOT READY.";
CASE 72: PRINT "DISK ERROR.";
CASE 76: PRINT "FILE PATH NOT FOUND.";
CASE 62: PRINT "INPUT PAST END OF FILE.";
CASE ELSE:
PRINT "AN ERROR HAS OCCURRED.";
END SELECT
PRINT "Press any key to continue...";
COLOR 15 'back to high intensity white
RESUME NEXT
SUB AddSummary
 subprogram to add input filename
 to bottom of population exposure file: POPFILE$
 and to the bottom of TALLYFILE$ if not NULL

OpenFile POPFILE$, 2, 3  'open file #2 for append
EXCL$ = ""
METH$ = ""
FOR I = 1 TO NUMGROUPS%
   EXCL$ = EXCL$ + LOCAT(I).EXCLUDE
   METH$ = METH$ + LOCAT(I).METHOD + "."
NEXT I
PRINT #2, "(" + INFILE$ + ", " + EXCL$ + ", " + METH$ + ", " + CALCMODE$ + ")"
CLOSE #2
IF TALLYFILE$ <> "" THEN
   OpenFile TALLYFILE$, 2, 3   'open file #2 for append
   PRINT #2, "(" + INFILE$ + ", " + EXCL$ + ", " + METH$ + ", " + CALCMODE$ + ")"
   CLOSE #2
END IF

END SUB

SUB AmbientArray (AMBIENT(), date2, date1, AMBDATA() AS STRING * 78)

'' sub program to get ambient data for current day from array AMBDATA$()

' CONST CONV = .6     'Conversion factor from PM-10 to PM-3.5?
FOR X = 1 TO 731
   L$ = AMBDATA$(X)      'assign to next string array
   D$ = LEFT$(L$, 5)
   f = VAL(D$)
   FOR I = 1 TO 24
      v$ = MID$(L$, (I * 3) + 3, 3)
      v = VAL(v$)
      AMBIENT(I) = v * CONV
   NEXT I
   IF f = date1 THEN
      date2 = F
      GOTO 12:
   END IF
NEXT X
12 :
   FOR i = 1 TO 24
      FOR j = (i - 1) * 60 + 1 TO i * 60
         RSP(j) = R1(i)
      NEXT j
   NEXT i

END SUB

SUB AmbientFile (AMBIENT(), date2, date1, AMBFILE$)

'' sub program to get ambient data for current day from file AMBFILE$

' CONST CONV = .6     'Conversion factor from PM-10 to PM-3.5?
CALL OpenFile(AMBFILE$, 2, 1)   'open as #2 for input
FOR X = 1 TO 731
   INPUT #2, L$  
   D$ = LEFT$(L$, 5)
   f = VAL(D$)
   FOR I = 1 TO 24
      v$ = MID$(L$, (I * 3) + 3, 3)
      v = VAL(v$)
      AMBIENT(I) = v * CONV
   NEXT I
   IF f = date1 THEN
      date2 = F
      GOTO 11:
   END IF
NEXT X
11 :
   FOR i = 1 TO 24
      FOR j = (i - 1) * 60 + 1 TO i * 60
         RSP(j) = R1(i)
   NEXT j

40
NEXT j
NEXT i
CLOSE #2

END SUB

SUB AssignMenu

** subprogram to assign method of calculating exposure: SCEM or sampling from real microenvironmental data distributions

OPT% = 0
CLS
WHILE OPT% = 0
    PlaceText "ASSIGN EXPOSURE CALCULATION METHOD", 2, 1, Title
    RepeatCH ":", 80, Lin
    FOR I = 1 TO NUMGROUPS%
        PlaceText STR$(LOCAT(I).CODE) + " " + LOCAT(I).NAME + " [" + LOCAT(I).METHOD + "]", 25, I + 2, Text
    NEXT I
    RepeatCH ":", 80, Lin
    PlaceText "SCEM = use SCEM model", 2, 20, Inst
    PlaceText "MICR = use real microenvironmental data", 2, 21, Inst
    RepeatCH ":", 80, Lin
    LOCATE 23, 1
    COLOR Quit
    INPUT "Enter Number of Parameter to Change or 0 to quit: ", I%
    IF I% <> 0 AND I% <= NUMGROUPS% THEN
        IF LOCAT(I%).METHOD = "SCEM" THEN LOCAT(I%).METHOD = "MICR" ELSE LOCAT(I%).METHOD = "SCEM"
        CALCOPT$ = LOCAT(I%).METHOD  'overall method is set to last indiv. one
    END IF
    IF I% = 0 THEN OPT% = 1
    CLS
WEND

END SUB

SUB Calender (date1, M, D, Y) STATIC

***Calculates Julian date given the month, day and year.
***12/31/93 ==> 93365% (<yr.><days after 1/1>)
    IF M = 1 THEN X = D
    IF M = 2 THEN X = 31 + D
    IF Y = 87 AND M = 3 THEN X = 59 + D
    IF Y = 88 AND M = 3 THEN X = 60 + D
    IF Y = 87 AND M = 4 THEN X = 90 + D
    IF Y = 88 AND M = 4 THEN X = 91 + D
    IF Y = 87 AND M = 5 THEN X = 120 + D
    IF Y = 88 AND M = 5 THEN X = 121 + D
    IF Y = 87 AND M = 6 THEN X = 151 + D
    IF Y = 88 AND M = 6 THEN X = 152 + D
    IF Y = 87 AND M = 7 THEN X = 182 + D
    IF Y = 88 AND M = 7 THEN X = 183 + D
    IF Y = 87 AND M = 8 THEN X = 212 + D
    IF Y = 88 AND M = 8 THEN X = 213 + D
    IF Y = 87 AND M = 9 THEN X = 243 + D
    IF Y = 88 AND M = 9 THEN X = 244 + D
    IF Y = 87 AND M = 10 THEN X = 273 + D
    IF Y = 88 AND M = 10 THEN X = 274 + D
    IF Y = 87 AND M = 11 THEN X = 304 + D
    IF Y = 88 AND M = 11 THEN X = 305 + D
    IF Y = 87 AND M = 12 THEN X = 334 + D
    IF Y = 88 AND M = 12 THEN X = 335 + D
    date1 = Y * 1000 + X

END SUB

SUB ClearProfile (N%, PROFILE%())

'routine for clearing a 1-D vector PROFILE% of length N%
    FOR I = 1 TO N%
        PROFILE%(I) = 0
    NEXT I

END SUB

SUB ClearVector (N%, VECTOR())

'routine for clearing a 1-D vector VECTOR of length N%
    FOR I = 1 TO N%
        VECTOR(I) = 0
    NEXT I
SUB Diary (WH%, LOCATION%(1), SMOKERS%(1), ACTIVITY%(1))
'***subprogram to place codes into beginning minute of diary event
' into 1440 minute profiles: Creates constant length diaries
' from an arbitrary number of diary events (tbeg = beginning diary time)
',
' calculates adjusted time and assigns values to
' LOCATION, ACTIVITY, SMOKERS vectors
'
t1 = INT(tbeg / 100)
t2 = (tbeg / 100 - t1) * 100
'...Convert Time to Minutes
mins = t1 * 60 + t2
MINSADJ = mins + 1
'
LOCATION%(MINSADJ) = WH%
SMOKERS%(MINSADJ) = DSMOKE
ACTIVITY%(MINSADJ) = ACT
'
END SUB

SUB DoTitle
',
'*** sub program to display title screen
',
COLOR 14, Back
CLS
PRINT ; PRINT ; PRINT ; PRINT
PRINT "              ***********************************************"
PRINT "              *              Welcome to the                 *
PRINT "              *                                             *
PRINT "              *         Total Human Exposure Model          *
PRINT "              *                  (THEM)                     *
PRINT "              *                                             *
PRINT "              *    This version calculates RSP exposure   *
PRINT "              *   based on actual Human Activity Patterns   *
PRINT "              *                                             *
PRINT "              *       Developed at Stanford University      *
PRINT "              *               August 1993                   *
PRINT "              ************************************************
PRINT
PRINT "              Press any key to continue..."
SLEEP: CLS

END SUB

SUB EnterDist (VECTOR()
',
'*** subprogram reads data into a univariate
'cumulative probability 2D array VECTOR
'*** Data is read until a "99" is encountered
'*** VECTOR must be at least a 2xN% array: VECTOR(2, N%)
',
N% = 1
TEST1 = 0  'variables to test for end of data by reading a 99
TEST2 = 0
LINE INPUT #2, h$  'there is one dummy line for distrib. label
DO WHILE TEST1 <> 99 AND TEST2 <> 99
  INPUT #2, TEST1, TEST2
  VECTOR(1, N%) = TEST1
  VECTOR(2, N%) = TEST2
  N% = N% + 1
 LOOP
  N% = N% - 1
',

END SUB

SUB EnterLNorm (VECTOR()
',
'*** subprogram reads data for geo. mean and geo. std. dev.
' into array VECTOR(2)
',
LINE INPUT #2, h$
INPUT #2, TEST1, TEST2
VECTOR(1) = TEST1  'geo. mean
VECTOR(2) = TEST2  'geo. standard deviation

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SUB ExcludeMenu
'*** this subprogram displays the menu for excluding exposure from
'    certain microenvironments
OPT% = 0
CLS
WHILE OPT% = 0
    PlaceText "EXCLUDE MICROENVIRONMENTS", 2, 1, Title
    RepeatCH ".", 80, Lin
    FOR I = 1 TO NUMGROUPS%
        PlaceText STR$(LOCAT(I).CODE) + " " + LOCAT(I).NAME + " [" + LOCAT(I).EXCLUDE + "]", 25, I + 2,
    NEXT I
    RepeatCH ".", 80, Lin
    PlaceText "X = exclude location", 2, 20, Inst
    PlaceText "O = include location", 2, 21, Inst
    RepeatCH ",", 80, Lin
    LOCATE 23, 1
    COLOR Quit
    INPUT "Enter Number of Parameter to Change or 0 to quit: ", I%
    
   CLS
    IF I% <> 0 AND I% <= NUMGROUPS% THEN
        IF LOCAT(I%).EXCLUDE = "X" THEN LOCAT(I%).EXCLUDE = "O" ELSE LOCAT(I%).EXCLUDE = "X"
    END IF
    IF I% = 0 THEN OPT% = 1
   CLS
WEND
END SUB

