

Apex 3.3 Updates

Summary of model changes from version 3.22

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This document does not constitute Agency policy.

APEX 3.30 Updates

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Introduction

The initial public release of TRIM.Expo_{Inhalation} (aka APEX) in May 2003 was APEX version 3.22. In 2004, this was replaced on the EPA web site with version 3.23. And on December 30, 2005, that was replaced on the web site with APEX version 3.30.

The initial public version (APEX3.22) was accompanied on the EPA web site by the “TRIM.Expo_{Inhalation} User’s Guide: Volume I: Air Pollutants Exposure Model (APEX, version 3) User’s Guide (April 24, 2003)”.

This short document describes revisions made to the model since the initial public version (APEX3.22). The revisions are divided into two groups, beginning with those made since the last version (3.23) and followed by a short set of items pertaining to minor revisions made between versions 3.22 and the 3.23.

Overview of Improvements from version 3.2

Several changes improve ease of use and flexibility of output and represent a substantial model enhancement. At this time the following important enhancements to APEX since version 3.2 have been completed: (1) improved audit trail capability via header records; (2) improved population employment data; (3) improved ventilation algorithm; and (4) new output file with detailed time-series information.

(1) Each of the data files and tables that APEX reads and writes can now have header records which identify the content and history of the file. This helps track which model inputs were used to produce an output file.

(2) One of the important inputs to APEX is a database of population employment probabilities. Version 3.2 can handle a set of employment probabilities specified for each age or age group, and these probabilities represent national averages. The new version can handle employment probabilities not only for ages and age groups, but also by gender and by Census tract. A database is provided with APEX3.3 on the web which APEX3.3 reads directly and which has employment probabilities for each age, gender, and Census tract combination.

(3) Improved ventilation algorithm and new input file

(4) A new output file (the EVENTS file) contains the activity data for simulated individuals with accompanying exposure and dose, at the diary event level.

Changes to Input Files

Changes to the PARAMS Input File

The PARAMS file now has additional parameters that may be set. See Table 1.

The keyword ‘agegroups’ is no longer recognized.

The keyword ‘COThresh’ has been changed to ‘AlertThresh’ to be non pollutant specific.

There is now an option not to write out the microenvironment summary file (msum.txt). The keyword “MSumOut” can now be set to YES or NO in the parameters file to indicate whether the microsummary input file should be written.

There is now the capability to write out events for user-specified profiles. The user can now specify a list of profiles in the parameters file using the variable CustomSample. The profile numbers should be entered as a comma-delimited list in ascending order. For example:

CustomSample= 1, 8, 23

The profiles designated by CustomSample are written in addition to the profiles specified by the EventSample variable. If both EventsSample and CustomSample are set, then all the EventsSample events are written as before and any additional CustomSample events are written in the appropriate place in the numerical profile order. Writing of CustomSample events is dictated by the value of the EventsOut variable, so no events will be written if EventsOut=NO, even if a CustomSample is specified. If neither CustomSample nor EventSample is set, then events are written as dictated by the default EventSample value (if EventsOut is YES). If the user wishes to write only the CustomSample events, then EventSample should be set to 0 in the parameters file.

Table 1. Additional parameters in the PARAMS file

Keyword	Default	Purpose
employment file	-	path and name of employment probability input file
ventilation file	-	path and name of VE/VO2 regression parameter input file
sites file	-	path and name of SITES output file
events file	-	path and name of diary events output file
KeepLeavers	No	Yes = keep persons who live in study area but work outside. No = do not keep these persons in the simulation
LeaverMult	0.0	Multiplicative factor for city-wide average concentration, applied when working outside study area (only used if KeepLeavers = yes)
LeaverAdd	0.0	Additive term applied when working outside study area (only used if KeepLeavers = yes).
EventsOut	No	Yes = create the EVENTS output file, No = do not create
EventSample	10	The number of persons to write to the EVENTS file
CustomSample		Provides an option to write out events for user-specified profiles. Otherwise, omit this keyword. The desired profile numbers are listed here, separated by commas. E.g., CustomSample = 1, 8, 23

