IVE Model Users Manual
Version 2.0
May, 2008

IVE Model

Disclaimer

This Complete User's Guide describes the assumptions, options, and limitations of the IVE model, version 2.0. It is recommended that the user read and understand this manual before using results of the model for any purpose. Any questions about the user's guide or model may be directed to: **ive_feedback@issrc.org**. This document and model may be found online at **www.issrc.org/ive**.

Table of Contents

Preface

Emissions from vehicles in most countries, particularly developing countries, are not well understood, and the ability to make accurate future emissions estimates does not presently exist. This has limited the ability of decision-makers to design effective control strategies. The International Vehicle Emissions (IVE) model, funded by the US Environmental Protection Agency, Office of International Affairs, is specifically designed to have the flexibility needed by developing nations in their efforts to address mobile source air emissions. IVE functions as a tool to help cities and regions develop emissions estimates to:

- Focus control strategies and transportation planning on those that are most effective;
- Predict how different strategies will affect local emissions; and
- Measure progress in reducing emissions over time.

There are three critical components necessary to develop accurate mobile source emissions inventories: 1) vehicle emission rates; 2) vehicle activity; and 3) vehicle fleet distribution. The IVE model is designed to use appropriate existing information and easily collectable local data to quantify these three essential inputs. Once this information is collected, appropriate mobile source inventories can be easily developed.

This manual is designed to help the model user achieve the best possible results. There are also four separate attachments to this main document to help the user to better understand the process of estimating vehicle emissions.

Revisions to this version of the Model (2.0)

Software:
- Spanish, French, Chinese & Russian language versions added.
- Fixed fleet / base adjustments sort buttons to work in both directions.
- Created Preference file to remember all settings when exiting.
- Search all sub-folders of the data folder for data files.
- Added tabs to distance/startup results and units in output file.
- Changed User technology name descriptions.
- Updated to make conducive with Mac version.

Data:
- Updated Base Emission factors: motorcycles, EU standards based on COPERT IV, using some EMFAC2007 EFs, and corrected all CO2 starting emission factors, SPFI 3 way catalyst vehicle emission rates. Revised HC, CO, and NOx base emission rates for starts for carbureted and SPFI to be equivalent to MPFI start emission rate data. This is not compatible with MOBILE 6 data but it is compatible with EMFAC and measured data in Mexico and Sao Paulo. This correction was applied to all gasoline, natural gas, ethanol, propane fueled vehicles (except small engines).
- Updated driving pattern adjustments.
- Updated VOC and CH4 emission rates for Natural gas fueled vehicles to be consistent with MOBILE 6 documentation.
- Lead in Fuel Adjustments: Added a lead adjustment for acetaldehyde, formaldehyde, and 1,3 Butadyene, Benzene. And added alternate driving bin mapping for leaded fuel.

I. Getting Started

A. INTRODUCTION

The International Vehicle Emissions (IVE) model is a computer model designed to estimate emissions from motor vehicles. Its prime purpose is for use in developing countries. The model predicts local air pollutants, greenhouse gas emissions, and toxic pollutants. The IVE model has been developed as a joint effort of the University of California at Riverside, College of Engineering – Center for Environmental Research and Technology (CE-CERT), Global Sustainable Systems Research (GSSR), and the International Sustainable Systems Research Center (ISSRC). Funding for model development was provided by the U.S. Environmental Protection Agency.

The IVE model can be downloaded and run with the help of this User's Manual, located at www.issrc.org/ive. The model requires two input files that describe the vehicle fleet and vehicle activity (i.e. driving behavior) for the location of interest. A third optional input file is used if the location of interest has site specific emission rate information. The fleet and activity information may already exist or may need to be collected. Information from over ten international locations have already been collected and formatted for use in the IVE model. Supplemental information for these cities, as well as information from new locations continues to be collected. These files can be downloaded from the web site and the data from a similar location can be used as an interim approach to making emissions estimates if a region does not have its own data.

B. SETTING UP YOUR COMPUTER

The IVE Model is written in Java and as such will require the Java Virtual Machine from Sun Microsystems to be installed on your computer. If you do not know if Java is already on your machine, you can try and run the model first (section I.C below). It takes about 20 seconds to start up. If it does not start, you will need to download and install the Java Virtual Machine. It can be downloaded for free from http://www.java.com/en/download/manual.jsp.

The model window is 830 x 722 pixels and should be viewed with a monitor with a resolution of at least 1024 x 768.

When you are ready to download the model and other files, all data for the IVE model is located at the website (www.issrc.org/ive). From the home page, you can click on the Software Download Tab or the Data Download Tab. You will find the following to download from each of these pages (Table I.1). You will probably want to download some data files so you may become familiar with using existing files with the model before creating your own.

1

Table I.1. Website Location of the IVE model and files

IVE home page	Software Download	Data Download
www.issrc.org/ive	http://www.issrc.org/ive/downloadmodel.html	http://www.issrc.org/ive/downloaddata.html
Description of the Model	http://www.java.com/en/download/manual.jsp (free program required to run the model)	Available Location and Fleet Files
Reports Related to the Model	IVE model	Location and Fleet File Templates

When downloaded, the model is a singe compressed file (.zip or equivalent). Upon decompressing, a single main folder will be created containing an exe file (IVE Model 2.0.exe), a zip file (IVECode.zip), and a data folder (IVE data) (Figure I.1). This main folder may be placed anywhere on a computer, but the contents must all be left inside the folder with the ".exe" file. To run the model, simply double click the exe file (IVE Model 2.0.exe). Be aware that when clicked, the Java Virtual Machine must start before the model. As a result, up to thirty seconds can pass after clicking the ".exe" file without anything appearing to happen. **All IVE data files that have been downloaded from the website or created should be placed in the <u>IVE data</u> folder**. The zip file (IVECode.zip) contains most components of the model and should be left undisturbed.
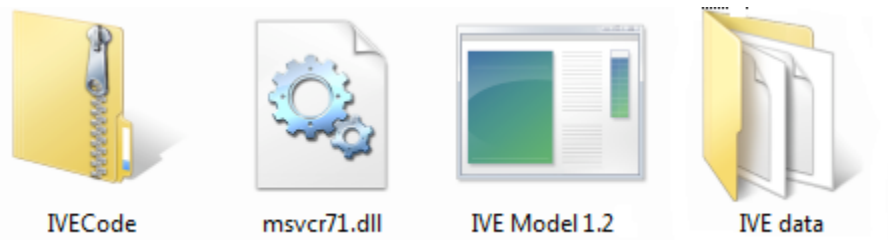

Figure I.1 Items in the IVE Model 2.0 Folder after Unzipping

C. QUICK START GUIDE

Step 1. Download Model
   a) Visit http://www.issrc.org/ive/downloadmodel.html (You may have to register if it is your first use)
   b) Click on the down arrow and save the file to the directory of your choice (for example C:\IVE model)

Step 2. Download Data
   a) Visit http://www.issrc.org/ive/downloaddata.html
   b) Scroll to the files you'd like to download. We will do all Pune files (Pune.zip) for this example.
   c) Click on the down arrow and save the file to the directory where the model is located and put in the IVE data folder (For example C:\IVEmodel2.0\IVE data). Unzip if necessary. All files must be placed directly in the IVE data folder before starting the model. The contents of folders placed in the IVE data folder will not be read and files placed into the IVE data folder after the model is started will not be read until the model has been restarted.

Step 3. Run Model
   a) Double click on IVE Model 2.0.exe in the C:\IVE model folder. If model does not open up in 20 seconds, see section I.B of this user's manual to learn how to install Java Virtual machine onto your computer.
   b) If you would like to use a model in an alternate language, select the language of choice from the 'Language' tab on the top left of the screen.
   c) There are four tabs on the top of the model page: Calculation, Location, Fleet, and Base Adjustments. You run the model from the Calculation Page. Before running the model, you must select a Fleet file and Location file. The available Location files are listed in the 'Available Locations' box on the right hand side. In parentheses is the fleet file that is currently assigned to that location. Scroll down in the section and click on desired file to model (for example Pune General (Pune, India: Overall 2003)). Then Click 'Add'.
   d) If there are no location files in the scroll down file, you will need to create one under the Location Tab, under 'File: New' or by downloading some from the IVE website and putting them in the IVE data folder (you will have to reopen the model for the model to see the files). Repeat for creating a Fleet File in the 'Fleet' Tab. If there is no fleet file in parentheses next to the location name, you will need to assign a fleet file to that location (Figure I.2). Under the 'Location' tab, select the location desired and then select a fleet file.
   e) You can view/change the files you just loaded by clicking on the 'Location' tab or the 'Fleet' tab. Change any data you wish by selecting the box you wish to edit and typing in new data.
   f) When you are ready to run your file, go back to the 'Calculation' tab.
   g) Click 'Calculate one hour' or 'Calculate one Day'. *Note the hour 0 and the all day share the same slot, therefore it is labeled '0:00/all day'.*

h) The results are displayed on the screen. To export results, click on 'File' and then 'export results'. The exported results can be opened in Excel or other software.

Figure I.2 Assigning a Fleet File to a Specific Location

.

For other options and details about using the IVE model, please refer to subsequent sections of this user's guide.

D. OVERVIEW OF THE MODEL

When you open the IVE model, the first page you will see is the calculation page. Figure I.3 shows a picture of the Calculation Page and the basic components and actions performed from this page. The calculation page displays the fleet and location file currently being analyzed, and the emission results of the current model run. From the calculation page, you can:

- Select a Language (English (default), Spanish, Chinese, or Russian)
- Select a Location File (and assigned Fleet File shown in parenthesis) to analyze
- Select the hour of the day or whole day to analyze
- Select the units of emissions output
- View and export the emissions results as desired