-------------------
SUB Fill (PROFILE%, N%)  
'.....Subroutine to fill activity codes into the vector PROFILE()
'.....The vector PROFILE(1440) stores 1-minute activity codes for the Day
'.....In the filling process, if a code other than zero is encounted,
'.......then repeatedly enter the same code until the next nonzero code appears
    temp% = 0
    FOR I = 1 TO N%
        IF PROFILE%(I) <> temp% AND PROFILE%(I) <> 0 THEN temp% = PROFILE%(I)
        PROFILE%(I) = temp%
    NEXT I

END SUB

SUB FindPersonID (PID&, FILENAME$)
'*** subroutine to forward in the activity file until it finds person with
'*** identification number ID#
'*** assumes activity input file #1 (FILENAME$) is already open
    CLOSE #1  'must start beginning so close, then,
    CALL OpenFile(FILENAME$, 1, 1)  'open file for input as #1
    
   CLS
    PRINT "Searching...."
    COUNT% = 0  'count number of lines from top
    ID% = -1
    WHILE ID% <> PID% AND NOT EOF(1)
        LOCATE 3, 1: PRINT "READING RECORD #: "; COUNT%  
        COUNT% = COUNT% + 1
        INPUT #1, ID%
        'PRINT ID%
    WEND
    'Position at top of file
    CLOSE #1
    CALL OpenFile(FILENAME$, 1, 1)
    
   PRINT
    IF EOF(1) THEN
        PRINT "End of file reached. Person ID "; PID%; " not found."
        PID% = 0
        PRINT "Press any key...": SLEEP
    ELSE
        PRINT "Found Person ID "; PID%; " at Record "; COUNT%;
        PRINT "Press any key...": SLEEP
        
    END IF

    PRINT "Press any key...": SLEEP
PRINT "Person ID "; PID&; " found."
'after closing file and opening to get back to top
' then go to COUNT% line 
' 
FOR I = 1 TO COUNT& - 1 'go to just before found PID
  INPUT #1, DUM
  PRINT DUM&
  NEXT I
' 
PRINT "File Pointer Positioned.": PRINT
PRINT "Press any key...": SLEEP
END IF
,
END SUB

SUB GetLoc
'*** sub program to read THEMLOC.DAT file containing regrouped locations
' and constant RSP concentrations due to ETS
' "NUMGROUPS%" IS A GLOBAL VARIABLE
','
PRINT "Reading Location Codes File..."
'
OpenFile PATH$ + "THEMLOC.DAT", 2, 1 'open #2 for input
' skip 15 comment lines
' FOR I = 1 TO 15
  LINE INPUT #2, SP$
NEXT I
' Read Number of Groups; dimension location array
' INPUT #2, NUMGROUPS%
REDIM LOCAT(1 TO NUMGROUPS%) AS LOCCODES
' set LOCAT.EXCLUDE option to include all locations
FOR I = 1 TO NUMGROUPS%
  LOCAT(I).EXCLUDE = "O"
NEXT I
' set calculation method for each location
' FOR I = 1 TO NUMGROUPS%
'  IF CALCOPT$ = "SCEM" THEN LOCAT(I).METHOD = "SCEM" ELSE LOCAT(I).METHOD = "MICRO"
' NEXT I
' read new code #, location name, CAP codes to regroup, RSP conc.
' all one one line
FOR I = 1 TO NUMGROUPS%
  LINE INPUT #2, L$
  LOCAT(I).CODE = GetFromStringN(L$, 1)
  LOCAT(I).NAME = GetFromStringS(L$, 2)
  LOCAT(I).NGROUP = GetFromStringN(L$, 3) 'number of regrouped codes
  FOR J = 1 TO LOCAT(I).NGROUP
    LOCAT(I).REGROUP(J) = GetFromStringN(L$, J + 3)
  NEXT J
  LOCAT(I).METHOD = GetFromStringS(L$, LOCAT(I).NGROUP + 4)
  NEXT I
' 
CLOSE #2
'
END SUB

SUB GoToPerson (N%)
' *** subprogram to skip through CAP activity file 'N&' people
' 
CLOSE #1 'close then open to get to beginning
CALL OpenFile(INFILE$, 1, 1)
'
CLS
COUNT% = 0
INPUT #1, PID&
FOR I = 1 TO N%
  LASTPID& = PID&
  DO UNTIL PID& <> LASTPID&
    INPUT #1, PID&
  NEXT I
END IF

END SUB
PRINT LASTPID&, PID&: SLEEP
COUNT% = COUNT% + 1    'number of lines from top
LOOP
  LOCATE 1, 1: PRINT "Person Number "; I; " Read."
  NEXT I
'Position at top of file
PRINT
'IF EOF(1) THEN
  PRINT "End of file reached before person number "; N%
  PID& = 0
  PRINT "Press any key...": SLEEP
ELSE
  PRINT "Person ID "; PID&; " found."; PRINT
  'after closing file and opening to get back to top
  'then go to COUNT% line #
  CLOSE #1
  CALL OpenFile(INFILE$, 1, 1)
  FOR I = 1 TO COUNT& - 1  'go to just before found PID
    INPUT #1, DUM
    'PRINT DUM&
  NEXT I
  PRINT "File Pointer Positioned."; COUNT% - 1; " lines from top."; PRINT
  PRINT "Press any key...": SLEEP
ENDIF
END SUB

SUB GraphProfile (LOCATION%(), SMOKERS%(), RSP())
  '*** subprogram to draw a graphical representation (in character format) on the
  'screen of a combined location, smoking, exposure profile.
  'locations and smoker presence are shown by codes
  'exposure is shown with a number whenever a smoker is present
  'HORIZ: 1440 minutes/80 characters = 18 minutes per character
  'VERT: 10 max/24-2 characters ~ 0.5 units per characters
  COLOR White, Blue
  CLS
  PRINT "Person Number: ", PEOPLE%, "   PID: ", LASTPID&
  PRINT "X=Exposure   L=Location   S=Smoker Present"
  O$ = "#"
  FOR I = 1 TO 1440
    IF I / 18 = CINT(I / 18) THEN
      X% = CINT(I / 18)
      LOCY% = LOCATION%(I)
      IF SMOKERS%(I) = 1 THEN SMOKY% = 10 ELSE SMOKY% = 0
      'LOCY% = 5: SMOKY% = 7
      LOCATE 23, X%: PRINT USING O$; RSP(I)
      'LOCATE LOCY%, X%: PRINT LOCATION%(I)
      'LOCATE SMOKY%, X%: PRINT SMOKERS%(I)
    END IF
  NEXT I
END SUB

SUB Initialize
  PATH$ = "d:\them\basic"    'Path for finding data files: locations, distributions
  'Histogram BarWidths
  BarWidthAve = 10    'Bar width for Average Indoor
  BarWidthAmb = 5     'Bar width for ambient exp.
  BarWidthMax = 25    'Bar width for Maximum exp.
  HOPT% = 0           'Specify only Barwidth for histogram
  '***** INITIALIZE COUNTERS AND ARRAYS *****
  'Initialize Person Record No. Counter (Counts records for each person)
  RECPERSON& = 0
  'Initialize Total Record No. Counter (Counts all records read)
FUNCTION MicroExp (LOCATION%, ACTIVITY%, SMOKER%)
  *** sub program to assign exposures based on distributions of microenvironmental data for each location and activity/smoker codes; here, smoker = 1 means smoker present
  Assign Exposures
  FOR J = 1 TO NUMGROUPS%
    IF LOCATION% = LOCAT(J).CODE THEN
      CURRENTRSP = DistSample(LOCAT(J).ETSDIST())
      LOCAT(CURRENTLOC%).SAMPLE = CURRENTRSP
      MicroExp = CURRENTRSP
    END IF
  NEXT J
END FUNCTION

SUB OptionsMenu
  *** subprogram to display and process Options menu
  OPT% = 0
  WHILE OPT% = 0
    PlaceText "OPTIONS, FILES", 2, 1, Title
    RepeatCH ",", 80, Lin
    PlaceText "A-Input file for Activity Patterns ["+ INFILE$ + "]", 10, 3, Text
    PlaceText "B-Input file for Ambient Data ["+ AMBFILE$ + "]", 10, 4, Text
    PlaceText "P-Output file for Population Exposure Data ["+ POPFILE$ + "]", 10, 5, Text
    PlaceText "E-Output file for Exposure-Time Tally ["+ TALLYFILE$ + "]", 10, 7, Text
    PlaceText "T-Output file for Exposure Profiles ["+ EXPFILE$ + "]", 10, 8, Text
    PlaceText "V-Output file for Activity Codes ["+ ACTFILE$ + "]", 10, 9, Text
    PlaceText "L-Output file for Location Codes ["+ LOCFILE$ + "]", 10, 10, Text
    PlaceText "S-Output file for Smoking Codes ["+ SMOKFILE$ + "]", 10, 11, Text
    PlaceText "H-Outputfile for Hourly Summaries ["+ HOURFILE$ + "]", 10, 12, Text
    PlaceText "R-Output file for 'RSP Episode' Parameters ["+ SCEMFILE$ + "]", 10, 13, Text
    PlaceText "(To View a File Press  and Enter Filename)", 10, 14, Inst
    PlaceText "0-Exclude Locations", 10, 17, Text
    PlaceText "1-Assign Exposure Method", 10, 18, Text
    PlaceText "2-Read Ambient Data ["+ AMBOPT$ + "]", 10, 20, Text
    PlaceText "3-Regroup Locations ["+ GROUPOPT$ + "]", 10, 21, Text
    PlaceText "0-Exclude Locations", 10, 17, Text
    PlaceText "1-Assign Exposure Method", 10, 18, Text
    PlaceText "2-Read Ambient Data ["+ AMBOPT$ + "]", 10, 20, Text
    PlaceText "3-Regroup Locations ["+ GROUPOPT$ + "]", 10, 21, Text
    PlaceText "Press <RET> to enter options...", 2, 22, Inst
    RepeatCH "", 80, Lin
    PlaceText "Press a Letter or Number...", 2, 24, Quit
    OPTIONN$ = GetAKey(""
    CLS
    SELECT CASE OPTIONN$
    CASE "a", "A": INPUT "Enter name for Activity File: ", INFILE$
    INPUT "Close #1: CALL OpenFile(INFILES, 1, 1)"
    CASE "b", "B": INPUT "Enter name for Ambient Data File: ", AMBFILE$
    CASE "p", "P": INPUT "Enter name for Exposure Data File: ", POPFILE$
    CASE "e", "E": PRINT "Enter name for file to contain Exposure Vectors"
    INPUT "Press <RET> for no file: ", EXPFILE$
    CASE "t", "T": PRINT "Enter name for file to contain Exposure Tally"
    INPUT "Press <RET> for no file: ", TALLYFILE$
    CASE "v", "V": PRINT "Enter name for file to contain Activity Codes"
    INPUT "Press <RET> for no file: ", ACTFILE$
    CASE "l", "L": PRINT "Enter name for file to contain Location Codes"
    INPUT "Press <RET> for no file: ", LOCFILE$
    CASE "s", "S": PRINT "Enter name for file to contain Passive Smoking Codes"
    INPUT "Press <RET> for no file: ", SMOKFILE$
    CASE "h", "H": PRINT "Enter name for file to contain Hourly Summaries"
INPUT "Press <RET> for no file: ", HOURFILE$
CASE "r", "R": PRINT "Enter name for file to contain SCEM Parameters"
    INPUT "Press <RET> for no file: ", SCEMFILE$
CASE "": CLS : INPUT "Enter filename:"; FIL$
    LookAndFeel FIL$
CASE "x", "X": CLS
    PRINT "Press <RET> to !DELETE! all person output files"
    PRINT "or Press <ESC> to CANCEL ": ANS$ = GetAKey("")
    IF ANS$ = CHR$(13) THEN    'if RET
        KILL TALLYFILE$
        KILL EXPFILE$
        KILL ACTFILE$
        KILL LOCFILE$
        KILL SMOKFILE$
        KILL HOURFILE$
        KILL SCEMFILE$
    END IF
CASE "0": ExcludeMenu
CASE "1": AssignMenu
CASE "2": IF AMBOPT$ = "Yes" THEN AMBOPT$ = "No" ELSE AMBOPT$ = "Yes"
CASE "3": IF GROUPOPT$ = "Yes" THEN GROUPOPT$ = "No" ELSE GROUPOPT$ = "Yes"
CASE CHR$(13): OPT% = 1    'press <RET> to enter..
CASE ELSE
    END SELECT
COLOR , 4: CLS    'red background
WEND