VAOutput	No	Write VA values to the events output file. If set to No, then the column for VA is set to zero.
		The following are switches for controlling output to the log file.
LogSectors	No	List all home sectors on log
LogDistrict	Yes	List all air districts on log
LogZones	Yes	List all temperature zones on log
LogPopulate	Yes	List population summary data on log
LogProfiles	Yes	List summary line for each profile generated
LogTables	No	Write all tables to log (as well as Tables file)
MSumout	Yes	Provides the user an option to write out the microenvironment summary file (msum.txt)

Input File Header Records

The user may use optional header lines on input files. Such lines are indicated by starting with an exclamation point ‘!’, and are ignored by APEX except to echo them to the LOG output file. In this manner, the user can select key information about the input files to be preserved on the LOG, to help identify certain features of a run. The processing of these header lines is accomplished by a new subroutine called OpenInput, in the Utility Module.

[2) All input files allow optional comment lines as a file header. Such lines must each start with an exclamation point ‘!’. This header may contain any number of lines, and ends when the first line not beginning with ‘!’ is found. All the header lines are copied to the log file, to allow the user to document the data being used for a particular model run. As before, other comment lines may appear further down in the input files, but these will not be echoed to the log file. This is handled in APEX3.3 by calling a new subroutine called ‘OpenInput’ to open files and echo any header lines to the log file.]

Changes to the Microenvironment Descriptions Input File

In previous versions of APEX, the microenvironment name was truncated to 12 characters when it was read into APEX from the microenvironment descriptions file. The MicroName variable has been changed to allow the microenvironment name to be up to 40 characters in length, and the msum output file has been changed accordingly. It should be noted that the microenvironment name still has to be “one word” (contain no spaces). The format is space-delimited. The columns don't have to line up.

New Employment Probabilities Input File

This is a new input file. The employment file contains probabilities of being employed full time, by age, gender, and census tract. This supplants the employment probabilities on the former ‘agegroups’ file. Apart from user comment lines, the employment file requires three header lines of data, indicating the gender, minimum age, and maximum age applying to each column of data.

Below that, each line starts with the sector ID, followed by a vector of probabilities (one per column). A standard, nationwide employment probability file was prepared, listing all the tracts from the 2000 census. Each record (tract) contains 26 probabilities (13 age groups each for males and females).

The employment file is opened on Unit 25.

In APEX versions 3.23 and earlier, the information on the population group age limits appeared on a separate input file called the 'agegroups' file. This file is no longer used by APEX.

Employment Probabilities Input File

4) A new input file containing employment probabilities is required with APEX 3.3. In previous versions the employment probabilities appeared on the agegroups input file. The old version did not allow probabilities to differ by sector or gender, and furthermore, the age groups for employment probability had to match the population age groups.

The new employment file gives separate probabilities for each gender and sector. The employment probability age groups no longer have to match the population file age groups. A single nationwide employment probability file has been prepared using data from the 2000 census. The user could replace this file with their own, if the format is followed. The file contains optional header lines (see 2), followed by three required lines. The first required line reports the gender for each column of data, the second line reports the age group minimum, and the third line reports the age group maximum. An example follows:

```
! This is one of the optional header comment lines
! This is another
Gender=      M      M      M      M      F      F      F      F
MinAge=      16     25     51     71     16     25     51     71
MaxAge=      24     50     70     85     24     50     70     85
01001020100 0.39744 0.94220 0.52258 0.13636 0.58462 0.90909 0.65276 0.15926
01001020200 0.45283 0.76415 0.60588 0.09167 0.44681 0.82731 0.54493 0.28334
...
```

This is not an extract from the actual national employment file, as that file contains too many data columns (26) to display on a page. This example uses four employment age groups for males and another four for females. The first item on each line below the header lines is the sector ID, followed by the eight employment probabilities for that sector. Each probability in the national file is calculated by dividing the number of employed persons by the total sector population for the specified age range and gender. Whenever the total sector population for a particular age range and gender is zero, then obviously the employed persons must also be zero. These 0/0 forms are reported as zero probabilities in the file. It should not matter what values are assigned, since no simulated persons of that type should ever be generated by the model (if the standard nationwide population files are used).