4

Figure I.3. Main (Calculation) Page of the IVE model
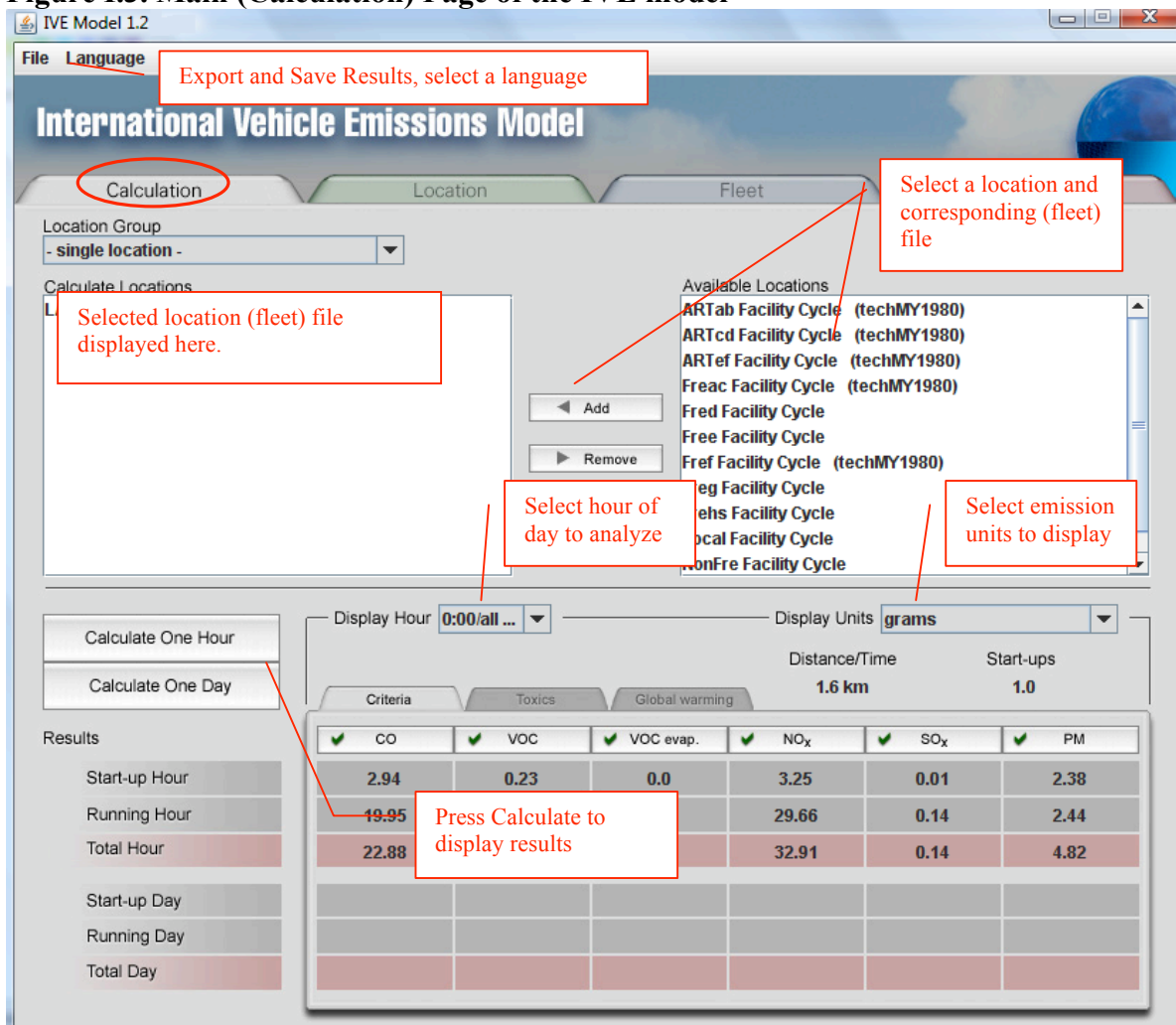
The Location Page (Figure I.4) displays all the information contained in the selected Location file. In the Location page, you can:

- Select a Location File and assign a corresponding Fleet and Base Adjustment File
- Create, View, Change and Save Location File Options (ambient conditions, fuel characteristics, and driving characteristics)

Figure I.4. Location Page of the IVE model

The Fleet page (Figure I.5) displays the technology distribution of the selected fleet. From the Fleet page, you can:

- Select a Fleet File
- Create, View, Change and Save the vehicle technology distribution of a fleet file

Figure I.5. Fleet Page of the IVE model

E.   MODEL RELEASE AND UPDATE PROCESS

The first version of the IVE model was first released in the Summer of 2003 (IVE 1.0.3). This version, 2.0 is released July 2008. The changes from the previous version can be found at the beginning of this document. To date, the IVE model has been used in China, India, South America and Africa. Data has been collected for the location and fleet input data from 11 specific locations, and this data can be downloaded from the website (Table I.2). Improvements and updates to IVE are continuous as new data is incorporated and new features are added to the model. There is an email notification list that informs users when an update to the model or new data has been posted. When you download the IVE model, you will be asked if you would like to be included on this email list. If you would like to be included to this email list without downloading the model, please send an email to ive_feedback@issrc.org.

Table I.2 IVE Fleet, Location, and/or Base Adjustment Factor Files from Cities Measured as of January 2008

City	Country	Available for download
Sao Paulo	Brazil	Now Available
Santiago	Chile	Now Available
Beijing	China	Now Available
Shanghai	China	Now Available
Pune	India	Now Available
Almaty	Kazakhstan	Now Available
Nairobi	Kenya	Now Available
Mexico City	Mexico	Now Available
Lima	Peru	Now Available
Los Angeles	United States	Now Available
Fleet files for standard cycles (i.e. FTP, EU cycles)	------	Now Available
Istanbul	Turkey	Coming in 2008
Bogota	Colombia	Coming in 2008
X'ian	China	Coming in 2008

II. Model Architecture

A. OVERVIEW

Figure II.1 illustrates the process of estimating emissions in the IVE model. The basis of the emission prediction process of the IVE model begins with a base emission rate and a series of correction factors are applied to estimate the amount of pollution from a variety of vehicle types. There are three critical components that are used in the IVE model to create accurate emissions inventories:

1) Vehicle emission rates (Base Emission Factor and Correction Factors);
2) Vehicle activity (Location Input Data shown in Yellow Box); and
3) Vehicle fleet distribution (Fleet Input Data shown in Yellow Box).

Figure II.1 Model Core Architecture
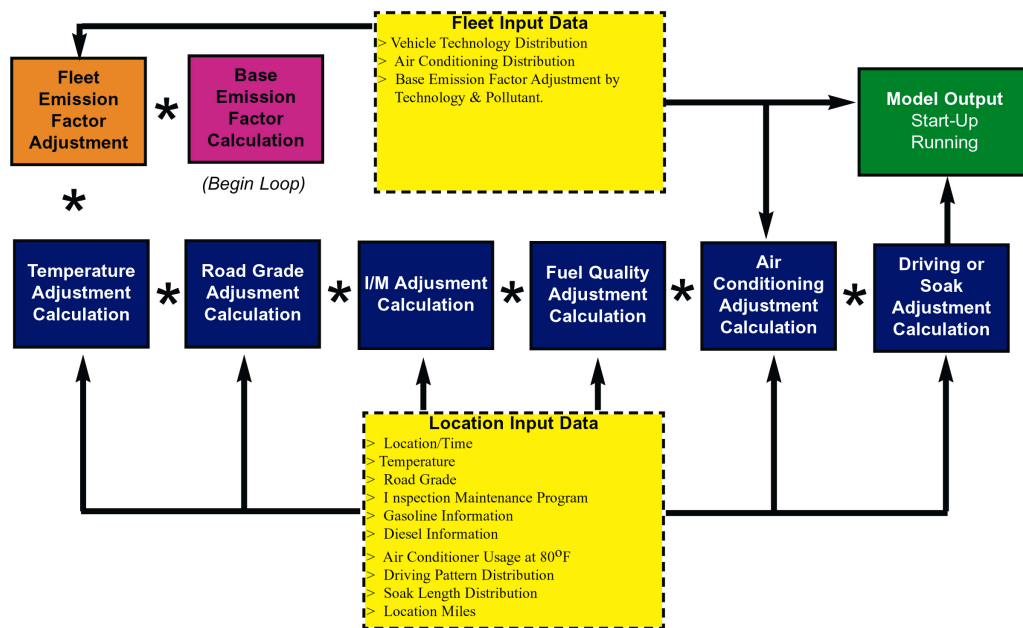
The IVE model is designed to use existing and new vehicle emission rates and easily collectable local data to quantify these three essential inputs. Once this information is collected, appropriate mobile source inventories can be easily developed and modified for alternative scenario evaluations. In cases where some data is missing, data from comparable urban areas may be used to make estimates until local data can be collected.

B. CALCULATION PROCESS

The emission estimation process in the IVE model is to multiply the Base emission rate for each technology by each of the correction factors, which are defined for each vehicle technology, and the amount of vehicle travel for each technology to arrive at a total amount of emissions produced. The calculation process internal to the model is shown in Equation 1 for estimating the adjusted emission rate. Equation II.1 multiplies the base emission rate (B) with a series of correction factors (K) to estimate the adjusted emission

9

rate (Q) from each vehicle type. *(Note: The driving correction factor is not used in Equation II.1. It is introduced in Equation II.2.)* The correction factors can be categorized into several categories (Table II.1). The value of each of these correction factors is dependent upon the entries selected in the **Location File** in the model.

$$Q_{[t]} = B_{[t]} * K_{(1)[t]} * K_{(2)[t]} * \ldots . K_{(x)[t]}$$ **(Eq. II.1)**

Table II.1. Correction Factors for Location Specific Information in the IVE Model

Local Variables	Fuel Quality Variables $K_{(Fuel)[t]}$	Power & Driving Variables $K_{[dt]}$
Ambient Temperature $K_{(Tmp)[t]}$	Gasoline Overall	Vehicle Specific Power*
Ambient Humidity $K_{(Hmd)[t]}$	Gasoline Sulfur	Road Grade
Altitude $K_{(Alt)[t]}$	Gasoline Lead	Air Conditioning Usage
Inspection/Maintenance Programs $K_{(IM)[t]}$	Gasoline Benzene	Start Distribution
Base Emission Adjustment $K_{(Cntry)[t]}$	Gasoline Oxygenate	
	Diesel Overall	
	Diesel Sulfur	

There are two types of base emission rates, one for running emissions and one for start emissions. Equation II.2 weights the adjusted emission rate by the travel fraction and type of driving for each technology. The travel fraction is information obtained from the **Fleet File** in the model. For running emissions, the travel fraction ($f_{[dt]}$) is given in percent time spent at each VSP condition. Therefore, to be properly weighted, the base emission rate $Q_{[t]}$ must be converted from grams/km to grams/time by multiplying by the average velocity of the ftp cycle ($\bar{U}_{FTP}$) before the fraction of time in each driving bin can be applied ($f_{[dt]}$). After this calculation, the grams/time value can be converted back to grams/distance by dividing by the average velocity of the cycle being evaluated ($\bar{U}_C$). The result is the average running emissions in g/km for the fleet and driving patterns being analyzed ($Q_{running}$). For starts, the emissions do not need to be converted into grams/time because the units are always grams/start. To get the overall emissions, simply multiply by the total distance traveled and the total number of starts.

$$Q_{running} = \Sigma_t \{ f_{[t]} * \Sigma_d [Q_{[t]} * \bar{U}_{FTP} * f_{[dt]} * K_{[dt]}] \} / \bar{U}_C$$ **(Eq. II.2)**

$$Q_{start} = \Sigma_t \{ f_{[t]} * Q_{[t]} * \Sigma_d [f_{[dt]} * K_{[dt]}] \}$$ **(Eq. II.2)**

Table II.2. Description of Variables found in the IVE Emission Rate Equations

Variable	Description
$B_{[t]}$	Base emission rate in for each technology (start (g/start) or running (g/km))
$Q_{[t]}$	Adjusted emission rate for each technology (start (g/start) or running (g/km))
$f_{[t]}$	Fraction of travel by a specific technology
$f_{[dt]}$	Fraction of time of each type of driving or fraction of soaks by a specific technology
$\bar{U}_{FTP}$	average velocity of the LA4 driving cycle (a constant (kph))
$\bar{U}_C$	Average velocity from the specific driving cycle, as input by user in Location File (kph)

Additional information on the calculation process internal to the model, correction factors, and technologies available may be found in Attachment A associated with this manual.

III. Calculating Emissions Using the Model

A. <u>OVERVIEW</u>

The Calculation Page is the first page that is seen when opening the IVE model. The Calculation Page can also be reached at any time by clicking on the 'Calculation' Tab (see circle 1 in Figure III.1). Once in the 'Calculation' Page, locations to calculate can be selected and emissions estimated for the selected location. In order to perform a calculation, the user must select a location (from the area indicated by circle 5, press the add button (circle 4), and then the location will be displayed in the selected location list (circle 3). After selecting options and units for output (circles 7 and 8) click on the calculate button (circle 6) and the results will be displayed in the results section (circles 13 and 14). Finally, the File tab (see circle 15 at the top of Figure III.1) allows users to export the results to a text file if desired. The next section describes each option in detail.