SUB PrintEpisode (HEAD$)
    '*** sub program to save SCEM parameters for each location for each person
    '*** gives new set of params for each new smoker location
    LPRINT
    LPRINT "****************************************************************
    LPRINT "LIST OF SCEM PARAMETERS"
    LPRINT HEAD$
    LPRINT OA$ = "Room Volume (m3):   ######     Source Strength (ug/cig.): #####"
    OB$ = "Smoking Rate (hr-1): ###.#     Air Exchange Rate (ach):  ####.#"
    OC$ = "Smoker Location:       ###     Average Conc. (ug/m3):   #####.#"
    LPRINT USING OA$; SCEM.VOLUME; SCEM.SOURCE
    LPRINT USING OB$; SCEM.SMRATE; SCEM.ACH
    LPRINT USING OC$; SCEM.SMLOC; SCEM.AVECONC
    LPRINT "****************************************************************
    END SUB

SUB PrintHourlySum (HEAD$, N%, RSP(), AMBIENT())
    '*** sub program for printing hourly summary to line printer
    'SetPrintStyle "4"   'cond print
    LPRINT
    LPRINT "****************************************************************
    LPRINT "SUMMARY OF AVERAGE HOURLY EXPOSURE (ug/m3)"
    LPRINT HEAD$
    LPRINT LPRINT
    LPRINT "  TIME         INDOOR         AMBIENT"
    LPRINT "---------------------------------------"
    O$ = " ##:00        ####.#         ####.#"
    FOR I = 1 TO 24
        INDOOR = Average((I - 1) * 60 + 1, I * 60, RSP(), 0, OMITOUT)
        IF AMBIENT(I) < 0 THEN AMBIENT(I) = 0
        LPRINT USING O$; I; INDOOR; AMBIENT(I)
    NEXT I
    O2$ = "OVERALL       ####.#         ####.#"
    LPRINT "--------------------------------------"
    LPRINT USING O2$; Average(1, 1440, RSP(), 0, OMITOUT); Average(1, 24, AMBIENT(), 0, OMITOUT)
    LPRINT "****************************************************************
    PrinterControl "FF"    'new printer page
    END SUB

SUB PrintOutOptions
    '*** sub program to handle write/printout/saving of calculation progress
    RUNOPT% = 0
END SUB

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CLS

WHILE RUNOPT% = 0
    PlaceText "SCREEN AND PRINTER OPTIONS", 2, 4, 10
    RepeatCH ",", 80, 13
    PlaceText "1-Personal Data to Screen [" + RT1$ + "]", 2, 6, 11
    PlaceText "2-Location & Activity Profiles to Screen [" + RT2$ + "]", 2, 7, 11
    PlaceText "3-Indoor Exposures to Screen [" + RT3$ + "]", 2, 8, 11
    PlaceText "4-Hourly Summary of Each Person to Screen [" + RT5$ + "]", 2, 9, 11
    RepeatCH ",", 80, 13
    PlaceText "5-Pause Calculation Between People [" + RT4$ + "]", 2, 11, 11
    RepeatCH ",", 80, 13
    PlaceText "6-Location & Activity Profiles to Printer [" + RT6$ + "]", 2, 13, 11
    PlaceText "7-Indoor Exposures to Printer [" + RT7$ + "]", 2, 14, 11
    PlaceText "8-Hourly Summary of Each Person to Printer [" + RT10$ + "]", 2, 15, 11
    RepeatCH ",", 80, 13
    PlaceText "9-SCM Parameters of Each Person to Printer [" + RT9$ + "]", 2, 16, 11
    RepeatCH ",", 80, 13
    PlaceText "0-Pause Between New Smoking Episodes [" + RT9$ + "]", 2, 18, 11
    RepeatCH ",", 80, 13
    PlaceText "Press <RET> to Enter Options Choices", 2, 20, 15
    RepeatCH ",", 80, 14
    ROPT$ = GetAKey(""
    SELECT CASE ROPT$
        CASE "1": IF RT1$ = "Yes" THEN RT1$ = "No " ELSE RT1$ = "Yes"
        CASE "2": IF RT2$ = "Yes" THEN RT2$ = "No " ELSE RT2$ = "Yes"
        CASE "3": IF RT3$ = "Yes" THEN RT3$ = "No " ELSE RT3$ = "Yes"
        CASE "4": IF RT5$ = "Yes" THEN RT5$ = "No " ELSE RT5$ = "Yes"
        CASE "5": IF RT4$ = "Yes" THEN RT4$ = "No " ELSE RT4$ = "Yes"
        CASE "6": IF RT6$ = "Yes" THEN RT6$ = "No " ELSE RT6$ = "Yes"
        CASE "7": IF RT7$ = "Yes" THEN RT7$ = "No " ELSE RT7$ = "Yes"
        CASE "8": IF RT8$ = "Yes" THEN RT8$ = "No " ELSE RT8$ = "Yes"
        CASE "9": IF RT10$ = "Yes" THEN RT10$ = "No " ELSE RT10$ = "Yes"
        CASE "0": IF RT9$ = "Yes" THEN RT9$ = "No " ELSE RT9$ = "Yes"
        CASE CHR$(13): RUNOPT% = 1    'hit RET to enter options
    CASE ELSE
    END SELECT
    WEND
    END SUB

SUB PrintProfile (HEADER$, VECTOR%())
    '*** subprogram for printing profiles to the line printer
    '  
    '  DIM OUTFIELD AS STRING * 3
    '  DIM OUT$,
    '  LPRINT "****************************************************************************"
    '  LPRINT HEADER$
    L$ = "Grid of 24 hours vs. 60 minutes per hour"
    L1$ = " HRS- 1     3     5     7     9    11    13    15    17    19    21    23"
    L2$ = "MINS     2     4     6     8    10    12    14    16    18    20    22    24"
    LPRINT L$
    LPRINT L1$
    LPRINT L2$
    LPRINT "--|-------------------------------------------------------------------------"
    FOR I = 1 TO 60
        OUT$ = ""
        CALL FillString(I, OUTFIELD, OUT$, 3, 3)
        OUT$ = OUT$ + "="
        FOR J = 1 TO 24
            Value = INT(VECTOR%(I + (J - 1) * 60))
            CALL FillString(Value, OUTFIELD, OUT$, 3, 3)
        NEXT J
        LPRINT OUT$
    NEXT I
    LPRINT "****************************************************************************"
    PrinterControl "FF"   'new printer page
    '---------------------
    SUB PrintSegs (Offset%, PROFILE%()) STATIC
        LPRINT "    Offset Time = ", Offset%, "minutes"
        LPRINT : LPRINT "24-Hour Profile Summary by 4 Segments per Hour:": LPRINT
        LPRINT "  Hour        Seg1          Seg2     Seg3     Seg4 "
        FOR h = 1 TO 24
            I = (4 * (h - 1) + 1)
            LPRINT "   "; (h - 1), PROFILE%(I), PROFILE%(I + 1), PROFILE%(I + 2), PROFILE%(I + 3)
        NEXT h
        LPRINT : LPRINT
    END SUB

49
SUB PrintVector (HEADER$, VECTOR())

'*** subprogram for printing exposure vectors to line printer

DIM OUTFIELD AS STRING * 3
DIM OUT$,
LPRINT
LPRINT -----------------------------------------------
LPRINT HEADERS$,
L$ = "Vector grid of 24 hours vs. 60 minutes per hour"
L1$ = " HRS- 1 3 5 7 9 11 13 15 17 19 21 23"
L2$ = "MINS  2 4 6 8 10 12 14 16 18 20 22 24"
LPRINT L$
LPRINT L1$
LPRINT L2$
LPRINT "|--|-------------------------------------------------------------"
FOR I = 1 TO 60
OUT$ = ""
CALL FillString(I, OUTFIELD, OUT$, 3, 3)
OUT$ = OUT$ + "="
FOR J = 1 TO 24
Value = INT(VECTOR(I + (J - 1) * 60))
CALL FillString(Value, OUTFIELD, OUT$, 3, 3)
NEXT J
LPRINT OUT$
NEXT I
LPRINT "|-------------------------------------------------------------------------|
LPRINT "****************************************************************************
PrinterControl "FF" 'new printer page

END SUB

SUB ProcessPerson

'*** sub program to handle control of reading activity data, calculating 
'RSP exposure and saving person exposure data.