Note that any ages not covered by one the employment age groups will automatically have an employment probability of zero. In the above example, this would apply to persons below age 16 or above age 85.

The employment probability file is indicated on the PARAMS file using the keyword 'Employment file'. The same keyword could optionally be used in version 3.23 for the

agegroups file, which contained the employment probabilities used in that version. Note that the keyword 'agegroups' is no longer recognized by APEX 3.3 as it is now ambiguous. The employment probabilities and the population files may use different age groups, so each file type must report its own age groupings.

The processing of the new employment file is handled by a new subroutine called 'ReadEmployment' in ProfileModule. It is called from the main APEX program after ReadPopulation and before StudyAreaPop.

New Ventilation Input File

This is a new input file for use with ozone and CO assessments. This file contains regression parameters used to estimate total ventilation VE from VO2. This is a small file (5 lines) constructed from a table provided by Stephen Graham of EPA on June 21, 2004. The ventilation file is opened on Unit 26.

!MinAge	MaxAge	b0	seb0	b1	seb1	b2	seb2	b3	seb3	eb	ew	R2
0	19	4.4329	0.0579	1.0864	0.0097	-0.2829	0.0124	0.0513	0.0045	0.0955	0.1117	0.925
20	33	3.5718	0.0792	1.1702	0.0067	0.1138	0.0243	0.045	0.0031	0.1217	0.1296	0.8927
34	60	3.1876	0.1271	1.1224	0.012	0.1762	0.0335	0.0415	0.0095	0.126	0.1152	0.8922
61	100	2.4487	0.3646	1.0437	0.0195	0.2681	0.0834	-0.0298	0.01	0.1064	0.0676	0.8932

"Revised Ventilation Rate (Ve) Equations for Use in Inhalation-Oriented Exposure Models, A NERL Internal Research Report," S.Graham and T. McCurdy, Feb 2005.

Changes to the Population Files

The population files have new requirements in terms of header information, and now include four header records of descriptors. These records must appear immediately after any header comment records (which start with '!') and before any population data. The data on these four records are read starting to the right of the '=' sign, if present. The descriptors to the left of the '=' signs are optional. The contents of these four records must be as follows:

- Descriptor record 1: Gender, Race (5 characters), Number of population groups
- Descriptor record 2: Race description (may contain blanks, up to 250 characters)
- Descriptor record 3: Minimum age for each group
- Descriptor record 4: Maximum age for each group

The fields in descriptor records 1, 3 and 4 are space-delimited.

Gender must be 'Female' 'Male' or 'All'. The 5-character label for race also appears as a column header on the personal data output file. This 5-character race must match the one given on the PARAMS file where this population file is first identified.

The race description is not used, but is copied to the log file for the benefit of the user. Only the shorter 5-character race that is given on the first line is used on the other output files.

The next two records specify the minimum and maximum ages for the age groups. Note that all the population data files must contain the same number of population groups, and furthermore, all the group age limits (minima and maxima) must match as well, or APEX will stop. All the population data are stored internally in a single array, so incompatible definitions for the groups cannot be allowed.

Example of descriptor header records:

```
Gender, Race, #Ages = Female, Asian, 11
Race description = Asian or Pacific Islander
Age group minimum = 0 6 11 16 21 31 41 51 61 71 86
Age group maximum = 5 10 15 20 30 40 50 60 70 85 99
```

This indicates that the population file applies to Asian females, and the data lines contain eleven columns of numbers after the sector ID corresponding to 11 age groups. For example, the second column of data represents the count of Asian females ages 6-10 inclusive for each sector.

Profile Functions Input File

The profile functions input file used to have one function for window position (called WindowPos), but now it needs two functions. These are called WindowCar and WindowRes, for car and residence.