B. <u>OPTIONS</u>

Each button, window, and options are described below in detail.

Figure III.1 Details of the Calculation Page
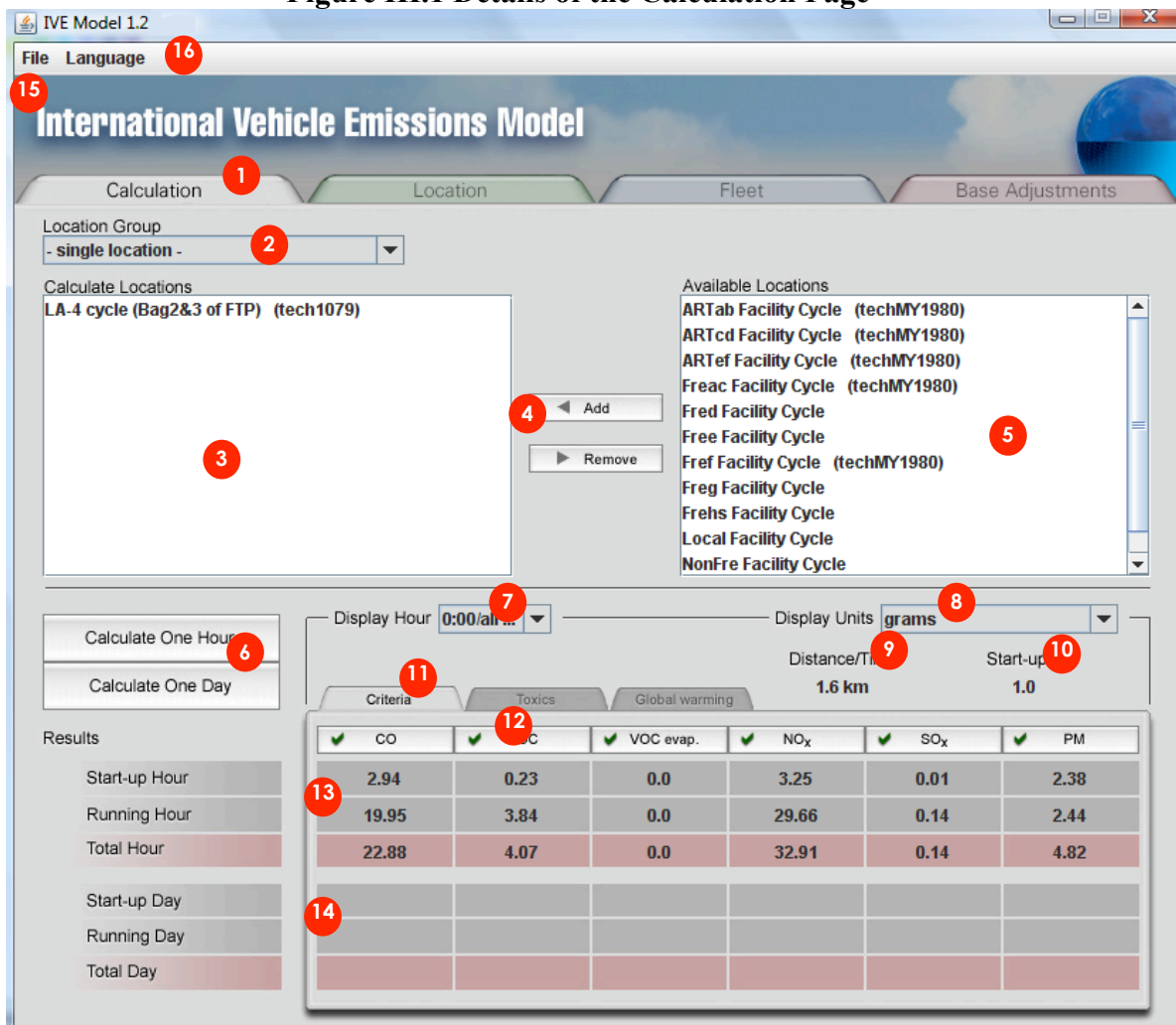
① When the **Calculation Tab** is pressed, the Calculation Page will be opened (displayed in Figure III.1). From the Calculation Page, the user may select files to calculate, view results and export emission files.

② **Location Group Drop Down Menu** contains the name of the current location group. If there is no group selected, the default location "- single location -" is displayed which allows the user to select only one location at a time. The group location allows a region or area of multiple locations to be estimated in one calculation. For example, a user may have a Location File for three adjacent cities that make up a region. The region group location would contain these three city locations. Another use of grouping locations is when the user has collected information on specific road types in a region. For example, if there is a Location File for the residential roadways in a city, one for arterial roadways, and one for freeways, the user could create a group location for the entire city that contains each of these specific roadway locations. Alternatively, a user may want to combine information from all cities or roadways into a single Location File for the area,

and not use the grouped locations. Additional information on how to create a Location Group File is shown in the instructions for the File Tab (circle 15).

③ Calculate Locations List displays the Location File(s) or Location Groups to be calculated.

④ Add Button adds all highlighted locations in the Available Locations List to the Selected Locations List (item 3). If the Location Group is "-single location-", only one location will be allowed at any time.

Remove Button removes all highlighted locations from the Location Group displayed in the Calculate Locations List. The removed files will be placed back into the Available Locations List.

⑤ Available Locations List contains all locations in the model that are available to be added to the displayed group. [New locations can be added by placing appropriately formatted text files in the IVE Data folder. This process is discussed in Chapter IV.] The first name is the actual Location File and the value in parenthesis is the Fleet File that is paired with that Location File. For example, in Figure III.1, the top Location File listed is "Pune ART" and the fleet paired with this Location File is "Pune, India: Arterial 2003". The second Location File "Pune India General" does not have a Fleet File selected with it and the user would need to edit the Location File by adding a fleet file before a calculation can be performed. If the user would like a different Fleet File to be paired with a specific location, the user will need to edit this on the Location Page discussed in Chapter IV.

Locations selected in the Available Locations List are moved to the Calculate Location List (circle 3) by pressing the Add Button (circle 4). Once a location is moved to the Calculate Locations List, it will no longer be displayed in the Available Locations List. To highlight a location in the Available Location List, click on the desired location. To highlight several consecutive locations, click on the first desired location, then hold down the 'shift' key while clicking on the last desired location. To highlight several nonconsecutive locations, click on one location, then hold down the 'ctrl' key while clicking on each subsequent location.

⑥ Calculate One Hour will calculate then add all current locations that are displayed in the Calculate Locations List (circle 3) and display them in the Hourly Results section (circle 13). The hour that will be estimated is displayed in the Display Hour Drop Down Menu (circle 7). If the hour selected is hour '0:00' but represents an entire day, an entire day will be displayed in the hourly results section. If the selected location file has no information for the hour of the day that is calculated, the results will be shown as zeros.

Calculate One Day will calculate the current locations that are displayed in the Calculate Locations List (circle 3) and display them in the Daily Results Section (circle 14). The Display Hour (circle 7) has no impact on a daily calculation. The daily results will add all of the hourly information contained in the location file together. If the location file has only one hour of information, the daily results will display that hour. If

the location file has 12 hours of information, the daily results will display the sum of the 12 hours.

7 **Display Hour Drop Down Menu** will allow selection of any hour of the day or an 'all day' selection. Often, the hour '0:00' is used for data that is intended to be for all day, instead of just the hour '0:00'. The options range from '0:00' (midnight to 1 am) through '23:00' (11 pm to 12 am). Note that if the location file does not contain hourly information for a specific hour, hourly results will be displayed as zeros.

8 **Display Units Drop Down Menu** will allow selection of the units of mass to display in the results section and to export. The options include milligrams, grams, kilograms, metric tons, pounds, and English tons.

9 **Distance/Time** displays the distance of travel (with corresponding units) that is specified in the location file. Alternatively, if an amount of time traveled was entered in the Location File for the current scenario, the time and units will be displayed. The calculated results will be the mass emissions for the displayed distance or time. For example, if the mass display units selected were grams, and the distance specified in the location file was 1 mile, the calculated results would be grams of pollutant per mile traveled. If the mass emission units selected were metric tons, and the Location File specified 12 hours of travel, the results displayed would represent tons of emissions per 12 hours of travel. If the user wishes to alter the total distance traveled, it will need to be done on the Location Page (Chapter IV).

10 **Start-ups** display the quantity of start-ups occurring during the period of calculation. This value is copied from the number of startups that is entered in the Location File. If there was 1 start up entered in the Location File for the specified scenario, then the results would be displayed in grams of pollutant per start. If the user wishes to alter the total number of start-ups, it will need to be done on the Location Page (Chapter IV).

11 **Emissions Display Tabs** allow the users to select the type of emissions to display. Simply click on the desired tab to display that category of emission results. There are a total of 3 emissions tabs which display a total of 15 pollutants:

- Criteria Pollutants: Carbon Monoxide (CO), volatile organic compounds (VOC), evaporative emissions of volatile organic compounds (VOC evap), oxides of nitrogen (NOx), oxides of sulfur (SOx), Particulate Matter less than 10 microns (PM)

- Toxic Pollutants: Lead, 1,3-Butadiene, Acetaldehyde, Formaldehyde, Ammonia (NH3), and Benzene

- Global Warming Pollutants: Carbon Dioxide (CO2), Nitrous oxide (N20) and Methane (CH4)

12 **Emissions Tabs** label the pollutant to which their respective column's data refer. When clicked, these tabs toggle between the default state of performing the calculation for the given pollutant (signified by a green check) and not performing the calculation for the given pollutant (signified by a red 'x'). The ability to turn off the calculation for a given set of pollutants is generally unnecessary but can be useful to shorten the calculation time when very large calculations are being performed on slower computers.

13 **Hourly Results** displays the results of the selected hour when item 6 'Calculate One Hour' is clicked. If a daily calculation was performed using hour 0:00, the hourly results will in reality be daily results. The top row displays running emissions, the second row displays starting emissions, and the last row is the sum of running and start emissions.

14 **Daily Results** displays the results of a 24-hour period when circle 6 'Calculate One Day' is clicked. The daily results will sum up every hour in the Location File. If only hour 2:00 and 5:00 were filled in the Location File, the daily results would display the sum of hours 2 and 5. If only a single hour was filled in the Location File, for example hour 0:00, the hourly values for hour 0:00 and the daily values will be equivalent. The hourly selection (circle 7) does not pertain to the daily calculation. Because the results of the daily calculation are dependent upon the proper information (all hours filled in) in the Location File, caution must be used to ensure the daily results are accurate.

15 The **File tab**, when selected allows for the following options:

- **About**: Contains the version and copyright information.
- **New**: Allows the user to create a new group of individual Location Files. Once you create a group, simply add the desired Location Files to the group and then save.
- **Rename**: When multiple locations have been selected, this function allows the user to rename the existing Location Group.
- **Save**: Allows the user to save the current Location Group.
- **Delete**: Allows the user to delete the current Location Group.
- **Export Results**: Allows the user to export the current calculation to a tab-delimited file that may be opened in a spreadsheet or other application. The results are automatically named the same name as the Location File if the calculation is for a single file, or the Location Group if the calculation is for multiple locations. The file is saved in the same location that the IVE model is located in a subdirectory called 'exports'. Table III.1 demonstrates the format of the exported Calculation File.

16 The **Language** tab, when selected allows for the following options:

- **English:** Displays the model in English.
- **Spanish (Español):** Displays the model in Spanish.
- **French (Francais):** Displays the model in French
- **Chinese (英文):** Displays the model in Chinese.
- **Russian (Английский):** Displays the model in Russian.