'Dimension arrays for profiles and exposure
'-----------------------------------------------
DIM LOCATION%(1440) '1440 min location profile for each person
DIM ACTIVITY%(1440) '1440 min activity profile for each person
DIM SMOKERS%(1440)  '1440 min smoker-present profile for each person
DIM AMBIENT(24)     'hourly ambient data
DIM RSP(1440)       'RSP From indoor sources
'-----------------------------------------------

'|------------------------Read Activities-------------------------|
'|----------------------and Create Profiles-----------------------|

ReadNextPerson LOCATION%(), ACTIVITY%(), SMOKERS%(), RSP(), AMBIENT()

'Save profiles to file
SaveWriteActivity LOCATION%(), ACTIVITY%(), SMOKERS%(), RSP(), AMBIENT()

'-----------------------------------------------

'|----------------- Calculate Exposure ---------------------------|
'1. read ambient data
'2. calculates exposures from ambient and const. indoor RSP values
'clear ambient and microenvironmental exposure profiles
CALL ClearVector(24, AMBIENT())
CALL ClearVector(1440, RSP())
'get ambient data
IF AMBOP$ = "Yes" THEN
    CALL UpdateScreen("Reading Ambient Data")
    CALL AmbientArray(AMBIENT(), date2, DATE, AMBDATA())
    CALL AmbientFile(AMBIENT(), date2, DATE, AMBFILE$)
END IF
CALL UpdateScreen("Calculating Microenvironmental Exposure")
'fill-in Exposure Profile: calls subprograms Mlcrexp and SCEMEEx
RSPFill LOCATION%(), ACTIVITY%(), SMOKERS%(), RSP()
'Save exposures/hourly summaries/parameters to file

50
SaveWriteExposure LOCATION(%), ACTIVITY(%), SMOKERS(%), RSP(), AMBIENT()

| Store 24-hour Exposures, Tally | StorePerson AMBIENT(), RSP() |

END SUB

SUB ReadAmbient

** sub program to read ambient data from file into AMBDATA$(1000) array

PRINT "Reading Ambient Data..."
CALL OpenFile(AMBFILE$, 2, 1) 'open as #2 for input
I = 1
DO UNTIL EOF(2)
    LINE INPUT #2, AMBDATA(I)
    I = I + 1
LOOP
CLOSE #2

SUB ReadDistParams

** sub program to read in all parameters for
** distributions
** uses sub programs EnterDist and EnterLNDist **

PRINT "Reading distribution parameters..."
SP% = 14 'Number of comment lines at top of THEMDIST.DAT file
OpenFile PATH$ + "THEMDIST.DAT", 2, 1 'open #2 for input
FOR I = 1 TO SP%
    LINE INPUT #2, SP$
NEXT I

1** Read in parameters for the 100s of sq. ft. of house
EnterDist FOOTAGE()

2** Read in parameters for the air exchange rate for house, ach
EnterDist EXCHANGE()

3** Read in parameters for number of rooms in a house
EnterDist NUMROOMS()

The following are the actual data parameters contained in
THEMDIST.DAT with some comments:

** FORM: [RANGE LIMIT, CUM. DIST. VALUE]
** The user may change the values and number of parameters
** A "99,99" is used to signal termination of data

** DATA FOR SQ. FOOTAGE OF A HOUSE (square feet)
--- Taken from: "Catalogue of Saturations"
Residential Appliance Saturation Survey
PG&E Market Planning and Research Dept.
Market Research and Info. Section, June 1987
1.000 line estimated
0.0000001 line estimated

'DATA 200, 0.00000001
'DATA 400, 0.014
'DATA 599, 0.040
'DATA 999, 0.14
'DATA 1499, 0.488
'DATA 1999, 0.782
'DATA 2699, 0.937
'DATA 3499, 0.980

51
'DATA 5000, 1.000
'DATA 99, 99

*** DATA FOR AIR EXCHANGE RATE OF A HOUSE-TOTAL (ACH)
---> Taken from: Table 1; Region 3: The Southwest,
    Pandian, Ott, Behar,
    "Residential Air Exchange Rates for Use in Indoor Air
'1.000 line estimated

'DATA 0.31, 0.05
'DATA 0.76, 0.25
'DATA 2.12, 0.40
'DATA 4.15, 0.75
'DATA 10.59, 0.95
'DATA 15.00, 1.000
'DATA 99, 99

*** Data for Number of Rooms in a House
---> Taken from: "Catalogue of Saturations"
    Residential Appliance Saturation Survey
    PG&E Market Planning and Research Dept.
    Market Research and Info. Section, June 1987
'1.000 line estimated

'DATA 1, 0.002
'DATA 2, 0.007
'DATA 3, 0.033
'DATA 4, 0.132
'DATA 5, 0.396
'DATA 6, 0.680
'DATA 7, 0.840
'DATA 8, 0.933
'DATA 9, 0.969
'DATA 10, 0.986
'DATA 15, 1.000
'DATA 99, 99

*** Read in log normal geo. mean and geo. st. dev.
    AND normal mean and st. dev.
    MUST BE CALLED AFTER: EnterDist for REAL Distributions
    uses EnterLNorm sub program
    data format:  log<mean>, log<STD>
    OR
    <mean>, <STD> for NORMAL distributions
    THE LOGARITHMS OF THE VALUES ARE NORMALLY DISTRIBUTED
    WE ENTER LOG(MEAN) AND LOG(STD) TO GET A LOGNORMAL
    DISTRIBUTION OF THE ACTUAL VALUES WHEN WE SAMPLE IT WITH
    LNormSample.

    Conversions: 1 ft³ = 0.02833 m³
                1 m³ = 35.298 ft³
                1 ft² = ? m²
                1 ft = ? m

EnterLNorm NVEHVOL()
EnterLNorm NVEHEXCHC()
EnterLNorm NVEHEXCHO()
EnterLNorm NSOURCE()
EnterLNorm NSMRATE()

***NORMAL Data for Vehicle Volume--cubic feet

    Ott, Langan & Switzer offer: 3.7 m³ = 130.6

'DATA 150, 50

--------------

***NORMAL Data for Vehicle Air Exchange Rate--ach

    Ott, Langan & Switzer (1992) offer the following:
    Windows Open, 20 mph: 121 ach
    Windows Closed, 20 mph: 13.1 ach
    Windows Closed, 0 mph: 1.41 ach

'DATA 75, 20
--------------
**NORMAL Data for Source Strength--ug/cig**

- Ott, Langan & Switzer offer: 49,000 ug/cig
- Ott & Klepeis offer: 12,100 ug/cig
- Other Researchers offer: ~15,800 ug/cig

'DATA 12100, 500

**NORMAL Data for Smoking Rate--cig/hr**

'DATA 2.0, 0.5

Data 12100, 500

---

**Read in microenvironmental RSP conc. distributions for reduced Microenvironmental Locations**

FOR I = 1 TO NUMGROUPS%
    EnterDist LOCAT(I).ETSDIST()
NEXT I
CLOSE #2

END SUB

** Sub program to handle the input of person diaries and other data and to create the LOCATION, ACTIVITY and SMOKER 1440 minute profiles**

'Clear the PROFILE vectors for use with next person
'They must be cleared to make use of FILL sub program effectively
'clear ACT and LOC profiles
CALL ClearProfile(1440, LOCATION%())
CALL ClearProfile(1440, SMOKERS%)()

---- Input diary and personal data ----

'Input first line of diary data
'DSMOEK contains 1 for no smoker, 5 for smoker, 0 for no data
'* Only read 1st diary line here if this is the very top of the file *
'* otherwise the first entry of the diary was read in from the *
'* last call to "InputPerson" *
'*
'IF PEOPLE% = 1 THEN INPUT #1, PID&, ID, a.y, tbeg, tend, etim, ctim, where, DSMOEK, ACT, dirm, dird, diry, dirwday
    LASTPID& = PID&
    CALL Calender(DATE, M, D, Y)

    CALL UpdateScreen("Reading Person")

    'Input all demographic information on current person
    and print out after reading in
    INPUT #1, PID&, RN01&, RSEL&, YSEL&, TPAC&, PRFX&, CLST&, STUM&, ACDT&, HHA&, HHAT&, HOUS&, PARK&,
    PRK2&, WKHB&, WKBK&, WKHR&, NJOB&, WPK1&, WP1&, WP2&, WP3&, WP4&, WP5&, WP6&
    INPUT #1, PID&, SMOK&, SMKY&, SMK2&, SMY2&, CLC4&, CLC6&, CLC8&, CLC10&, PGAR&, PGYS&, PGAS&, GSTV&, NSTV&, MS1&,
    MST&, MS2&,

    GLUE&, PNT1&,

    CALL UpdateScreen("Reading Person")

    'Input all demographic information on current person
    and print out after reading in
    INPUT #1, PID&, RN01&, RSEL&, YSEL&, TPAC&, PRFX&, CLST&, STUM&, ACDT&, HHA&, HHAT&, HOUS&, PARK&,
    PRK2&, WKHB&, WKBK&, WKHR&, NJOB&, WPK1&, WP1&, WP2&, WP3&, WP4&, WP5&, WP6&
    INPUT #1, PID&, SMOK&, SMKY&, SMK2&, SMY2&, CLC4&, CLC6&, CLC8&, CLC10&, PGAR&, PGYS&, PGAS&, GSTV&, NSTV&, MS1&,
INPUT #1, PID&, PST2&, SOAP&, OCLN&, AERO&, SHWR&, BATH&, MOTH&, DEOD&, RMFR&, AGE&, EDUC&, GDGR&, MRTL&, ZIP&, CNTY&, AREA&, HHT&, BG15&, BG16&, BG17&, RSEX&, INCM&, INCA&, INCB&, INC4&, INC6&, INCE&, INC8&, ISUM&, HHTT&, YTJB&

INPUT #1, PID&, YWHR&, YVHR&, YNJB&, YWP1&, YWP2&, YWP3&, YWP4&, YWP5&, YWP6&, YSTU&, YSMK&, YSMY&, YSM2&, YSY2&, YCC6&, YCC8&, YPG4&, YPG6&, YPGR%, YPGS%, YSTV%, YNST%, YMS1%, YMSM%, YMS2%, YGSP4%, YGTM4%, YPIT%, YGLU4%, YPT1%, YPT2%, YSLV4%, YST4%, —

INPUT #1, PID&, PAPS%, YCLN, YARO4, YSHR4, YBTH4, YAGE4, YEDU4, YSEX4, YCDT4, AOUT4, YOUT4, TTIM4, INUM4, TCNT4, RIN4, ANYO4, CSUM4, ANUM4, ZSTT4, ADIFF4, YDIFF4, NPHONE4, YINTV4, dirm4, dirdd4, diryy4

INPUT #1, PID&, ADWKDAY4, CMPM4%, CMPD4%, CMPY4%, ACWKDAY4, OCC4, YDIRM4, YDIRD4, YDIRY4, YDWKDAY4, YCMPM4%, YCMPD4%, YCMPY4%, YCDT4, AOUT4, YOUT4, TTIM4, INUM4, TCNT4, RIN4, ANYO4, CSUM4, ANUM4, ZSTT4, ADIFF4, YDIFF4, NPHONE4, YINTV4, dirm4, dirdd4, diryy4