APEX no longer requires functions that are not used (this is the change). The profile functions input file must include a function called DiaryPools, used to assign CHAD diaries to temperature and weekday categories. All other functions are optional, and must be provided only if the microenvironments require the information to calculate concentration. If functions are not provided and not required, then APEX runs, although some variables on the output files (such as GasStove, GasPilot, AC_Home, and AC_Car) will be indicated by 'X' to signify that their status is undetermined.

Age Groups Input File

In APEX versions 3.23 and earlier, the information on the population group age limits appeared on a separate input file called the 'agegroups' file. This file is no longer used by APEX.

Changes to Output Files

All output files now contain a standard header. There is one new output file, the EVENTS file, and a number of changes to the LOG file.

Output File Header Records

All output files now contain the same set of header lines, allowing files generated from the same run to be identified. The header consists of six lines followed by a blank line. The contents are:

- Line 1: APEX version, Date, Time (start of run)
- Line 2: Location (from PARAMS file)
- Line 3: Pollutant (from PARAMS file)
- Line 4: Scenario (from PARAMS file)
- Line 5: Echo first line of PARAMS file
- Line 6: Echo first line of Air District Site file

The Location, Pollutant, and Scenario are whatever descriptions the user chooses to attach to those keywords on the PARAMS file. The very first line of the PARAMS file should echo its name and possibly date and brief purpose. Similarly, the first line of the Air Districts Site file should indicate the source or type of data used for Air Quality. The set of header lines is constructed and written by a new subroutine called OpenOutput, in the Utility Module.

New EVENTS Output File

The EVENTS file contains a summary of the activity diary with accompanying exposure and dose, at the diary event level (no aggregation in time). Its variables include person, date, time, duration, activity, microenvironment, place, METS, VA, VE, exposure, average dose, and instantaneous dose. This file can become very large, averaging about 1.4 MB per person-year. For this reason, the user is given the option of only writing the events for only a fraction of the simulated persons. This is explained below in the section on new parameters on the PARAMS file.

Table 2. Variables in the APEX3.3 events output file

Header	Description
Person	Profile number
Seq	Sequential event number for this profile
Day	Sequential day number for this profile, from start of run
Year,Mn,Dy,Hr	The hour during which this event occurred (year, month, day, hour)
Dur	The duration of this event (integer minutes)
Act	Activity code in the metabolic file CHADMets.txt (5-digit integer or X or U) (1 to 166)
Mic	APEX microenvironment code defined in the microenvironment mapping file (1 to 34)
HW	Place of event (1, 2 or 3 for home, work, or other)
METS	METS (Metabolic equivalents of work) (units)
VA	Alveolar ventilation rate (units) (optional)
VE	Total ventilation rate ($L \text{ min}^{-1}$)
Exposure	The concentration in the microenvironment during the event (units of concentration)
AvDose	Average dose over the event (units depend on pollutant)

EndDose	Instantaneous dose at the end of the event (units depend on pollutant)
---------	--

Example:

Person	Seq	Day	Year	Mn	Dy	Hr	Dur	Act	Mic	HW	METS	VA	VE	Exposure	AvDose	EndDose
1	1	1	1997	1	1	1	60	64	1	1	0.935	0.	2176.	0.867	0.511	0.529
1	2	1	1997	1	1	2	60	64	1	1	0.878	0.	2017.	1.965	0.554	0.579
1	3	1	1997	1	1	3	60	64	1	1	0.920	0.	2342.	2.509	0.605	0.631
1	4	1	1997	1	1	4	60	64	1	1	0.897	0.	2044.	2.257	0.653	0.675
1	5	1	1997	1	1	5	52	64	1	1	0.905	0.	2167.	2.176	0.692	0.708
1	6	1	1997	1	1	5	3	17	1	1	3.305	0.	7358.	2.176	0.708	0.707
1	7	1	1997	1	1	5	1	16	15	3	6.752	0.	16873.	4.780	0.707	0.708

Changes to the LOG File

The LOG file has additional output and many small format changes. There are now a set of six switches in the parameters file that allow the user to print or suppress printing of various information to the log. These switches are:

<u>Switch</u>	<u>Default</u>	<u>Purpose</u>
LogSectors	No	List all home sectors on log
LogDistricts	Yes	List all air districts on log
LogZones	Yes	List all temperature zones on log
LogPopulate	Yes	List population summary data on log
LogProfiles	Yes	List summary line for each profile generated
LogTables	No	Write all tables to log (as well as Tables file)

Note that the tables are written to the TABLES output file even if LogTables = No. Similarly, the information on sectors, districts, and zones is written to the SITES file, regardless of these settings.