16

Table III.1 Tab-Delimited Output from an IVE calculation

Calculation Results:

Group: - single location -   Units: metric tons

Containing Locations: Fleets:

Santiago-Hourly WkDay   SantiagoGen2001

Hour: 0:00

index	Technology	CO Group 1 start-up	CO Group 2 start-up	CO Group 1 running	CO Group 2 running	VOC Group 1 start-up	*other pollutants here*
0 0	Pt: Auto/SmTk : Lt : Carb : None : PCV : <79K km	0.004250815	0	0.001791611	0	2.32E-04	
1 1	Pt: Auto/SmTk : Lt : Carb : None : PCV : 80-161K km	0.11643355	0	0.049159727	0	0.006526931	
2 2	Pt: Auto/SmTk : Lt : Carb : None : PCV : >161K km	0.276211286	0	0.11598506	0	0.015876398	
3 3	Pt: Auto/SmTk : Med : Carb : None : PCV : <79K km	0.012327364	0	0.005233926	0	6.73E-04	
4 4	Pt: Auto/SmTk : Med : Carb : None : PCV : 80-161K km	0.126783191	0	0.053529477	0	0.007107103	
5 5	Pt: Auto/SmTk : Med : Carb : None : PCV : >161K km	0.230941495	0.02952377	0.096975629	0.0140315	0.013274327	
6 6	Pt: Auto/SmTk : Hv : Carb : None : PCV : <79K km	0.008671116	0	0.002005584	0	5.80E-04	
	other technologies here						
	HOURLY TOTALS:	1.024661548	0.085685902	0.421471527	0.138162417	0.054444898	

Hour: 2:00

index	Technology	CO Group 1 start-up	CO Group 2 start-up	CO Group 1 running	CO Group 2 running	VOC Group 1 start-up
0 0	Pt: Auto/SmTk : Lt : Carb : None : PCV : <79K km	0.002609217	0	0.001067519	0	1.42E-04
1 1	Pt: Auto/SmTk : Lt : Carb : None : PCV : 80-161K km	0.071468728	0	0.029291474	0	0.004006332
2 2	Pt: Auto/SmTk : Lt : Carb : None : PCV : >161K km	0.169542794	0	0.069108875	0	0.00974518
3 3	Pt: Auto/SmTk : Med : Carb : None : PCV : <79K km	0.007566728	0	0.003118598	0	4.13E-04
4 4	Pt: Auto/SmTk : Med : Carb : None : PCV : 80-161K km	0.077821499	0	0.031895159	0	0.00436245
5 5	Pt: Auto/SmTk : Med : Carb : None : PCV : >161K km	0.14175549	0.01812215	0.05778224	0.00836057	0.008147989

Other hours here

DAILY TOTALS:

CO Group 1 start-up	CO Group 2 start-up	CO Group 1 running	CO Group 2 running	VOC Group 1 start-up
109.046055	7.354085822	45.01733534	8.963058927	6.581660524

IV. Creating and Editing Location Files

A. OVERVIEW

In order to estimate emissions in an area, it is necessary to develop information on the driving behavior and environmental conditions specific to that area. Once collected, this information can be input into an IVE Location File. The Location File contains information about the area's:

1) Driving behavior
   - Amount of driving
   - The driving patterns (speed, acceleration profile)
2) Start patterns
   - Amount of starts
   - The soak pattern (the distribution of how long the engine has been resting when it is started)
3) Environmental variables
   - Altitude
   - Road grade
   - Temperature
4) Fuel Characteristics
   - Fuel Quality
   - Amount of contaminants and additives

Some of this information may not exist and may need to be collected before an accurate emissions inventory can be created. Each of these parameters is included in the IVE model because it has a noticeable and potentially significant impact on the emissions. In the Field Study attachment (Attachment D) is a description of how driving patterns and start patterns can be collected and processed. This chapter of the user's manual assumes the user has already collected this information and is ready to make a new Location File, or simply edit an existing Location File.

The remainder of the Overview section provides a general discussion of these four categories. Next, a detailed description of each item found in the Location Page is given. Finally, a discussion on how to create a Location File is given.

1) Driving Behavior

A vehicle's velocity, acceleration and deceleration events all have a profound effect on the tailpipe emissions of a vehicle. Figure IV.1, which displays vehicle emissions as a function of engine power demand and stress, shows these variations can increase CO emissions up to 200 times under certain driving conditions, demonstrating the importance of properly characterizing driving patterns.

Figure IV.1. Example of Emissions Variation due to Driving Behavior
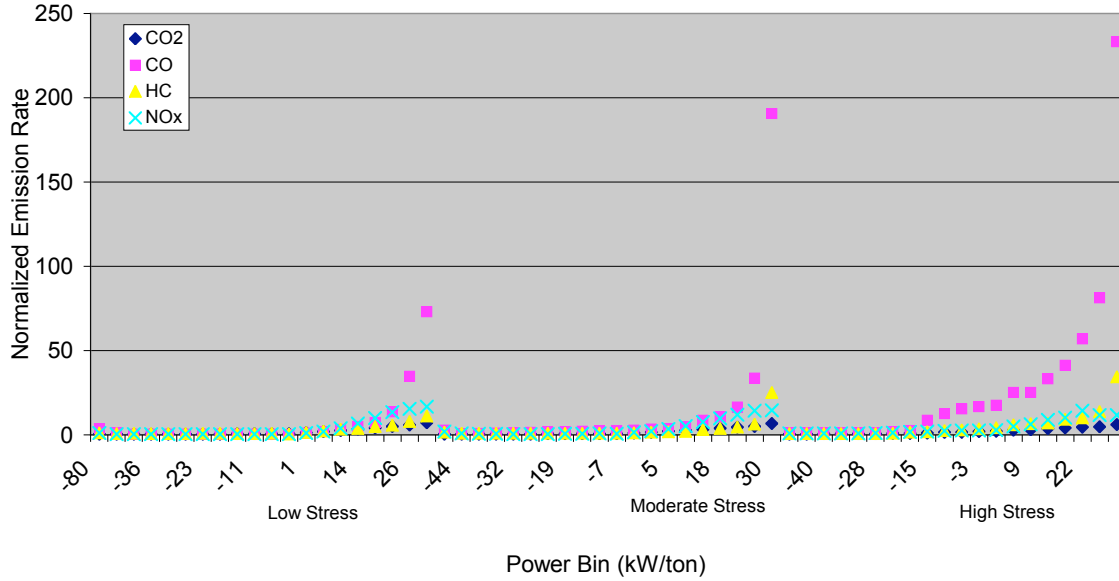
In the IVE model, driving patterns are characterized using two parameters:

- Vehicle Specific Power (VSP)
- Engine Stress

Both of these parameters can be obtained from general knowledge of the vehicle type and a second-by-second velocity trace. If road grade is included, second-by-second altitude is also required. If road grade is not to be included, grade can be assumed to be zero in equation IV.1. Equations IV.1 and IV.2 show how to estimate VSP and engine stress.

$$VSP = v[1.1a + 9.81 \ (atan(sin(grade)))+0.132] + 0.000302v^3 \qquad \text{(Eq. IV.1)}$$

$$grade = (h_{t=0} - h_{t=-1})/ \ v_{(t=-1to0seconds)}$$
$$v = \text{velocity (m/s)}$$
$$a = \text{acceleration (m/s}^2)$$
$$h = \text{Altitude (m)}$$

Engine Stress *(unitless) = RPMIndex + (0.08 ton/kW)*PreaveragePower* (Eq. IV.2)

$$PreaveragePower = Average(VSP_{t=-5sec \ to \ -25 \ sec}) \ (kW/ton)$$
$$RPMIndex = Velocity_{t=0}/SpeedDivider \ (unitless)$$
$$Minimum \ RPMIndex = 0.9$$

The velocity information can be collected on a set of vehicles equipped with combined global positioning satellite (CGPS) units. If desired, the velocity information can then be sorted into various categories, either by congestion level, roadway type, or time of day. The velocity is then processed in a computer program using several filters and the equations above to estimate VSP and engine stress. More information on how to collect and process activity information can be found in Attachments C and D.

The result of the processed data is the fraction of time spent driving in each of the VSP and stress categories. There are three stress categories and 20 VSP categories, making a

total of 60 bins. The list of VSP and stress categories corresponding to the 60 bins is listed in Table IV.1. Their position on the location page is denoted in Figure IV.1 as diamond 17. The fraction of travel in each of these bins is entered in the Location File and should always add to 1 (100%). For example, if a user has measured the passenger car driving in a region and has determined that 60% of the time the vehicles operate in Bin 11 and 40% of the time they operate in Bin 12 (which is not a possible real world scenario) the user would enter a 0.6 in bin 11 and 0.4 in bin 12.

Table IV.1. Boundaries Assumed in VSP/Engine Stress Binning

Bin	VSP (kW/Ton)		Engine Stress	
	Lower	Upper	Lower	Upper
0	-80.0	-44.0	-1.6	3.1
1	-44.0	-39.9	-1.6	3.1
2	-39.9	-35.8	-1.6	3.1
3	-35.8	-31.7	-1.6	3.1
4	-31.7	-27.6	-1.6	3.1
5	-27.6	-23.4	-1.6	3.1
6	-23.4	-19.3	-1.6	3.1
7	-19.3	-15.2	-1.6	3.1
8	-15.2	-11.1	-1.6	3.1
9	-11.1	-7.0	-1.6	3.1
10	-7.0	-2.9	-1.6	3.1
11	-2.9	1.2	-1.6	3.1
12	1.2	5.3	-1.6	3.1
13	5.3	9.4	-1.6	3.1
14	9.4	13.6	-1.6	3.1
15	13.6	17.7	-1.6	3.1
16	17.7	21.8	-1.6	3.1
17	21.8	25.9	-1.6	3.1
18	25.9	30.0	-1.6	3.1
19	30.0	1000.0	-1.6	3.1
20	-80.0	-44.0	3.1	7.8
21	-44.0	-39.9	3.1	7.8
22	-39.9	-35.8	3.1	7.8
23	-35.8	-31.7	3.1	7.8
24	-31.7	-27.6	3.1	7.8
25	-27.6	-23.4	3.1	7.8
26	-23.4	-19.3	3.1	7.8
27	-19.3	-15.2	3.1	7.8
28	-15.2	-11.1	3.1	7.8
29	-11.1	-7.0	3.1	7.8
30	-7.0	-2.9	3.1	7.8
31	-2.9	1.2	3.1	7.8
32	1.2	5.3	3.1	7.8
33	5.3	9.4	3.1	7.8
34	9.4	13.6	3.1	7.8
35	13.6	17.7	3.1	7.8
36	17.7	21.8	3.1	7.8
37	21.8	25.9	3.1	7.8
38	25.9	30.0	3.1	7.8
39	30.0	1000.0	3.1	7.8
40	-80.0	-44.0	7.8	12.6
41	-44.0	-39.9	7.8	12.6
42	-39.9	-35.8	7.8	12.6
43	-35.8	-31.7	7.8	12.6
44	-31.7	-27.6	7.8	12.6
45	-27.6	-23.4	7.8	12.6
46	-23.4	-19.3	7.8	12.6
47	-19.3	-15.2	7.8	12.6
48	-15.2	-11.1	7.8	12.6
49	-11.1	-7.0	7.8	12.6
50	-7.0	-2.9	7.8	12.6
51	-2.9	1.2	7.8	12.6
52	1.2	5.3	7.8	12.6
53	5.3	9.4	7.8	12.6
54	9.4	13.6	7.8	12.6
55	13.6	17.7	7.8	12.6
56	17.7	21.8	7.8	12.6
57	21.8	25.9	7.8	12.6
58	25.9	30.0	7.8	12.6
59	30.0	1000.0	7.8	12.6

If a user would like to enter in more than two driving patterns, such as one for motorcycles, one for passenger vehicles, and one for buses, multiple Location Files would be required. To combine these data sets, the user would then create a group on the Calculation Page as discussed in Chapter III that would use two Location Files that include all of the vehicle fleet and driving patterns. It is important to note that if this is done that the appropriate driving distance or time must be allocated to each vehicle group in their respective Location Files.