INPUT #1, PID&, PAPS%, YCLN, YARO4, YSHR4, YBTH4, YAGE4, YEDU4, YSEX4, YCDT4, AOUT4, YOUT4, TTIM4, INUM4, TCNT4, RIN4, ANYO4, CSUM4, ANUM4, ZSTT4, ADIFF4, YDIFF4, NPHONE4, YINTV4, dirm4, dirdd4, diryy4

IF RT1$ = "Yes" THEN
    CALL UpdateScreen("Press any key to view personal data..."): SLEEP: CLS
    PRINT PID&$, RN01$, RSEL$, YSEL$, TPAC$, PRFX$, CLST4$, STUM4, ACDT4$, HHA4, HHA4, HOU4, PARK4, PRK4$, WKJB4, WKHR4, VHR4, RN04$, WP14$, WP24$, WP34$, WP44$, WP54$, WP64$: SLEEP: CLS
    CALL PrintPID4$, SMOK4$, SMY4$, SMK24$, SMY24$, CLC4$, CLC6$, PGR4$, PGR6$, PGYS4$, PGYS6$, GSTV4$, NSTV4$, MSM4$, MSTM4, MS24$, GSFR4$, GSTM4, PLCT4$, HT4$, HTFL4$, HEA4$, OPE4$, OPN4$, OPN24$, FAN14$, FAN24$, AIRC4$, ACTP4$, GLUE4$, PNT14$, PNT24$, SOLV4$, PEST4$: —
    SLEEP: CLS
    PRINT PID4$, PAPS4$, YCLN4, YARO4, YSHR4, YBTH4, YAGE4, YEDU4, YSEX4, YCDT4, AOUT4, YOUT4, TTIM4, INUM4, TCNT4, RIN4, ANYO4, CSUM4, ANUM4, ZSTT4, ADIFF4, YDIFF4, NPHONE4, YINTV4, dirm4, dirdd4, diryy4
    END IF

'print out personal info. to screen

WHILE NOT (EOF(1)) AND PID& = LASTPID&

    'regroup locations from "where" into "wh%"
    WH% = where
    IF GROUPOPT$ = "Yes" THEN CALL RegroupLoc(WH%)
    'Place LOC, ACT, SMOK codes into appropriate first minute
    'of current diary event; tbeg= beginning time
    CALL Diary(WH%, LOCATION%(), SMOKERS%(), ACTIVITY%())

    'Increment Record No. Counters
    RECPERSON& = RECPERSON& + 1
    RECTOTAL& = RECTOTAL& + 1

    'input a new line from diary
    INPUT #1, PID&, ID, a.y, tbeg, tend, etim, ctim, where, DSMOKE, ACT, dirm, dird, diry, dirwkday

    WEND

    '****************************
    IF EOF(1) THEN
        PRINT "End of File Reached...": SLEEP
        ALLSTOP% = 1
        END IF

    'Fill the 1-minute activity profiles with
    '    contiguous values in time
    CALL UpdateScreen("Creating 1440-min. Profiles")
    CALL Fill(LOCATION%(), 1440)
    CALL Fill(ACTIVITY%(), 1440)
    CALL Fill(SMOKERS%(), 1440)

    END SUB
FOR I = 1 TO NUMGROUPS%
    FOR J = 1 TO LOCAT(I).NGROUP
        IF WH% = LOCAT(I).REGROUP(J) THEN WH% = LOCAT(I).CODE
    NEXT J
NEXT I

SUB RestartCalc
    '*** Subprogram to end of one run through of data **
    '1. prints out summary of people analyzed
    '2. reinitializes file INFILE$ for activity input
    '3. reinitializes parameters
    PRINT "Reinitializing file pointers for "; INFILE$; ". . ."
    PRINT : PRINT "Number of Persons Analyzed = ", PEOPLE%
    PRINT "Number of Records Analyzed = ", RECTOTAL&
    PRINT
    ANS$ = GetAKey("Press <ESC> to cancel and any other key to initialize...")
    IF ANS$ <> CHR$(27) THEN
        CLOSE #1
        OPEN INFILE$ FOR INPUT AS #1
        '#2 is the ambient data file, opened and closed in AMBEXP sub program
        CALL Initialize
    END IF
END SUB

SUB RetrieveOptions
    '***sub program to retrieve options from THEM.OPT file
    ON LOCAL ERROR GOTO ReadError
    PRINT "Reading options file...
    CALL OpenFile("THEM.OPT", 8, 1) 'open file for input
    INPUT #8, INFILE$ 'write options to file
    INPUT #8, AMBFILE$
    INPUT #8, POPFILE$
    INPUT #8, TALLYFILE$
    INPUT #8, EXPFILE$
    INPUT #8, ACTFILE$
    INPUT #8, LOCFILE$
    INPUT #8, SMOKFILE$
    INPUT #8, HOURFILE$
    INPUT #8, SCEMFILE$
    INPUT #8, AMBOPT$
    INPUT #8, GROUPOPT$
    INPUT #8, RT1$
    INPUT #8, RT2$
    INPUT #8, RT3$
    INPUT #8, RT4$
    INPUT #8, RT5$
    INPUT #8, RT6$
    INPUT #8, RT7$
    INPUT #8, RT8$
    INPUT #8, RT9$
    INPUT #8, RT10$
    CLOSE #8
    Quit:
    EXIT SUB
    ReadError:
        CLS : BEEP
        PRINT "Error Reading Options File: THEM.OPT": PRINT
        INFILE$ = ""
        PRINT "Press any key to continue...": SLEEP: CLS
        RESUME Quit:
        END SUB

SUB RSPFill (LOCATION%(), ACTIVITY%(), SMOKERS%(), RSP())
    '*** subprogram to fill in the exposure profile with RSP average concentrations
**assigns ave. exp. to all minutes during the time in one location
'RSP() contains the exposure profile
' Look at segments of exposure over all 1440 minutes of the day
'---Breaking up into Locations
'clear exposure array
CALL ClearVector(1440, RSP())
'clear tally of "exposure minutes" in each location for last person
FOR I = 1 TO NUMGROUPS%
    LOCAT(I).TALLY = 0
NEXT I

***************************************************************************
'MAIN LOOP TO CREATE 1440-minute EXPOSURE PROFILE
***************************************************************************
FOR I = 1 TO 1440
    'current location, activity and smoker presence
    CURRENTLOC% = LOCATION%(I)
    CURRENTACT% = ACTIVITY%(I)
    CURRENTSMOK% = SMOKERS%(I)
    'if a code is outside regrouped range make in the first group: Home
    IF CURRENTLOC% > NUMGROUPS% THEN CURRENTLOC% = 1
    'IF LOCAT(CURRENTLOC%).EXCLUDE = "X" THEN
    '    LOCATE CURRENTLOC%, 1
    '    PRINT "X HERE"
    'END IF
    IF LOCAT(CURRENTLOC%).EXCLUDE <> "X" THEN
        'LOCATE CURRENTLOC%, 1
        'PRINT "O HERE"
        SELECT CASE SMOKERS%(I)
        CASE 1           'a smoker is present
            'add 1-minute to the tally in current location
            LOCAT(CURRENTLOC%).TALLY = LOCAT(CURRENTLOC%).TALLY + 1
            IF LOCATION%(I) = LOCATION%(I - 1) AND INT(RSP(I - 1)) <> 0 AND I <> 1 THEN
                RSP(I) = RSP(I - 1)
            ELSEIF LOCATION%(I) <> LOCATION%(I - 1) OR INT(RSP(I - 1)) = 0 OR I = 1 THEN
                IF LOCAT(CURRENTLOC%).METHOD = "SCEM" THEN RSP(I) = SCEMExp(LOCATION%(I))
                IF LOCAT(CURRENTLOC%).METHOD = "MICR" THEN RSP(I) = MicroExp(LOCATION%(I), ACTIVITY%(I), SMOKERS%(I))
                UpdateScreen ("A New Smoking Episode " + "(" + LOCAT(CURRENTLOC%).NAME + ")")
                LASTEXPOS = RSP(I)
                'Print or display smoker episode information
                IF RT9$ = "Yes" THEN
                    CALL UpdateScreen("Smoker Present: " + "" + LOCAT(CURRENTLOC%).METHOD + ": Method..."")
                    SLEEP
                END IF
            IF HEAD$ = "PERSON # " + STR$(PEOPLE%) + " / PID #" + STR$(LASTPID&) + " / " + INFILE$ + **
                IF RT10$ = "Yes" THEN
                    CALL UpdateScreen("Printing Parameters to Line Printer"")
                    CALL PrintEpisode(HEAD$)
                END IF
            IF LOCAT(CURRENTLOC%).METHOD = "SCEM" AND SCEMFILE$ <> "" THEN
                CALL UpdateScreen("Saving SCEM Parameters to File")
                CALL SaveSCEM(HEAD$)
            END IF
        CASE ELSE
            END SELECT
        END IF
    END SELECT
    IF RT9$ = "Yes" THEN
        CALL UpdateScreen("Smoker Present: " + "" + LOCAT(CURRENTLOC%).METHOD + ": Method..."")
        SLEEP
    END IF
END IF
END IF

***************************************************************************
END SUB

SUB SaveHourlySum (RSP(), AMBIENT())
CALL OpenFile(HOURFILE$, 2, 3) 'append #2 for each person
PRINT #2, "" 
PRINT #2, "HOURLY SUMMARY OF EXPOSURE (ug/m3)"
PRINT #2, "FOR PERSON #"; PEOPLE%
PRINT #2, "" 
PRINT #2, "TIME     INDOOR     AMBIENT"
PRINT #2, "----------------------------------"
O$ = "##:00     ####.#     ####.#"
FOR I = 1 TO 24
    INDOOR = Average((I - 1) * 60 + 1, I * 60, RSP(), 0, OMITOUT)
    IF AMBIENT(I) < 0 THEN AMBIENT(I) = 0
    PRINT #2, USING O$; I; INDOOR; AMBIENT(I)
NEXT I
O2$ = "OVERALL     ####.#     ####.#"
PRINT #2, "---------------------------------"
PRINT #2, USING O2$; Average(1, 1440, RSP(), 0, OMITOUT); Average(1, 24, AMBIENT(), 0, OMITOUT)
CLOSE #2
END SUB