Except for the output tables, all information on the Log file is restricted to 90 columns width, to assist in printing the contents of the log on normal pages. At the end of the log, the job execution time is now given in hours as well as in seconds.

There are now more settings for the DebugLevel parameter. Lower settings produce less output to the log. DebugLevel = 0 is the production-mode setting. DebugLevel = 3 with LogProfiles = YES should only be used if there is a problem with the run and it is not going to completion.

Changes to the Log File

5) The log file now reports whether the random seed was set internally using the clock, or whether preset by the user. For example, the line

Seed from clock = No

indicates that the user selected the random number seed. This line appears immediately before the reported value for the seed on the log file.

6) The contents of the LOG file have changed somewhat. First, it now starts with the header line containing the date, time, and scenario. Next, it indicates the opening of the PARAMS file and

echoes any header comment lines on that file. Then comes the listing of files and job parameters as seen before, with two additions. First, the PARAMS file itself is named among the input files. Second, immediately before the reporting of the random number seed, the log file now reports whether the seed came from the clock or was preset by the user (see 5 above). A few other changes occur later in the LOG file, for example, the employment age groups are now listed.

Changes to the Personal Summary File (PSUM)

The Personal Summary file now contains four new variables RMR (the resting metabolic rate) and VEinter, VEslope, VResid (what are these?) (related to the new algorithm for total ventilation rate VE). The variable HemFac (what) is no longer written to this file. The new format is described by:

Record length = 243

There are 8 header records before the data.

The format of the data records can be cryptically described by:

profile HSect WSect HDis WDis Zone DGRP Age Gender \$ 47 Race \$ 54 Empl \$ 60 Stove \$ 66
Pilot \$ 72 ACHom \$ 78 ACCar \$ 84 @91 Height Weight Hemoglob Diffus RMR BloodVol
Endgn1 Endgn2 VEinter VEslope VResid NumEvents AvgExp AvgDose MaxExp MaxDose

Changes to the Microenvironment Summary File (MSUM)

Column widths in msum.txt are wider, so that they are separated by spaces. The field widths for the Minutes, MeanConc, and MaxConc are now all set to 14 columns, which should be sufficient. Also, the ME name can now be up to 40 characters. The file format is now:

```
WRITE(MSumU, '(I9,I6,3X,A40,I14,2F14.4)') P,I,MicroName(I),  
MSum(I)%Minutes, MSum(I)%MeanConc, MSum(I)%MaxConc
```

New And Updated Algorithms

New Algorithm For Total Ventilation Rate VE – used for ozone and CO assessments

In APEX, the resting metabolic rate RMR is expressed in units of kcal/min. The energy conversion factor ECF is in units of liters-O₂ / kcal. The product of the two terms gives the basal rate of oxygen consumption

$$VO_{2rest} \text{ (liter-O}_2 \text{ / min)} = \text{RMR} \times \text{ECF}$$

For non-rest activities, the ratio of energy consumption to the resting rate is given by METS. This is also taken to be the ratio of oxygen consumption. Dividing by body mass, one obtains

$$VO_2 / \text{BM} = \text{RMR} \times \text{ECF} \times \text{METS} / \text{BM}$$

The new equation for VE is a log-log regression equation:

$$\log (VE/BM) = b_0 + b_1 * \log (VO_2 / BM) + b_2 * \log (1+age) + b_3 * gender + eb + ew$$

This is the equation supplied by Stephen Graham of EPA, except that his log (age) term was replaced by log (1+age) to avoid problems for ages < 1.