2) Start Patterns

Similar to driving patterns, different kinds of starts can have a profound impact on tailpipe emissions. The most predominate effect is the engine soak period before an engine starts. In this model, a cold start is referred to as a start when the engine has been completely cooled off, resting for 18 hours or more. A cold start typically has the most emissions because the engine must warm up and the catalyst, if one exists, will take longer to heat up to operating conditions. A completely warm start is when a warm engine is shut off for five minutes or less before starting again. The term engine soak is defined as the length of time that a warmed-up engine has been shut off before starting. There are ten groups of engine soaks in the IVE model (Table IV.2). Similarly, if a user would like to enter in more than two start patterns, such as one for motorcycles, one for passenger vehicles, and one for buses, multiple location files would be required as described in Section 1, Driving Behavior.

Table IV.2 Engine Soak Categories for Starting Patterns in the IVE model

Bin Description	Beginning Soak Period (minutes)	End Soak Period (minutes)
15 min	0	15
30 min	16	30
1 hour	31	60
2 hours	61	120
3 hours	121	180
4 hours	181	240
6 hours	241	360
8 hours	361	480
12 hours	481	720
18 hours	721	n/a

3) Environmental Variables
A few other local parameters are used to adjust emissions, such as ambient temperature, relative humidity, and road grade. The option of using road grade is included in the Location File but should not be used if road grade is already included in the driving pattern calculation. If a road grade is selected in the local parameters, the model will move a portion (depending upon the grade) of the fraction of driving in one VSP bin to an adjacent bin to account for the increased or decreased power demand on the vehicle. The road grade option should normally be used if overall there is a prevailing road grade. For example, if the user wished to estimate emissions on an uphill section of the roadway, the user could enter in the grade and estimate its impact on emissions. Alternatively, if the user wishes to estimate emissions in a city that has hills, great care should be used in applying a road grade adjustment to this situation since the driving is up and down in different parts of the city. The proper alternative is to collect and incorporate road grade information into the driving pattern data set.

4) Fuel Characteristics
The quality and contents of the fuel can have a substantial impact on the emissions from a vehicle. Many of the fuel characteristics can be obtained by testing the fuel, or contacting the fuel manufacturers. Although the model can incorporate vehicles of many fuel types, such as methanol and ethanol, only fuel characteristics can be provided for diesel and gasoline fuels at this time. The entries include overall fuel quality, and sulfur content for both diesel and gasoline, and lead, benzene, and oxygenate levels for gasoline fuel. The specific impact of each of these parameters and the data used to estimate these impacts can be found in Attachment B.

B. OPTIONS
Listed below Figure IV.1 is a detailed description of each item contained in the Location Page.

Figure IV.1 Details of the Location Page in the IVE Model

 ① When the **Location Tab** is clicked, the Location Page will open. From the Location Page, the user may enter location-specific data such as local ambient conditions, fuel variables, and driving behavior to create, view and save Location Files for use in the IVE model.

 ② **Location Drop Down Menu** shows the current Location File. By clicking on the arrow on the right hand side of this menu, the user can choose from the available Location Files.

 ③ **Fleet Drop Down Menu** shows the Fleet File that is paired with the Location File. The selected Fleet File will be used in calculations and is displayed in parenthesis on the main Calculation Page. To change the Fleet File that is paired with this Location File, simply click on the arrow at the right of the menu and the available fleets to select will appear.

 ④ **Base Adjustment Drop Down Menu** shows the Base Adjustment File paired with the current Location File. While having a Fleet and Location File is mandatory, a Base

24

Adjustment File is optional and should only be used if the user has specific information on the emission rates of vehicles in the area of interest. To change the Base Adjustment File, simply click on the arrow at the right of the menu and the available files will appear. At present no Base Adjustment Files have been created. Future studies may result in the development of base adjustment files. Chapter VI describes how to create a Base Adjustment File.

5 The **Date Drop Down Menu** displays the day and year of the Location File. This is intended only to be a label and will not change any of the calculations the model performs. The Date Menu represents the date that the calculation is being performed *for*, not the date the calculation is performed *on.* This allows the user to label and create different files for different seasons or years. Many times a user will like to project into the future several years and change fuel quality and driving patterns. To edit the date, simply click on the right arrow of each menu and enter in the appropriate selection.

6 The **Day of the Week Drop Down Menu** displays the day of the week for the Location File. This is intended only to be a label and will not change any of the calculations the model performs as described above for the Date Menu. The Day of the Week menu represents the day of the week the calculation is being performed *for*, not the day the calculation is performed *on.* This allows the user to label and create different files for different days of the week. Many times an area will have significantly different driving behavior on different days of the week, like the weekends, for example. Perhaps on the weekends, travel occurs later in the day with a lower velocity. To edit the day of the week, simply click on the right arrow of the menu and enter in the appropriate selection.

7 The **Altitude Entry Box** displays the altitude above sea level that the area of interest is located. Because the amount of oxygen in the air varies with altitude, if the air/fuel ratio is not adjusted accordingly, the amount of emissions will be altered with change in altitude. To change the altitude, simply click inside the box and type in the desired number. To change the units, click on the box containing the units until the desired selection is displayed. The units available are feet and meters.

8 The **I/M Class Drop Down Menu** stands for Inspection and Maintenance. It refers to the general condition of the fleet in the area of interest. Some areas implement inspection/maintenance programs where they require vehicles to undergo emission tests to ensure the fleet is operating properly. The use of an I/M program limits the number of high emitting vehicles and therefore reduces emissions of the fleet. Different types of I/M programs vary in effectiveness and it is difficult to estimate how effective specific programs are or will be in a particular location. The IVE model offers general corrections for several popular types of I/M programs. They are:

- No I/M program
- Idle Decentralized program for passenger vehicles
- Idle Centralized program for passenger vehicles
- Loaded Centralized program for passenger vehicles
- Idle Decentralized program for passenger vehicles and 2 and 3 wheeled vehicles
- Idle Centralized program for passenger vehicles and 2 and 3 wheeled vehicles

- Loaded Centralized program for passenger vehicles and 2 and 3 wheeled vehicles
- Idle Decentralized program for all vehicles
- Idle Centralized program for all vehicles
- Loaded Centralized program for all vehicles

An idle program refers to an I/M program that consists of an emissions test while the vehicle is idling. A loaded mode program refers to an emissions test that puts a load on the engine while it is being tested. A loaded program is more efficient at capturing high emitting vehicle and is therefore considered more effective. A decentralized I/M program is a program operated by independent business owners rather than the government or a single contractor selected by the government. Decentralized I/M programs are generally considered to be less effective that centralized programs. The estimates provided by this portion of the program are based on experience in the United States and should be treated with care relative to use in another country.

9 The **A/C Use Entry Box** displays the percentage of time the fleet that is equipped with air conditioning would use it at a temperature of 27°C. This value is prorated for temperatures between 15 and 32°C. At a temperature of 15°C, it is assumed that none of the fleet uses air conditioning, and at 32°C the entire fleet that is equipped with air conditioning would use it all the time, regardless of the value entered in the A/C Use Box. If the user puts 0.0% in the A/C Use box then the model will assume that no air conditioning is used up to 27°C. However, if the ambient temperature in the location file (diamond 13) is entered as 30°C, the model will assume that the vehicles that are equipped with air conditioning use it 50% of the time. The model will perform the calculation using the value listed in this box, plus the fraction of the fleet that is equipped with air conditioning from the Fleet File, and the ambient temperature from diamond 13 to calculate the magnitude of emissions impact to the fleet. For more information about the effect of air conditioning on emissions, please refer to Attachment B.

1 The **Road Grade Entry Box** is an optional box that allows the user to incorporate road grade to the entire portion of the location. The road grade option should normally be used if there is a prevailing road grade for the entire location, and only if road grade is not already incorporated into the driving pattern binning. For example, if the user wished to estimate emissions on an uphill section of the roadway, the user could enter in the grade and estimate it's impact on emissions. Alternatively, if the user wishes to estimate emissions in a city that has hills, the road grade option in the local variable section will produce questionable results. Instead, road grade should be collected and incorporated into the driving pattern information. Road grade is entered in the box as a percentage. Road grades of less than 14% can be approximated as vertical rise over slope length and is calculated by the following calculation:

grade $= (h_{t=0} - h_{t=-1})/ d_{(t=-1to0)}$
where $h_{t=0}$ is the altitude at the beginning of the link or roadway (m)
      $h_{t=-1}$ is the altitude at the end of the link or roadway (m), and
      $d_{(t=-1to0)}$ is the length of the link or roadway from beginning to end (m)

Grade numbers from 0 to 1 will be accepted in the model. However, actual road grades rarely exceed 0.15.

1 The **Fuel Characteristics Section** allows the user to enter in the characteristics and quality of the fuel. The amounts of the effect of changes in the fuel quality are documented in Attachment B. The options are:

- **Overall Gasoline Fuel Quality Drop Down Menu**: Allows the user to vary emissions depending upon the overall fuel quality. Moderate/Premixed is the default and will not have an effect on emissions. Clean fuel will improve emissions of four stroke gasoline vehicles and Non-premixed fuel will deteriorate emissions of two-stroke gasoline vehicles. Non-premixed refers to the condition when the vehicle's owner manually mixes oil and gasoline as opposed to the manufacturer or the fuel retailer. There are four options for overall gasoline fuel quality:

  - Moderate/Premixed (default)
  - Moderate/Non-Premixed
  - Clean/Premixed
  - Clean/Non-Premixed

  In the future, additional fuel quality options may be added.

- **Overall Diesel Fuel Quality**: Allows the user to vary emissions depending upon the overall fuel quality. Moderate is the default and this selection will not have an impact on emissions. Clean and biodiesel options will moderately improve emissions and water emulsification will increase emissions. Biodiesel is derived from plant or animal fat based oils or from their transesterified counterparts. Water emulsification of the fuel is when water is added to the fuel or cylinder to lower combustion temperature and can decrease emissions. The choices are:

  - Clean
  - Moderate (default)
  - Biodiesel
  - Water Emulsification

  In the future, additional fuel quality options may be added.

- **Gasoline Sulfur Level Drop Down Menu**: Allows the user to select a sulfur content of the fuel that most closely matches the local gasoline. Sulfur affects the effectiveness of the catalyst and directly impacts the amount of sulfur oxide emissions. The amount of sulfur in the fuel is measured by the parts per million (ppm) of sulfur in the fuel. The low and super low sulfur options will decrease sulfur-related emissions and the moderate and high sulfur options will increase sulfur-related emissions and effectively make catalyst vehicles perform like non-catalyst vehicles. The options are:

> ➢ Super Low (15 ppm)
> ➢ Low (50 ppm)
> ➢ Moderate (300 ppm) (default)
> ➢ High (600 ppm)

- **Diesel Sulfur Level Drop Down Menu**: Allows the user to select a sulfur content of the fuel that that most closely matches the local diesel fuel. Sulfur affects the amount of sulfur oxide emissions and particulate matter. The amount of sulfur in the fuel is measured by the parts per million (ppm) of sulfur in the fuel. The low and super low sulfur options will decrease sulfur-related emissions and the moderate and high sulfur options will increase sulfur-related emissions. The options are:

> ➢ Super Low (15 ppm)
> ➢ Low (50 ppm)
> ➢ Moderate (500 ppm) (default)
> ➢ High (5000 ppm)

Sulfur also impacts the performance of control systems. This is particularly true of NOx control systems.