SUB SaveOptions
' *** subprogram to save THEM options to a file called THEM.OPT
' *** when program ends
' *** THEM also reads this file before starting
CLS : PRINT "Saving options..."
CALL OpenFile("THEM.OPT", 8, 0)    'open them.opt for output
WRITE #8, INFILE$                  'write options to file
WRITE #8, AMBFILE$
WRITE #8, POPFILE$
WRITE #8, TALLYFILE$
WRITE #8, EXPFILE$
WRITE #8, ACTFILE$
WRITE #8, LOCFILE$
WRITE #8, SMOKFILE$
WRITE #8, HOURFILE$
WRITE #8, SCEMFILE$
WRITE #8, AMBOPT$
WRITE #8, GROUPOPT$
WRITE #8, RT1$
WRITE #8, RT2$
WRITE #8, RT3$
WRITE #8, RT4$
WRITE #8, RT5$
WRITE #8, RT6$
WRITE #8, RT7$
WRITE #8, RT8$
WRITE #8, RT9$
WRITE #8, RT10$
CLOSE #8                             'close them.opt
END SUB

SUB SaveProfile (FILENAME$, HEADING$, VECTOR%(), N%)
' *** sub program to save location/activity vector% for one person to file
DIM OUTFIELD AS STRING * 3
DIM OUT$ 
CALL OpenFile(FILENAME$, 2, 3)     'append file for each person
PRINT #2, "*************************************************************************
PRINT #2, HEADING$
L$ = "Grid of 24 hours vs. 60 minutes per hour"
L1$ = " HRS- 1     3     5     7     9    11    13    15    17    19    21    23"
L2$ = "MINS     2     4     6     8   10   12   14   16   18   20   22   24"
PRINT #2, L$
PRINT #2, L1$
PRINT #2, L2$
PRINT #2, "----------------------------------"
FOR I = 1 TO 60
    OUT$ = ""
    CALL FillString(I, OUTFIELD, OUT$, 3, 3)
OUT$ = OUT$ + "="
FOR J = 1 TO 24
  Value = INT(VECTOR%(I + (J - 1) * 60))
  CALL FillString(Value, OUTFIELD, OUT$, 3, 3)
NEXT J
PRINT #2, OUT$
NEXT I
PRINT #2, "": PRINT #2, ""
CLOSE #2
END SUB

SUB SaveSCEM (HEAD$)
  '** sub program to save SCEM parameters for each location for each person
  '**   gives new set of params for each new smoker location
  CALL OpenFile(SCEMFILE$, 2, 3)  'open for append as #2
  PRINT #2, ""
  PRINT #2, "**************************************************************************
  PRINT #2, "LIST OF SCEM PARAMETERS"
  PRINT #2, ""
  PRINT #2, HEAD$
  OA$ = "Room Volume (m3):   ######     Source Strength (ug/cig.): #####"
  OB$ = "Smoking Rate (hr-1): #####     Air Exchange Rate (ACH):  ####.#"
  OC$ = "Smoker Location:       ###     Average Conc. (ug/m3):   #####.#"
  PRINT #2, USING OA$; SCEM.VOLUME; SCEM.SOURCE
  PRINT #2, USING OB$; SCEM.SMRATE; SCEM.ACH
  PRINT #2, USING OC$; SCEM.SMLOC; SCEM.AVECONC
  PRINT #2, "**************************************************************************
  CLOSE #2
END SUB

SUB SaveVector (FILENAME$, HEADING$, VECTOR(), N%)
  '** sub program to save exposure vector for one person to file
  CALL OpenFile(FILENAME$, 2, 3)   'append file for each person
  PRINT #2, "**************************************************************************
  PRINT #2, HEADING$
  L$ = "Vector grid of 24 hours vs. 60 minutes per hour"
  L1$ = " HRS- 1     3     5     7     9    11    13    15    17    19    21    23"
  L2$ = "MINS     2     4     6     8    10    12    14    16    18    20    22    24"
  PRINT #2, L$
  PRINT #2, L1$
  PRINT #2, L2$
  PRINT #2, "--|----------------------------------------------------------------------"
  FOR I = 1 TO 60
    OUT$ = ""
    CALL FillString(I, OUTFIELD, OUT$, 3, 3)
    OUT$ = OUT$ + "="
    FOR J = 1 TO 24
      Value = INT(VECTOR(I + (J - 1) * 60))
      CALL FillString(Value, OUTFIELD, OUT$, 3, 3)
    NEXT J
    PRINT #2, OUT$
  NEXT I
  PRINT #2, "": PRINT #2, ""
  CLOSE #2
END SUB

SUB SaveWriteActivity (LOCATION%(), ACTIVITY%(), SMOKERS%(), RSP(), AMBIENT())
  '** subprogram to save profiles and summaries for each person
  HEAD$ = "PERSON # " + STR$(PEOPLE%) + " / PID #" + STR$(LASTPID&) + " / " + INFILE$ + ""

  Header for all vector prints to file or printer
Save vectors and profiles to FILE if opted for

IF ACTFILE$ <> "" THEN
    CALL UpdateScreen("Saving Activities to File")
    CALL SaveProfile(ACTFILE$, "ACTIVITIES FOR " + HEAD$, ACTIVITY%(), 1440)
END IF

IF LOCFILE$ <> "" THEN
    CALL UpdateScreen("Saving Locations to File")
    CALL SaveProfile(LOCFILE$, "LOCATION FOR " + HEAD$, LOCATION%(), 1440)
END IF

IF SMOKFILE$ <> "" THEN
    CALL UpdateScreen("Saving Smokers to File")
    CALL SaveProfile(SMOKFILE$, "SMOKERS FOR " + HEAD$, SMOKERS%(), 1440)
END IF

'------------------------------------
'print stuff to PRINTER if opted for

IF RT10$ = "Yes" THEN PrinterControl "FF"   'advance a page
IF RT6$ = "Yes" THEN
    CALL UpdateScreen("Printing Profiles to Line Printer")
    CALL PrintProfile("ACTIVITY FOR " + HEAD$, ACTIVITY%())
    CALL PrintProfile("LOCATION FOR " + HEAD$, LOCATION%())
    CALL PrintProfile("SMOKERS FOR " + HEAD$, SMOKERS%())
END IF

'--------------------------------------------------
'** write vectors to SCREEN if opted for

IF CALCMODE$ = "Detailed" OR RT2$ = "Yes" THEN
    CALL UpdateScreen("Press Any Key for 1440-min. Profiles...")
    SLEEP: CLS
    CALL WriteProfile("ACTIVITY FOR " + HEAD$, ACTIVITY%())
    CALL WriteProfile("LOCATION FOR " + HEAD$, LOCATION%())
    CALL WriteProfile("SMOKERS FOR " + HEAD$, SMOKERS%())
    SetUpScreen
END IF
END SUB

SUB SaveWriteExposure (LOCATION%(), ACTIVITY%(), SMOKERS%(), RSP(), AMBIENT())

'** subprogram to save profiles and summaries for each person

'Header for all vector prints to file or printer
HEAD$ = "PERSON # " + STR$(PEOPLE%) + " / PID #" + STR$(LASTPID&) + " / " + INFILE$ + ""

'Save vectors and profiles to FILE if opted for
IF EXPFILE$ <> "" THEN
    CALL UpdateScreen("Saving Exposures to File")
    CALL SaveVector(EXPFILE$, "EXPOSURE FOR " + HEAD$, RSP(), 1440)
END IF

IF HOURFILE$ <> "" THEN
    CALL UpdateScreen("Saving Hourly Summary to File")
    CALL SaveHourlySum(RSP(), AMBIENT())
END IF

'print stuff to PRINTER if opted for
IF RT10$ = "Yes" THEN PrinterControl "FF"   'advance a page
IF RT7$ = "Yes" THEN
    CALL UpdateScreen("Printing Exposures to Line Printer")
    CALL PrintVector("MICROENVIRONMENTAL EXPOSURE FOR " + HEAD$, RSP())
END IF

IF RT8$ = "Yes" THEN
    CALL UpdateScreen("Printing Hourly Summary to Line Printer")
    CALL PrintHourlySum(HEAD$, PEOPLE%, RSP(), AMBIENT())
END IF

'** write vectors to SCREEN if opted for

IF CALCMODE$ = "Detailed" OR RT3$ = "Yes" THEN
    CALL UpdateScreen("Press Any Key for Exposures...")
    SLEEP: CLS

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CALL WriteVector("EXPOSURE FOR " + HEAD$, RSP())
SetUpScreen
END IF
'
hourly summary if opted
'
IF CALCMODE$ = "Detailed" OR RT5$ = "Yes" THEN
    CALL UpdateScreen("Press Any Key for Hourly Summary....")
    SLEEP: CLS
    CALL WriteHourlySum(RSP(), AMBIENT())
    SetUpScreen
END IF
'
GraphProfile LOCATION%(), SMOKERS%(), RSP(): SLEEP
SetUpScreen
'
END SUB

FUNCTION SCEMExp (LOCATION%)
    
    ** sub program to assign indoor exposures to RSP based on
    ** location and smoking activity codes using
    ** SCEM (Sequential Cigarette Exposure Model)
    
    ** For information on this model please consult the following paper:
    
    ' Ott et al, Journal of Exposure Assessment and Environmental Epidemiology,
    ' v. 2, s. 2 1992, p. 175-
    
    ** The equation on p. 185 for the average RSP due to one smoker is:
    
    ' Z = (Go*F*S)/(PHI*V) where  Go = source strengh (ug/min)
    '    F = smoking rate (cig./hr.)
    '    S = cigarette duration (min./cig.)
    '    PHI = air exchange rate (ach)
    '    V = room volume (m3)
    
    'SHARED SCEM AS SMPARAMS
    
    SCEM.ACH = DistSample(EXCHANGE())    'ach
    SCEM.SOURCE = NormSample(NSOURCE())   'ug/cig.
    SCEM.SMRATE = NormSample(NSMRATE())   'cig/hr
    SCEM.SMLOC = LOCATION%
    '
    SELECT CASE LOCATION%
    CASE 1, 3, 4  'house; other indoor; bar/rest
        SCEM.VOLUME = DistSample(NUMROOMS())
    CASE 2  'office/fact
        SCEM.VOLUME = DistSample(FOOTAGE()) * 10 * .02833 / SCEM.NUMROOMS
    CASE 5  'outdoor
        SCEM.VOLUME = 100000#
    CASE 6  'vehicle
        SCEM.VOLUME = NormSample(NVEHVOL()) * .02833
        WIN% = Die(1)
        IF WIN% = 1 THEN
            SCEM.ACH = NormSample(NVEHEXCHO())
        ELSEIF WIN% = 0 THEN SCEM.ACH = NormSample(NVEHEXCHC())
        END IF
    CASE ELSE
        SCEM.VOLUME = 100000000
        SCEM.ACH = 1
    END SELECT
    '
    SCEM.AVECONC = (SCEM.SOURCE * SCEM.SMRATE) / (SCEM.ACH * SCEM.VOLUME)
    SCEMExp = SCEM.AVECONC  'set to minute in exp. profile
END FUNCTION