Data are read from the ventilation input file for b0, b1, b2, b3, eb, and ew. All are distributions that include a random normal component. Gender is a flag with value -1 for males and +1 for females. The (VO₂ / BM) term is given in terms of the APEX variables by the previous equation. This allows the left hand side to be evaluated for each diary event. Note that b0, b1, b2, b3, eb, age, gender, RMR, ECF, and BM are assumed to be constant over time for a given simulated person, whereas METS and ew vary from event to event.

EPOC METS corrections

Implemented the EPOC (Excess Post-Exercise Oxygen Consumption) corrections to the METS values. There are no changes to input or output file formats resulting from this modification.

Commuting Outside of Study Area

1) APEX allows for some flexibility in the treatment of persons in the modeled population who commute to destinations outside the study area. By specifying “KeepLeavers = No” in the simulation control parameters file, people who live in the study area but work outside of it are not modeled. By specifying “KeepLeavers = Yes,” these commuters are modeled. This triggers the use of two additional parameters, called LeaverMult and LeaverAdd. While a commuter is at work, if the workplace is outside the study area, then the ambient concentration is assumed to be related to the average concentration over all air districts at the same point in time, and is calculated as:

$$\text{Ambient Concentration} = \text{LeaverMult} \times \text{avg}(t) + \text{LeaverAdd}$$

where:

<i>Ambient Concentration</i>	=	Calculated ambient air concentrations for locations outside of the study area (ppm or ppm)
<i>LeaverMult</i>	=	Multiplicative factor for city-wide average concentration, applied when working outside study area
<i>avg(t)</i>	=	Average ambient air concentration over all air districts in study area, for time <i>t</i> (ppm or ppm)
<i>LeaverAdd</i>	=	Additive term applied when working outside study area

If the needs of an assessment dictate that exposures occurring outside of the study area be zero, this could be accomplished by setting both the LeaverMult and LeaverAdd variables to zero.

Personal Profile Variables Updates

5) The following personal profile variables allow the user to set the number of levels:

<u>Variable</u>	<u>Purpose</u>
AC_Home	Has home AC?
AC_Car	Has AC in car?
WindowRes	Position of windows at home
WindowCar	Position of car windows
MaxTempCat	Number of categories for daily maximum temperature
AvgTempCat	Number of categories for daily average temperature
SpeedCat	Number of categories for average vehicle speed

The first two of these variables are set once per person, the others are set once per day. The parameters used to define the microenvironmental concentrations may depend on these variables. For example, the air exchange rate distribution may depend on the settings for AC_Home and WindowRes. All such dependences are categorical rather than functional. This means that each variable in the above list may only take on integer values (1, 2, ..., N), and a separate distribution must be specified for each value. Thus, if there are 3 settings for AC_Home, and 3 settings for WindowRes, then the user must supply 9 air exchange rate distributions, one for each combination of values of these two parameters (assuming AER depends on both variables).

Other Modifications

Job Completion Codes

Upon job completion, APEX returns a completion code of 0 if the job was successful, or 1 if an internal error occurred that it recognized.

Diagnostic Messages

APEX now counts the number of persons inside the study area who meet all the conditions for inclusion. For example, if one requests only >65 year old persons, and the population file does not have any in the requested sectors, then a message is generated that there are 'No persons within requested age range' and the run stops.

Output Tables

Some of the field widths in the output tables have been increased to make it easier to accommodate large numbers.

Order of Sectors in Input Files

The order of listing sectors on the population, employment, and commuting files must agree with the order on the file listing the sector coordinates.

Changes to the File Unit Numbers

The unit numbers assigned to some of the input and output files have changed. This should have no practical effect unless a screen message prompts the user for a particular unit number. Under the new system, input files have unit numbers 10-29, with the PARAMS file as unit 10. The output files have numbers in the range 30-39, starting with the LOG file (unit 30).