- **Gasoline Lead Content Drop Down Menu**: Allows the user to select a lead content that most closely represents the local gasoline fuel. Lead in the fuel directly affects lead emissions and renders the catalyst ineffective. Choosing a low or high lead level will increase the lead in the emissions and catalyst vehicles will perform like non-catalyst vehicles. The options are:

> ➢ None (default)
> ➢ Low (0.07 grams lead/Liter fuel)
> ➢ High (0.2 grams lead/Liter fuel)

- **Gasoline Benzene Content Drop Down Menu**: Allows the user to select a benzene content that most closely represents the quantity in the local gasoline fuel. Benzene in the fuel directly affects benzene emissions. Choosing a super low or low benzene level will decrease benzene emissions and selecting a high benzene level will increase benzene emissions. The options are:

> ➢ Super Low (0.2%)
> ➢ Low (0.5%)
> ➢ Moderate (1.5%) (Default)
> ➢ High (3.0%)

- **Gasoline Oxygenate Content Drop Down Menu**: Allows the user to select an oxygenate content that most closely represents the quantity in the local gasoline fuel. Oxygenates are fuel additives that increases the amount of oxygen in the fuel

and improves emissions. The two most prominent oxygenates are ethanol and MTBE. Choosing fuel with oxygenate will decrease emissions. The options are:

- 0% (default)
- 1%
- 2%
- 3%

◆1 The **Hour Drop Down Menu** allows the user to input different driving and start patterns for each hour of the day. The options are 0:00 to 23:00. If the user would like to do an all day entry, the hour 0:00 (default) is typically used. Once an hour is selected by clicking on the arrow at the right of the menu, the driving patterns and start patterns associated with this hour are displayed. Everything inside the 'hour' box (items 11 – 20) will vary by hour. If the boxes are blank, there are no entries for this hour.

◆1 The **Temperature and Relative Humidity Entry Boxes** allows the user to enter in the ambient temperature and relative humidity for each hour of the day (or daily values, if a daily calculation is being conducted). To change the temperature or humidity, simply click inside the box and type in the desired value. To change the temperature units that are displayed, click on the units box to the right of the temperature. Humidity should be entered in percent.

◆1 The **Distance/Time Entry Box** is where the amount of travel conducted for that hour (or day) is entered. This is the total distanced traveled by the fleet of interest. For example, if your fleet is comprised of 100 vehicles that each travel 5 miles on roadway that you wish to model during the hour you are modeling, you would enter 500 miles in this box. Alternatively, you can enter a total travel time in this box. For example, if you are conducting a daily estimate, and you know the average vehicle travels 3 hours per day and your fleet consists of 100 vehicles, you would enter 300 hours in this box. The model will estimate the distance traveled using the average velocity entered in diamond 18. To change the units displayed, simply click on the box that displays the units. The units available are: kilometers, miles, hours, and minutes. If the user is developing a location file that will be used in combination with other Location Files as a group, the distance or time entered in each location file should correspond to the driving associated with the vehicles to be included in the specific Location File.

◆1 The **Start-Up Entry Box** is where the user will enter the number of starts that occur during the specific time period. This should be the total number of starts for the fleet and include both cold and warm starts. When the Location File is intended to be used with other Location Files as a group, the number of starts in each location file should correspond to the start-ups for the vehicles represented by the Location File.

◆1 The **Group 1 and Group 2 Tabs** apply to the driving correction and start correction bins (diamonds 17 and 19). Only Group 1 should be used.

◆1 The **Driving Pattern Entry Bins** are where the driving pattern information is entered. There are a total of 60 VSP bins, the total of which should add up to 100 percent.

For more information on the driving pattern bins, refer to the Overview (Section 1) in this chapter.

1 The **Average Velocity Entry Box** is the average speed that corresponds to the driving pattern profile entered in diamond 17. The units can be changed by clicking in the box and entering a value. The units can be changed from kilometer per hour to miles per hour by clicking on the unit box. There is a temptation here to keep a given driving pattern and to modify the speed to represent some new driving situation. Great care should be exercised in taking this step. The driving patterns represented by the 60 driving characteristic bins will likely change for different average speeds. It is better to seek out driving patterns that correspond to a given traffic speed at a given location, rather than simply change the speed.

1 The **Soak Pattern Bins** are where the distribution of engine soak period is entered. There are a total of 10 bins, the entries must add to 100 percent. For more information on the soak pattern bins, refer to the general description portion of this section.

2 The **Totals Box** displays the sum of the driving pattern bin and soak pattern bins. They should each total 100 percent (Rounding sometimes produces values that are not exactly 100%. The model will give a warning if the sum is too different from 100%).

2 The **File Menu** allows the user to save or create new Location Files.

C. CREATING A LOCATION FILE

The user has two options for creating a Location File. The user can input the information directly into the entry boxes of the IVE model itself, or input the information in a database spreadsheet such as Microsoft Excel and export it into the IVE model. If the user enters information directly into the boxes of the IVE model, once finished the user can simply go to File, Save and save the new Location File. Once the Location File has been created and saved, it will be located in the IVE data subdirectory with the extension '.lct'. A '.lct' file is only viewable through the IVE user's interface. Additionally, the user can edit information in an existing location file as save it as a different file under File: Save as a Copy.

If the user chooses to first create the file in a spreadsheet database, there is an Excel Location File template that can be downloaded from the IVE website (Figure IV.2). When a user is first developing a Location File with multiple times of the day or many inputs, this is probably the easiest way to enter in the information. Also, the user can keep an easily editable version of all the Location Files so that the files can be referred to. When the user has completed entering in all of the data in the spreadsheet, they need to save it, then go to File, Save as, and save as a tab delimited file in the IVE data folder. The next time you open the IVE model, the model will read the file and change it to a '.lct' file. Make sure if you want access to it, to save the Excel and text files because the saving as a table delimited file process will destroy the original Excel files.

Figure IV.2 Example of Creating a Location File in an Excel Spreadsheet

		Latitude	Longitude	Altitude	Units	
Location:	Santiago-Hourly WkDay					
	Various Input	**Latitude**	**Longitude**	**Altitude**	**Units**	
Location Info:	Template			500	m	m=meters, ft=feet
	MM/DD/YYYY					
Date:	8/28/2002					

		Units	
Road Grade:	N/A	%	positive value is uphill, negative number is downhill
I/M Class:	none	none	enter text for one of five options
Percent AC In Use at 80 F (27 C):	80	%	percent of public with AC on vehicle using AC at 80F (27C) ambient temperature
Fleet File to Use:	owntown Santiago, Chile 2002		
Interpolation File to Use:		A blank will be interpreted to use a linear fit for missing hours	

	Overall	**Lead(Pb)**	**Sulfur(S)**	**Benzene**	**Oxygenate**	
Gasoline:	moderate/non-premixed	none	moderate (300ppm)	moderate (1.50%)	0%	Enter gasoline related data.
Diesel:	moderate	N/A	moderate (500ppm)	N/A	N/A	Enter diesel related data.

		Units
Description:	Santiago 6 AM	
Time Period:	6	hr
Total Distance (or Time) Driven:	146396.44	km
Number of Startups:	46633	S
Temperature:	14	C
Relative Humidity:	63	%
Average Velocity for Group 1 Vehicles:	62.64	km/hr
Average Velocity for Group 2 Vehicles:	62.64	km/hr

Units

sec=seconds, min=minutes, hr=hours, M hr=1000's of hours
km=kilometers, M km=1000s of kilometers, mi=miles, M mi=thousands of miles
S=single units, M=1000's
C=degrees Centigrade, F=degrees Fahrenheit
m/s=meters/second, mph=miles per hour, km/hr=kilometers/hour

Driving Style Distribution (Facility Cycle Distribution)--Group 1 Vehicles

VSP Bin 1	VSP Bin 2	VSP Bin 3	VSP Bin 4	VSP Bin 5	VSP Bin 6	VSP Bin 7	VSP Bin 8
0.01%	0.02%	0.03%	0.06%	0.10%	0.19%	0.37%	0.74%

Soak Time Distribution--Group 1 Vehicles

36.9%	4.6%	3.1%	0.0%	1.5%	3.1%	4.6%	29.2%
15 min	30 min	1 hour	2 hour	3 hours	4 hours	6 hours	8 hours

Driving Style Distribution (Facility Cycle Distribution)--Group 2 Vehicles

VSP Bin 1	VSP Bin 2	VSP Bin 3	VSP Bin 4	VSP Bin 5	VSP Bin 6	VSP Bin 7	VSP Bin 8
0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	0.46%	0.95%

Soak Time Distribution--Group 2 Vehicles

36.9%	4.6%	3.1%	0.0%	1.5%	3.1%	4.6%	29.2%
15 min	30 min	1 hour	2 hour	3 hours	4 hours	6 hours	8 hours

Regardless of whether the user is entering the information via a spreadsheet or directly in the user interface of the model, the same information and options apply as discussed in the previous section. The user can add driving and start data in a single hour, or multiple hours. When the user adds data to a selected hour, it is necessary to enter in a distance traveled and average velocity. The model will give an error if these fields are left blank. Also, if the user enters in data that does not add up to 100%, the model will notify the user.

V. Creating Fleet Files

A. OVERVIEW

In addition to defining the driving style of a region, it is equally necessary to properly define the technologies that make up the vehicle fleet that operates in a region. This section explains the format of a Fleet File and how to create one once the information has been collected. To learn about how to collect information on the fleet make-up in your region, refer to the Field Study attachment in Attachment D.

A Fleet File is simply a list of the fraction of vehicle travel by each technology. The IVE model contains a total of 1372 predefined technologies, and an additional 45 non-defined technologies. The technologies are grouped using the following parameters:

- Vehicle Size (7 options including trucks)
- Fuel Type (5 options)
- Vehicle Use (3 options)
- Fuel Delivery System (3 options)
- Evaporative Control System (varies)
- Exhaust Control System/Standards (varies)

The number in the parenthesis indicates how many variables are in each classification. Table V.1 lists some of the more commonly used vehicle technologies. Each of the classes listed in Table V.1 have additional categories for vehicle age, vehicle size, and evaporative control. For a full description of vehicle technology categories, refer to Attachment A.

Table V.1. Vehicle Class and Technology Categories.