SUB SetUpScreen
    
    ** subprogram to set up the screen during calculations of exposure
    
    UpdateScreen updates the values and the status bar
    
    TIMES$ = 0    'number of times UpdateScreen is called
    COLOR , 0    'black background
    CLS
    PlaceText "CALCULATION INFORMATION AND STATUS", 2, 1, 12
    PlaceText "--Press ESC to CANCEL--", 2, 2, 10
    IF CALCMODE$ = "N" THEN
PRINT "N =" + STR$(NUMBER%) + " Calculation", 2, 3, 15
ELSE
PRINT CALCMODE$ + " Calculation", 2, 3, 15
END IF
'
PRINT : PRINT : RepeatCH ",", 80, 11
PlaceText "SAMPLED RSP VALUE", 1, 8, 14
PlaceText "ETS MODEL PARAMETERS", 50, 6, 14
RepeatCH ",", 45, 11
RepeatCHV ",", 6, 5, 46, 11
PlaceText "MICROENVIRONMENTAL EXPOSURES", 2, 5, 9
OA$ = "Source Strength (ug/cig.):"
OB$ = "Room Volume (m3):  Air Exchange Rate (ACH):"
OC$ = "Smoking Rate (hr-1):  Average Conc. (ug/m3):"
PlaceText OA$, 48, 7, 15
PlaceText OB$, 21, 8, 15
PlaceText OC$, 21, 9, 15
RepeatCHV ",", 2, 8, 19, 11
PRINT
RepeatCH ",", 80, 11
'
PRINT : PRINT : RepeatCH ",", 80, 11
PlaceText "PERSON STATUS", 2, 12, 9
PRINT
O1$ = "              Person ID:              No. Person Records:         
PRINT O1$
O2$ = "          Person Number:              Total Records Read:         
PRINT O2$
PRINT "                    Diary Date (Julian Format) :"
PlaceText "LAST 24-HR EXPOSURE:", 1, 16, White
PlaceText "Micro: ", 30, 16, White
PlaceText "Ambient: ", 50, 16, White
'
PRINT : PRINT : RepeatCH ",", 80, 11
PlaceText "CALCULATION STATUS", 2, 19, 9
COLOR 10
LOCATE 24, 1
RepeatCH ",", 80, 11
END SUB

SUB ShowGroupLoc
'*** sub program to show regrouped location codes

OPT% = 0
WHILE OPT% = 0
CLS
PlaceText "Regrouped Location Codes & Corresponding Exposure Calculation Method", 2, 1, Title
RepeatCH ",", 80, Lin
FOR I = 1 TO NUMGROUPS%
GSTR$ = ""
FOR J = 1 TO LOCAT(I).NGROUP
GSTR$ = GSTR$ + STR$(LOCAT(I).REGROUP(J))
NEXT J
PlaceText STR$(LOCAT(I).CODE) + "  " + LOCAT(I).NAME + "  " + LOCAT(I).METHOD + "  " + GSTR$, 1, I + 3, Text
NEXT I
LOCATE 23, 1
INPUT "Enter Number of Desired Group Distribution or 0 to quit: ", I%
IF I% = 0 THEN OPT% = 1
IF I% > 0 AND I% <= NUMGROUPS% THEN
CLS
WriteDist LOCAT(I%).ETSDIST()
SLEEP
END IF
CLS
WEND
END SUB

SUB ShowLocations
'*** sub program to show location codes

CLS
PRINT " 1  IN KITCHEN           2  IN LIVING ROOM"
PRINT " 3  IN DINNING ROOM      4  IN BATHROOM"
PRINT " 5  IN BEDROOM           6  IN STUDY"
PRINT " 7  IN GARAGE            8  IN BASEMENT"
PRINT " 9  IN UTILITY ROOM     10 POOL,SPA"
PRINT "11  IN YARD             12 ROOM TO ROOM"
PRINT "13  OTHER HH ROOM       21 AT OFFICE"
PRINT "22  AT PLANT            23 AT HOTEL - MOTEL"
PRINT "24  AT SHOPPING MALL    25 AT SCHOOL"
PRINT "26  AT BAR - NIGHTCLUB  27  AT HOSPITAL"
PRINT "28  AT RESTAURANT       29 AT BAR - NIGHTCLUB"
PRINT "30  AT INDOOR GYM      31 AT INDOOR GYM"
PRINT "32  AT OTHERS HOME      33 AUTO PRINT REPAIR"
PRINT "34  AT PLAYGROUND       35 AT HOTEL - MOTEL"
PRINT "36  AT DRY CLEANERS     37 AT BEAUTY PARLOR"
PRINT "38  AT WORK: MOVING     39 OTHER INDOOR"
PRINT "40  OTHER OUTDOOR       51  IN CAR"
PRINT "52  IN VAN              53 WALKING"
PRINT "54  AT BUS STOP         55 ON BUS"
PRINT "56  ON RAPID TRAIN      57 OTHER TRUCK"
PRINT "58  ON AIRPLANE         59 ON BICYCLE"
PRINT "60  ON MOTORCYCLE       61 OTHER TRANSPORTATION"
PRINT "99  UNKNOWN LOCATION    Press any key...": SLEEP
END SUB

SUB ShowParamsMenu
'* ** sub program to show calculation parameters/distributions

PARAMOPT% = 0
CLS
WHILE PARAMOPT% = 0
PlaceText "LOCATION CODES AND DISTRIBUTION PARAMETERS", 2, 4, 10
RepeatCH ".", 80, 13
PlaceText "L-Standard Location Codes", 28, 6, 11
PlaceText "R-Regrouped Location Codes & Constant Exposures", 28, 7, 11
PlaceText "F-House Footage CDF", 28, 8, 11
PlaceText "A-Air Exchange (ach) CDF", 28, 9, 11
RepeatCH ".", 80, 13
'PlaceText "Vehicle ach normal Mean: " + STR$(NVEHEXCH(1)), 28, 12, 11
'PlaceText "Vehicle ach normal STD: " + STR$(NVEHEXCH(2)), 28, 13, 11
'RepeatCH ".", 80, 13
PlaceText "ESC-Return to Previous Menu", 2, 15, 15
RepeatCH ".", 80, 14
PlaceText "Press Letter of Parameters to view...", 2, 17, 14
ROPT$ = GetAKey(""
PRINT
SELECT CASE ROPT$
CASE "l", "L":  ShowLocations 'prints location codes
CASE "r", "R": CLS : ShowGroupLoc 'print regrouped loc codes
CASE "f", "F": CLS : PRINT "HOUSE FOOTAGE DISTRIBUTION"
PRINT : CALL WriteDist(FOOTAGE()): SLEEP
CASE "a", "A": CLS : PRINT "AIR EXCHANGE DISTRIBUTION"
PRINT : CALL WriteDist(EXCHANGE()): SLEEP
CASE CHR$(27): PARAMOPT% = 1
CASE ELSE
END SELECT
CLS
WEND
END SUB

SUB StorePerson (AMBIENT(), RSP())
'* ** sub program to store exposure data for one person

DIM INDOOR(24)
DIM TOTALRSP(24)

CALL UpdateScreen("Saving 24-Hour Exposures to File")

'ug/m3 threshold for determining unexposed people
THRESH = .5

AVEEXP = Average(1, 1440, RSP(), 0, OMITOUT)
AVEAMB = Average(1, 24, AMBIENT(), 0, OMITOUT)
MAXEXP = Maximum(1440, RSP())

'Find hourly averages of Personal Indoor Exposure
FOR I = 1 TO 24
  INDOOR(I) = Average((I - 1) * 60 + 1, I * 60, RSP(), 0, OMITOUT)
  TOTALRSP(I) = INDOOR(I) + AMBIENT(I)
NEXT I

TOTMAX = Maximum(24, TOTALRSP())
' set code in PERSONDATA for unexposed person if average exposure is 0 ug/m^3
' exposed people are indicated by a 1
IF AVEEXP > THRESH THEN PERSONDATA.EXPOS = 1 ELSE PERSONDATA.EXPOS = 0

' store demographic info.
PERSONDATA.PID = LASTPID
PERSONDATA.AGE = AGE
PERSONDATA.SEX = RSEX

' save current person 24-hour exposures & maximum exp. to file

OpenFile POPFILE$, 2, 3 'open file #2 for append
O$ = " #### ##### ## # #  ####.##      ####.##         ####.##       ####.##"
PRINT #2, USING O$; PEOPLE%; PERSONDATA.PID; PERSONDATA.AGE; PERSONDATA.SEX; PERSONDATA.EXPOS;
AVEEXP; MAXEXP; AVEAMB; TOTMAX
CLOSE #2

' save tally of number of "exposure hours in each location"
IF TALLYFILE$ <> "" THEN
   OpenFile TALLYFILE$, 2, 3 'open file #2 for append
   O$ = "  ####  ">
   TOT = 0
   PRINT #2, USING O$; PEOPLE%; PERSONDATA.PID;
   FOR I = 1 TO NUMGROUPS
      PRINT #2, USING O$; LOCAT(I).TALLY;
      TOT = TOT + LOCAT(I).TALLY
   NEXT I
   PRINT #2, USING O$; TOT
   END IF
   CLOSE #2

' pause if opted

IF RT4$ = "Yes" THEN
   CALL UpdateScreen("Press Any Key to Start Next Person...")
   SLEEP
END IF