Changes To Internal Model Restrictions and Array Limits

Practical experience with APEX 3.23 revealed certain limitations on inputs. The two main types were restrictions on character/numeric data types, especially for site names, and upper bounds on certain array sizes. One restriction that has been removed is that the sector ID no longer must start with a numeric field, and the district names must no longer be character, so it is possible to have districts and sectors share the same names.

The following internal array limits have been changed:

<u>Type</u>	<u>Old Limit</u>	<u>New limit</u>
districts	1000	no limit
sectors	70000	no limit
zones	1000	no limit
counties	1000	4000
destinations/home	1000	2000

The limits on districts, sectors, and zones were removed by a full revision of the logic for reading and processing the site lists. The old method used subroutine SelectSites, which is now replaced by two subroutines, ReadSiteLists and MatchSites. ReadSiteLists actually reads each site file twice, the first time only to count items and the second time to store the data. MatchSites is more sophisticated than before in ensuring that every sector is within range of both an air district and a temperature zone, or else the sector is deleted from the study area. Previously, only sector-district distances were checked.

The list of counties is the list provided by the user for inclusion in the study area. It is rare that such a list would exceed 20 counties or so. The destinations/home array contains the list of work sectors (destinations) to which commuters may go from each home tract. The number shown above is the limit on the overall ratio of the number of home-work pairs to the number of home sectors. Thus, if there are 5000 home sectors then the destinations array holds room for $5000 \times 2000 =$ ten million home-work pairs. Note that some of the destinations may be outside the study area, but still require array space. While a ratio of 1000 was always sufficient when the sectors are census tracts, APEX can be run using smaller areas (such as blocks) as sectors. In that case, there are more possible destinations than are found in the national commuting database (which refers only to census tracts).

Two internal limits that were NOT changed are 8192 diaries per diary pool, and 1,048,576 diary activity events for the entire diary database.

Age Limits

Age may exceed 100 on the population input files and in the personal summary file. The physiology routines limit age to a maximum of 99, so any simulated person above age 99 uses the same functions to determine all physiological properties (like height, weight, surface area, blood volume, resting metabolic rate, etc.) as a 99 year old.

Window Position Profile Functions

The profile functions input file used to have one function for window position (called WindowPos), but now it needs two functions. These are called WindowCar and WindowRes, for car and residence. These functions must be defined even if the user does not want to use them, otherwise APEX fails.

CHANGES IN APEX3.23 FROM APEX3.22

- 1) The bug in the RMean function has been fixed. This occurred when the user specified a MASSBAL micro with a concentration source that did not use the default value for RMean.
- 2) The log file and the msum output file now include the microenvironment names as well as their numbers.
- 3) The record length on the population input files has been extended to permit more age groups to be processed.
- 4) Earlier versions of APEX limited the maximum age to 99. This has been eliminated, so persons of higher ages can be modeled. However, it is assumed that the physiology data for 100 year old persons also applies to anyone over age 100.
- 5) If APEX generates an error that it recognizes, then it returns a completion code of one. This may be used by the operating system.
- 6) The gender and race specification has been improved. Now, any number of races are permitted, although just the first five characters are echoed to the psum output file.
- 7) If the user sets the main random number seed to zero, APEX uses the clock to select the seed. This is the standard mode of operation for generating random profiles. The seed value returned by the clock is reported near the top of the log file. This seed can be entered for a subsequent model run if the user wishes to regenerate the same data again.
- 8) The height function for children has been altered. It uses the following regressions for children. Height is in inches and age in years. 'Z' is a unit normal distribution (mean=0, standard deviation=1).

Age0-5, Male height = 30.4 + 2.77 * age + 1.76 * Z
Age0-5, Female height = 29.6 + 2.94 * age + 1.91 * Z

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Age6-11, Male height = $33.9 + 2.21 * \text{age} + 2.53 * Z$

Age6-11,Female height = $31.5 + 2.49 * \text{age} + 2.50 * Z$

Age12-17, Male height = $41.0 + 1.74 * \text{age} + 3.20 * Z$

Age12-17, Female height = $55.2 + 0.56 * \text{age} + 2.59 * Z$