Light Duty Gasoline Vehicles		Light Duty Diesel Vehicles		Light Duty Vehicles (Ethanol, Natural Gas, Propane, retrofits, etc)		Heavy Duty Gasoline Vehicles		Heavy Duty Diesel Vehicles		Heavy Duty Vehicles (Ethanol, Natural Gas, Propane, etc)		Gasoline and Ethanol Motorcycles	
Carburetor	None	Pre-Chamber Inject.	None	Carb/Mixer	None	Carburetor	None	Pre-Chamber Inject.	None	Carburetor	None	2-Cycle, FI	None
Carburetor	2-Way	Pre-Chamber Inject.	Improved	Carb/Mixer	2-Way	Carburetor	2-Way	Direct Injection	Improved	Carburetor	2-Way/EGR	4-Cycle, Carb	None
Carburetor	2-Way/EGR	Direct Injection	EGR+	Carb/Mixer	2-Way/EGR	Carburetor	2-Way/EGR	Direct Injection	EGR+	Carburetor	3-Way/EGR	4-Cycle, Carb	Catalyst
Carburetor	3-Way	FI	PM	Carb/Mixer	3-Way	Carburetor	3-Way	FI	PM	FI	3-Way/EGR	4-Cycle, FI	None
Carburetor	3-Way/EGR	FI	PM/NOx	Carb/Mixer	3-Way/EGR	Carburetor	3-Way/EGR	FI	PM/NOx			4-Cycle, FI	Catalyst
Single-Pt FI	none	FI	EuroI	Single-Pt FI	2-Way	FI	none	FI	EuroI				
Single-Pt FI	none/EGR	FI	EuroII	Single-Pt FI	2-Way/EGR	FI	2-Way	FI	EuroII				
Single-Pt FI	2-Way	FI	EuroIII	Single-Pt FI	3-Way	FI	2-Way/EGR	FI	EuroIII				
Single-Pt FI	2-Way/EGR	FI	EuroIV	Single-Pt FI	3-Way/EGR	FI	3-Way	FI	EuroIV				
Single-Pt FI	3-Way	FI	Hybrid	Multi-Pt FI	3-Way	FI	3-Way/EGR	FI	EuroV				
Single-Pt FI	3-Way/EGR			Multi-Pt FI	3-Way/EGR	FI	EuroI	FI	Hybrid				
Multi-Pt FI	none			Multi-Pt FI	3-Way/EGR	FI	EuroII						
Multi-Pt FI	none/EGR				ZEV	FI	EuroIII						
Multi-Pt FI	3-Way					FI	EuroIV						
Multi-Pt FI	3-Way/EGR					FI	EuroV						
Multi-Pt FI	3-Way/EGR												
Multi-Pt FI	LEV												
Multi-Pt FI	ULEV												
Multi-Pt FI	SULEV												
Multi-Pt FI	EuroI												
Multi-Pt FI	EuroII												
Multi-Pt FI	EuroIII												
Multi-Pt FI	EuroIV												
Multi-Pt FI	Hybrid												

If a user would like to have different driving patterns for various categories of vehicles, such as one for motorcycles, one for passenger vehicles, and one for buses, multiple Fleet Files must be created. Typically, many users create a Fleet File for each class of vehicles (passenger cars, trucks, etc). This allows the user to associate a separate driving pattern,

average velocity, and number of starts to each type of vehicle class, and to estimate emissions from the passenger car fleet, the truck fleet and the two and three-wheeler fleet separately. Another option in the calculation sheet is to group the fleets together. For example, you can add multiple locations/fleet files – one for passenger cars, one for taxis, and one for trucks into the calculation tab and name that as 'Mexico City Overall Fleet". In this way, the entire fleet emissions can be estimated with the click of a button. So, by creating a separate fleet file for each category of vehicle, the user can easily estimate the emissions of each class and all the classes together.

Each technology is associated with an Index Number. Associated with each index number is an abbreviated description, (see Figure V.I). A full description of each index number and technology can be found in Appendix A. Table V.2. shows the most common definitions of the descriptions.

**Table V.2. Definition of Common Abbreviations used in the Fleet Files**

Abb. Description	Description	Meaning
Pt	Petrol	Petroleum-fueled vehicle (gasoline)
Ds	Diesel	Diesel-fueled vehicle
Ng	Natural Gas	Natural gas (mostly methane) fueled vehicle
Ngrt	Natural Gas Retrofit	Originally built gasoline vehicle modified to run on Natural gas fuel
Pr	Propane	Propane-fueled vehicle
Prrt	Propane retrofit	Originally built gasoline vehicle modified to run on propane fuel
Et	Ethanol	Ethanol fueled vehicle
Etrt	Ethanol Retrofit	Originally built gasoline vehicle modified to run on ethanol fuel
CNG/LPG	Compressed Natural Gas or Liquified Propane Gas	Used for natural gas or propane-fueled motorcycles or three wheeled vehicles
Carb	Carbureted	Vehicle equipped with a carbureted fuel delivery system
SgPt FI	Single Point Fuel Injection	Vehicle equipped with a electronically delivered single stream of fuel to the intake manifold
MPFI	Multi Point Fuel Injection	Vehicle equipped with a electronically delivered stream of fuel to each combustion chamber (most new vehicles)
Pre-Inj	Pre-Injection	Diesel Vehicle equipped with no advanced fuel delivery system
Dir-Inj	Direct Injection	Diesel Vehicle equipped with advanced fuel delivery system that delivers fuel directly into each combustion chamber
2cyc	2-cycle	Gasoline fueled small engine (motorcycle or three wheeler) that operates on a two stroke combustion

		cycle, and requires oil to be mixed with the fuel
4cyc	4 cycle	Gasoline fueled small engine (motorcycle or three wheeler) that operates on a conventional 4-stroke combustion cycle
Hybrid	Hybrid Vehicle	A vehicle that operates partially off of battery power
Auto/Sm Truck	Auto/Small Truck	Passenger vehicle (automobile, truck, Van or SUV) weighing less than 9000 lbs
Truck/Bus	Truck/Bus	Refers to all vehicles that weigh more than 9000 lbs.
SmlEng	Small Engine	Refers to motorcycles or three-wheeled vehicles
Lt	Light	Vehicle with engine size less than 1.5 liter (typically the vehicle will weigh less than 5000 lbs.)
Md	Medium	Vehicle with engine size greater than 1.5 liters and less than 3 liters. (typically the vehicle will weigh less than 6600 lbs.)
Hv	Heavy	Vehicle with engine size greater than 3 liters and weighing less than 9000 lbs (gross vehicle weight rating)
None	None	No emissions control technology
PCV	Positive Crankcase Ventilation	A control that routes air from the crankcase back to the combustion chamber and eliminates some evaporative emissions
2wy	2-way catalyst	A catalyst treating the engine exhaust that removes HC and CO
3wy	3-way catalyst	A catalyst treating the engine exhaust that removes HC, CO, and NOx (most new vehicles)
EGR	Exhaust Gas Recirculation	A control that recirculates a portion of the exhaust back to the combustion chamber to lower peak combustion temperatures and reduce NOx formation
Particulate	Particulate Trap	A filter on the exhaust that removes Particulate matter with an approximate efficiency of 90%
K km	Thousand of kilometers	Defining the age of the vehicle in terms of odometer reading in thousand of kilometers traveled.
User	User	A user defined vehicle that does not have pre-set emission rates.

B. OPTIONS

Listed below Figure V.1 is a detailed description of each item contained in the Fleet Page.

Figure V.1 Details of the Fleet Page in the IVE Model
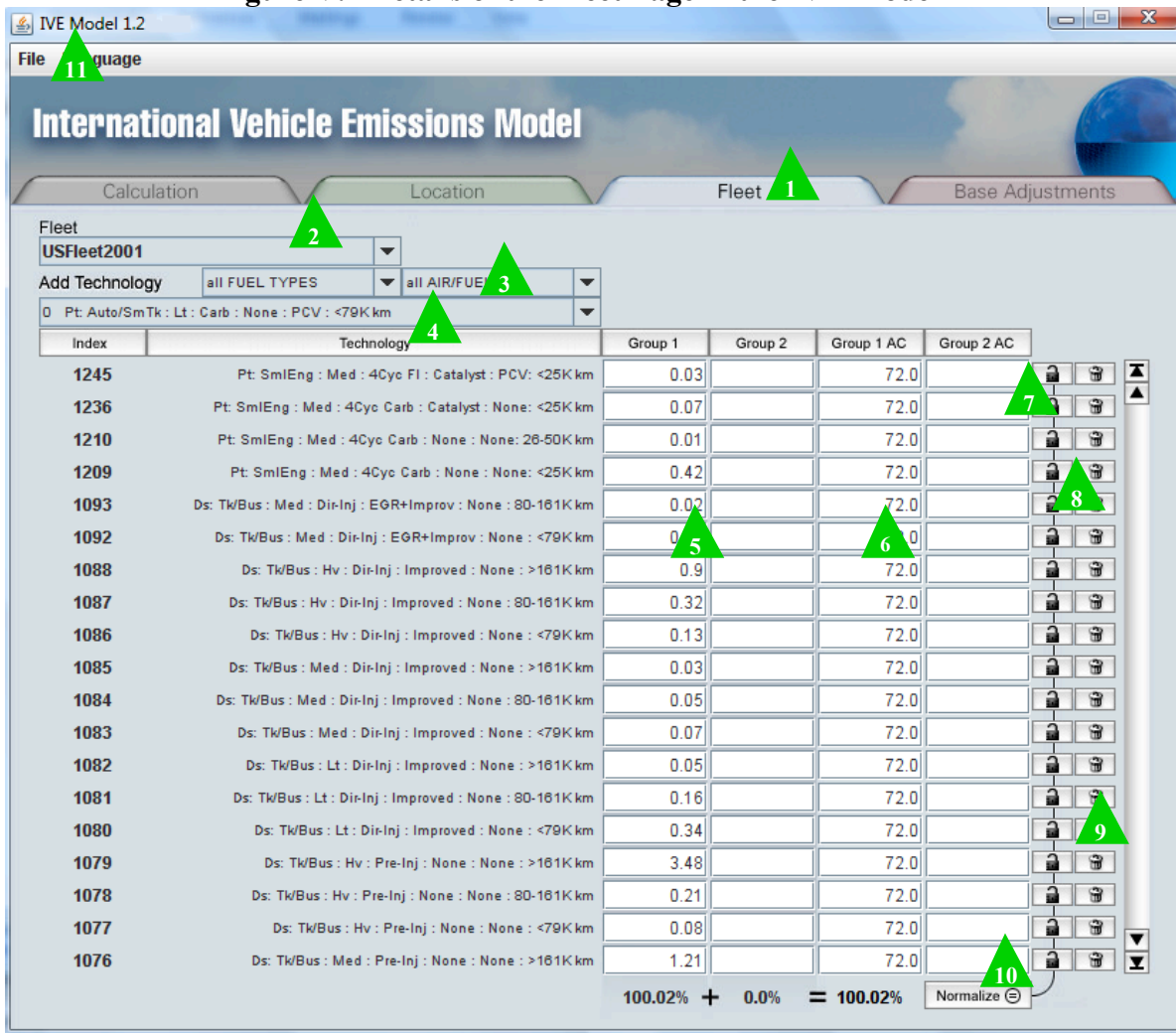
When the **Fleet Tab** is pressed, the Fleet Page will be opened. From the Fleet Page, the user may enter in the technology distribution of the current fleet, save, and name the current Fleet File.

Fleet File Drop Down Menu shows the current Fleet File. By clicking on the arrow on the right hand side of this menu, the user can choose from the available Fleet Files.

From the **Add Technology Drop Down Menu**, the user may select a group of technologies to display in the list. The user may limit the selection by specifying the fuel types and technology type. The available technologies to select from will then be listed in the third drop down menu when the user clicks on the arrow at the right end of the menu. To select from this list, scroll down and click on the desired technology. Once selected, the technology will be displayed in the table below.

▲ **Column Header Buttons** label the contents of the column. When clicked, the associated column is sorted in descending order. When clicked a second time, the column will be sorted in ascending order.