END SUB

SUB UpdateScreen (STATUS$)
,
'** sub program to update to the screen the progress of the calculation
*-------------------------------------------------------------------------
' Update-Screen Codes are as follows:
' Major Task Announcements
'   1 - Read Activity Data for Person; 2 - Read Ambient Data
'   3 - Create 1440-minute Profiles; 4 - Calculate Micro. Exp.
'   5 - Smoker Present in: ?????
'   6 - Saving 24-hour exposures
' Input/Output Status
'   10 - Press any key for profiles
'   11 - Press any key for exp...
'   12 - Press any key for exp...
'   13 - Press any key for hour sum...
'   14 - Printing profiles....
'   15 - Printing exposures....
'   16 - Printing hourly sum...
'   17 - Saving profiles...
'   18 - Saving exposures....
'   19 - Saving hourly sum...
'   20 - Press any key to return to Main Menu...
' Misc.
'   30 - UPDATE LOCATION LEGEND
'   33 - UPDATE ACTIVITY LEGEND
*---------------------------------------------------------------------------
TIMES% = TIMES% + 1
COLOR , 0   'black background
COLR% = 10
S1% = 45   'Status X coord.
S2% = 34   'Status Y coord.
IF CURRENTSMOK% = 1 AND LOCAT(CURRENTLOC%).EXCLUDE <> "X" THEN PlaceText "Smoker Present: " + LOCAT(CURRENTLOC%).NAME + "(" + LOCAT(CURRENTLOC%).METHOD + ")", 1, 6, COLR% IF LOCAT(CURRENTLOC%).METHOD = "MICR" THEN
   IF CURRENTLOC% < 1 OR CURRENTLOC% > 100 THEN CURRENTLOC% = 1
   PlaceNumber LOCAT(CURRENTLOC%).SAMPLE, "#### (ug/m3)", 1, 9, COLR%
   PRINT : PRINT : PRINT : PRINT
ELSE
**Update-Screen Codes are as follows:**

- **Major Task Announcements**
  - 1 - Read Activity Data for Person;
  - 2 - Read Ambient Data
  - 3 - Create 1440-minute Profiles;
  - 4 - Calculate Micro. Exp.
  - 5 - Smoker Present in: ??????
  - 6 - Saving 24-hour exposures
- **Input/Output Status**
  - 11 - Press any key for profiles
  - 12 - Press any key for exp...
  - 13 - Press any key for hour sum...
  - 14 - Printing profiles....
  - 15 - Printing exposures....
  - 16 - Printing hourly sum...
  - 17 - Saving profiles...
  - 18 - Saving exposures...
  - 19 - Saving hourly sum...
  - 20 - Press any key to return to Main Menu...
- **Misc.**
  - 30 - UPDATE LOCATION LEGEND
  - 33 - UPDATE ACTIVITY LEGEND

---

COLOR , 0    'black background
COLR% = 10
S1% = 45      'Status X coord.
S2% = 34      'Status Y coord.

SELECT CASE CODE%
CASE 1 'read person
PlaceLong PID&, "#######", 27, 13, COLR%
PlaceLong RECPERSON&, "#####", 63, 13, COLR%
PlaceInteger PEOPLE%, "#######", 27, 14, COLR%
PlaceLong RECTOTAL&, "#######", 60, 14, COLR%
PlaceNumber DATE, "#####", 55, 15, COLR%
CASE 2 'ambient
PlaceNumber AVEEXP, "#####.", 36, 16, COLR%
PlaceNumber AVEAMB, "#####.", 60, 16, COLR%
CASE 3 'profiles
PlaceText "Creating 1440-minute Profiles", S1%, S2%, Yellow
CASE 4 'calc exposure
PlaceText "Calculating Microenvironmental Exposures", S1%, S2%, Yellow
CASE 5 'Smoker Present:
  IF CURRENTSMOK% = 1 AND LOCAT(CURRENTLOC%).EXCLUDE <> "X" THEN PlaceText "Smoker Present: " + LOCAT(CURRENTLOC%).NAME + ", " + LOCAT(CURRENTLOC%).METHOD + ", " + LOCAT(CURRENTLOC%).EXCLUDE
  IF LOCAT(CURRENTLOC%).METHOD = "MICR" THEN
    IF CURRENTLOC% < 1 OR CURRENTLOC% > 100 THEN CURRENTLOC% = 1
  PlaceNumber LOCAT(CURRENTLOC%).SAMPLE, "##### (ug/m3)", 1, 9, COLR%
  END SELECT
PRINT STATUS$
PRINT : PRINT : PRINT : PRINT
ELSE
    PlaceNumber SCEM.SOURCE, "########", 75, 7, COLR$
    PlaceNumber SCEM.VOLUME, "########", 41, 8, COLR$
    PlaceNumber SCEM.ACH, "###.#", 76, 8, COLR$
    PlaceNumber SCEM.SMRATE, "##.#", 43, 9, COLR$
    PlaceNumber SCEM.AVECONC, "#####.#", 74, 9, COLR$
END IF
CASE 6  'save 24-h exposures
    PlaceText "Saving 24-hour Exposures to File", S1%, S2%, Yellow
    PlaceNumber AVEEXP, "LAST EXPOSURE:  #####.##", 10, 16, COLR$
    PlaceNumber AVEAMB, "LAST AMBIENT:  #####.##", 45, 16, COLR$
CASE 11: PlaceText "Saving Profiles", S1%, S2%, Yellow
CASE 12: PlaceText "Saving Exposures", S1%, S2%, Yellow
CASE 13: PlaceText "Saving Hourly Summary", S1%, S2%, Yellow
CASE 14: PlaceText "Printing Profiles", S1%, S2%, Yellow
CASE 15: PlaceText "Printing Exposures", S1%, S2%, Yellow
CASE 16: PlaceText "Printing Hourly Summary", S1%, S2%, Yellow
CASE 17: PlaceText "Press any key for Profiles...", S1%, S2%, Yellow
CASE 18: PlaceText "Press any key for Exposures...", S1%, S2%, Yellow
CASE 19: PlaceText "Press any key for Hourly Summary...", S1%, S2%, Yellow
CASE 20: PlaceText "Press any key for Main Menu...", S1%, S2%, Yellow
CASE 30: 'location legend
CASE 31: 'activity legend
CASE ELSE
END SELECT
.EXIT SUB
PLACE Text LOCAT(CURRENTLOC%).NAME, 27, 13, COLR$
PLACE Integer CURRENTACT%, "###", 64, 13, COLR$
COLOR 10
SELECT CASE TIMES$
CASE 1: LOCATE 20, 1:
    RepeatCH " ", 80, 0: RepeatCH " ", 80, 0:
    RepeatCH " ", 80, 0: RepeatCH " ", 80, 0:
    COLOR 11: LOCATE 20, 1
CASE 2: COLOR 12: LOCATE 20, 42
CASE 3: COLOR 13: LOCATE 21, 1
CASE 4: COLOR 14: LOCATE 21, 42
CASE 5: COLOR 15: LOCATE 22, 1
CASE 6: COLOR 10: LOCATE 22, 42
CASE 7: COLOR 11: LOCATE 23, 1
CASE 8: COLOR 4: LOCATE 23, 42: TIMES% = 0
CASE ELSE
    COLOR 10: LOCATE 20, 1
END SELECT
PRINT STATUS$
END SUB
SUB WriteDist (VECTOR())
    '' sub program to print out distribution vectors of length N%
    '' vectors must have form VECTOR(2, N%)  
    COLOR Green
    L1$ = "   RANGE          CDF"
    L2$ = "------------------------"
    O$ = "######.####       #.###"
    PRINT L1$: PRINT L2$
    TEST = 0
    I = 0
    DO UNTIL TEST = 99
        I = I + 1
        TEST = VECTOR(1, I)
        IF TEST <> 99 THEN PRINT USING O$; VECTOR(1, I); VECTOR(2, I)
    LOOP
    PRINT : PRINT "Press any key..."
END SUB
SUB WriteHourlySum (RSP(), AMBIENT())
    '' subprogram for printing to the screen the hourly summary of exposures
    COLOR Green
    PRINT "SUMMARY OF AVERAGE HOURLY EXPOSURE (ug/m3)"
    PRINT "         OVER A 24-HOUR PERIOD"
    PRINT
    PRINT "  TIME         INDOOR         AMBIENT"
    PRINT "--------------------------------------"
OS = "##:00  ######  ######"
FOR I = 1 TO 24
  INDOOR = Average((I - 1) * 60 + 1, I * 60, RSP(), 0, OMITOUT)
  IF AMBIENT(I) < 0 THEN AMBIENT(I) = 0
  PRINT USING OS; I; INDOOR; AMBIENT(I)
SELECT CASE (I / 18)
  CASE 1, 2: SLEEP: ANS$ = INKEY$
END SELECT
NEXT I
O2$ = "OVERALL  ######  ######"
PRINT "-----------------------------"
PRINT USING O2$; Average(1, 1440, RSP(), 0, OMITOUT); Average(1, 24, AMBIENT(), 0, OMITOUT)
PRINT "Press any key to continue...": SLEEP
END SUB
SUB WriteProfile (HEADING$, VECTOR%())
  *** sub program to save exposure/activity vector% for one person to file
  COLOR Green
  DIM OUTFIELD AS STRING * 3 'field for numbers
  DIM OUT$   'variable length string for line output
  PRINT "*******************************************
  PRINT HEADING$
  PRINT "Grid of 24 hours vs. 60 minutes per hour"
  PRINT "---|--------------------------------------------------------------------------"
  FOR I = 1 TO 60
    OUT$ = " 
    CALL FillString(I, OUTFIELD, OUT$, 3, 3)
    OUT$ = OUT$ + "=
    FOR J = 1 TO 24
      Value = INT(VECTOR%(I + (J - 1) * 60))
      CALL FillString(Value, OUTFIELD, OUT$, 3, 3)
    NEXT J
    PRINT OUT$
    SELECT CASE (I / 18)
      CASE 1, 2: SLEEP: ANS$ = INKEY$
    END SELECT
  NEXT I
  SLEEP
END SUB
SUB WriteVector (HEADING$, VECTOR())
  *** sub program to save exposure/activity vector for one person to file
  *** currently rounds off values to integers
  COLOR Green
  DIM OUTFIELD AS STRING * 3
  DIM OUT$
  PRINT "Vector grid of 24 hours vs. 60 minutes per hour"
  PRINT "---|-------------------------------------------------------------------------"
  FOR I = 1 TO 60
    OUT$ = " 
    CALL FillString(I, OUTFIELD, OUT$, 3, 3)
    OUT$ = OUT$ + "="
    FOR J = 1 TO 24
      Value = INT(VECTOR(I + (J - 1) * 60))
      CALL FillString(Value, OUTFIELD, OUT$, 3, 3)
    NEXT J
    PRINT OUT$
    SELECT CASE (I / 18)
      CASE 1, 2: SLEEP: ANS$ = INKEY$
    END SELECT
  NEXT I
  SLEEP
END SUB
'------------------------
SUB WriteVectors (LOCATION%, SMOKERS%, INDRSP(), AMBIENT()) STATIC
  PRINT ; PRINT "TIME, LOCATION, SMOKERS, RSP EXPOSURE"
  FOR I = 1 TO 1440
    PRINT I, LOCATION%(I), SMOKERS%(I), INDRSP(I), AMBIENT(I)
    pause% = I / 21
    IF I / 21 - pause% = 0 THEN
      SLEEP: ANS$ = INKEY$
    END IF
  NEXT I
END SUB