▲ The **Group 1 and Group 2 Columns** are where the travel fraction for each technology type is entered. Only Group 1 is used, Group 2 is ignored. The very bottom row indicates the current sum of all fractions entered. The applicable values entered range from 0 to 1. A value of 1 would indicate that 100% of the vehicles in the fleet are that technology. A blank cell is interpreted as zero. Once completed, the column should add to 100%.

▲ The **Group 1 and 2 AC Columns** are where the fraction of the technology that is equipped with air conditioning (AC) is entered. Only Group 1 values should be entered. The applicable values entered range from 0 to 1. A blank cell is interpreted by the model as zero.

▲ The **Lock Button** when clicked will "lock" the associated technology from normalization so that if the Normalize Button (triangle 10) is clicked, the percentages in locked rows will not be adjusted.

▲ The **Delete Button** when clicked will delete the associated technology from the current file.

▲ The **Scroll Bar** can be used to scroll up and down for viewing the complete list of technologies. The single arrow will scroll by one technology at a time, the arrow with a line will scroll to the end of the selection.

▲ The **Normalize Button** when clicked will force all percentages in the displayed fleet to total 100% by adjusting all percentages proportionally to their value except for those technologies that are locked with the Lock Button (triangle 7). Please note that because of rounding, some combinations of percentages will not total exactly 100% even after normalization.

▲ The **File Menu** allows the user to save or create new Fleet Files.

C. <u>CREATING A FLEET FILE</u>

The user has two options for creating a Fleet File. The user can input the information directly into the boxes of the IVE model itself, or input the information in a database spreadsheet such as Microsoft Excel and export it into the IVE model. If the user enters information directly into the boxes of the IVE model, they need to create a new file or edit an existing one. To create a new file, to to File: New and enter a file name. To edit an existing file, simple open the file you want to edit. Then, simply fill in or change the

boxes with values, and go to File then Save and save their Fleet File. Once the Fleet File has been created and saved, it will be located in the IVE Data subdirectory with the extension '.flt'. An '.flt' file is only viewable through the IVE user's interface.

If the user chooses to first create the file in a spreadsheet database, there is an Excel fleet file template that can be downloaded from the IVE website (Figure V.2). The user can keep an easily editable version of all the Fleet Files so that they can be referred to. When the user has completed entering in all of the data in the spreadsheet, the user should save it, then go to File, Save as, and save as a tab delimited file in the IVE Data folder. The next time you open the IVE model, the model will read the file and change it to an '.flt' file. Make sure if you want access to it to save the Excel and text files because the process will destroy the text file in the IVE data folder.

Regardless of whether the user is entering the information via a spreadsheet or directly in the user interface of the model, the same information and options apply as discussed in the previous section. Also, if the user enters in technology fractions that do not add up to 100%, and the user does not normalize the fleet before saving, the model will give the user a prompt that the file does not add up to 100%.

Figure V.2 Example of Creating a Fleet File in an Excel Spreadsheet

Fleet: <mark>Overall Santiago, Ch</mark> 1.000

Description	Fuel	Weight	Air/Fuel Control	Exhaust Control	Evapor-ative Control	Age	New Index	Fraction of Miles Driven Group 1 vehicles	Fraction with AC Group 1 vehicles	Fraction of Miles Driven Group 2 vehicles	Fraction with AC Group 2 vehicles
Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV	<79K km	0	0.000	0.000	0.000	0.000
Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV	80-161K km	1	0.014	0.000	0.000	0.000
Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV	>161K km	2	0.027	0.000	0.000	0.000
Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV	<79K km	3	0.000	0.000	0.000	0.000
Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV	80-161K km	4	0.024	0.143	0.000	0.000
Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV	>161K km	5	0.041	0.333	0.004	0.000
Auto/Sml Truck	Petrol	Heavy	Carburetor	None	PCV	<79K km	6	0.000	0.000	0.000	
Auto/Sml Truck	Petrol	Heavy	Carburetor	None	PCV	80-161K km	7	0.000	0.000	0.000	0.000
Auto/Sml Truck	Petrol	Heavy	Carburetor	None	PCV	>161K km	8	0.007	0.000	0.000	0.000
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way	PCV	<79K km	9				
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way	PCV	80-161K km	10				
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way	PCV	>161K km	11				
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way	PCV	<79K km	12				
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way	PCV	80-161K km	13				
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way	PCV	>161K km	14				
Auto/Sml Truck	Petrol	Heavy	Carburetor	2-Way	PCV	<79K km	15				
Auto/Sml Truck	Petrol	Heavy	Carburetor	2-Way	PCV	80-161K km	16				
Auto/Sml Truck	Petrol	Heavy	Carburetor	2-Way	PCV	>161K km	17				
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way/EGR	PCV	<79K km	18				
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way/EGR	PCV	80-161K km	19				
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way/EGR	PCV	>161K km	20				
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way/EGR	PCV	<79K km	21				
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way/EGR	PCV	80-161K km	22				
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way/EGR	PCV	>161K km	23				
Auto/Sml Truck	Petrol	Heavy	Carburetor	2-Way/EGR	PCV	<79K km	24				
Auto/Sml Truck	Petrol	Heavy	Carburetor	2-Way/EGR	PCV	80-161K km	25				
Auto/Sml Truck	Petrol	Heavy	Carburetor	2-Way/EGR	PCV	>161K km	26				

VI. Adjusting Base Emission Factors

A. OVERVIEW

The IVE model uses base emission rates for running and start emissions for each vehicle technology in the IVE model. The base emissions are developed from dynamometer testing on a specific cycle at standard conditions. Most of the present data for creating base emission factors is derived from studies carried out in the United States. Thus, the model provides a method for a user to modify the base emission rates used by the model in cases where the base factors in the model appear to be incorrect for a specific location. A series of correction factors can be applied to the base emission rates to obtain 'real world' emission estimates for specific locations for selected technologies.

The IVE model's base emission rates are based on the United States' Federal Test Procedure (FTP) driving cycle. Running emissions are from the LA4 cycle, which is roughly equivalent or very similar to Bags 2 and 3 of the FTP cycle. Start emission rates are roughly equivalent to Bag 1 minus Bag 3 of the FTP. It is anticipated that some users will have local data for various technologies based on a cycle other than the LA4. When such data exists, users are encouraged to apply their own base emission rates instead of the default emission rates provided in the IVE model. By creating a Base Adjustment File, the user will be able to reflect the emissions from specific technologies in an area instead of generalized emissions for that technology. This adjustment file will increase or decrease emission rates compared with a default base emissions rates.

B. OPTIONS

Listed below Figure V.1 is a detailed description of each item contained in this page.

Figure VI.1. Base Adjustment Worksheet in the IVE model

1 When the **Base Adjustment Tab** is pressed, the Base Adjustment Page will be opened. From the Base Adjustment Page, the user may enter in corrections for the base emissions rates for each technology of interest.

2 **Base Adjustment Drop Down Menu** shows the current Base Adjustment File. By clicking on the arrow on the right hand side of this box, the user can choose from the available adjustment files.

3 From the **Add Technology Section**, the user may select a group of technologies to display in the list. The user may limit the selection by specifying the fuel types and technology type. The available technologies to select from will then be listed in the third box when the user clicks on the arrow at the right end of the menu. To select from this

41

list, scroll down and click on the desired technology. Once selected, the technology will be displayed in the table below.

4 **Column Header Buttons** label the contents of the column. When clicked, the associated column is sorted in descending order. When clicked a second time, the column will be sorted in ascending order.

5 **Display Header Buttons** display the contents of the label, when clicked. The current selection will be highlighted in white. To select a different group of pollutants, click on the gray label of interest. When clicked, the selected pollutant values will be displayed and the label will be highlighted white.

6 The **Base Adjustment Entry Boxes** displays the current adjustments for each technology. To edit, simply click in each box and type in the desired number. A 1.0 does not change the base emission rate and a blank is interpreted as a 1.0. A 1.10, for example, will increase the base emission factor by 10%.

7 The **Delete Button** when clicked will delete the associated technology from the current file.

8 The **Scroll Bar** can be used to scroll up and down for viewing the complete list of technologies. The single arrow will scroll by one technology at a time, the arrow with a line will scroll to the end of the selection.

9 The **File Menu** allows the user to save or create new Fleet Files.

C. <u>CREATING A BASE ADJUSTMENT FILE</u>

WARNING: Creating a Base Adjustment File is one of the more difficult procedures associated with the IVE model. The base emission rates found in the model are based on hundreds of vehicle tests and great care should be taken in making adjustments to these values. Normally, tests of 10 or more vehicles of a technology type are needed before a meaningful adjustment factor can be developed for that technology type. Even in the case of 10 vehicle tests of the same type a check of the standard deviation of the sample set will inform the user that the resulting average may be unreliable. Base adjustments should not be made based on the sampling of one or two vehicles or if the 90% confidence limit for the pollutant of concern of the sampled vehicles significantly overlaps the IVE model base emission rate. Also, it may be wise to make a partial adjustment to the base emission rate consistent with the confidence limits of the data set. For example, the modeler could use a sampled value that is one standard deviation from the sampled emission rate in the direction of the IVE model base emission rate.

The following procedure outlines the step-by-step process of applying location specific emission rates as the base emission rates for a specific set of technologies. Alternatively, there are 2 different templates (one using an automated program that bins the emissions data for you and one that calculates it in excel). The instructions and templates for these

two methods can be found in separate documents with this users guide. A brief description of each is below

Method 1. Manual correction calculation
1. Estimate Emissions from your Testing. Take the second by second processed speed and emissions data from your test for a vehicle type. Make sure the data are processed, time-aligned, and error free. Calculate the VSP fraction in each bin, and the average emission rates in g/km for each pollutant (use the BERAF excel template, if desired, or the speed analysis program for expedited processing of many data files). These are the actual data from your vehicle emissions tests. (Result 1)

2. Normalize the Test Data. The user should create a Location File to contain the average velocity and percent of driving in each VSP driving bin that was calculated in step 1 (see Chapter IV). If the driving cycle is the LA4, this is available for download on the data download page. There are additional standardized driving cycles on the website as well. The user should also check to make sure in the Location file that the ambient and fuel conditions are selected to be consistent with the values during the testing. (i.e same temperature, humidity, fuel grade, etc.). This file is termed the 'test-specific' location file. Create a fleet file with only one technology, corresponding to the appropriate vehicle tested. Run this location/fleet combination and export/note the emission results. The output will contain emission rates predicted for the test-specific location data for IVE base emission rate data. (Result 2)

3. The BER CF = Result 1 * Result 2. This is the ratio the normalized emissions from your testing to the IVE default emissions – or the base correction factor for this technology. (All three of these steps can be completed in the BERCF.xls template, if desired)

4. Insert these ratios in the Base Adjustments Tab in the IVE model. Click on the Base Adjustments Tab, go to File, New, and then add the technologies you are interested in (see Figure VI.1 and the legend directly below). Save when done. Now, when you go to the Location tab and select your fleet, you can also select the Base Adjustments File to use. For every type of driving analyzed using this Fleet Profile, the results will reflect the new user-input emission adjustments. For some pollutants not directly measured, you can use the values of a more common pollutant to estimate the approximate effects, as shown in the table below. For example, if I wanted to estimate the NH3 levels of my vehicle but did not test them, I would use the same BERCF as what I calculated for CO2.

For Pollutant	Use the BERCF calculated from
VOC	VOC
CO	CO
NOx	NOx

PM	PM
Lead	CO2
SO2	CO2
NH3	CO2
1,3 butadiene	VOC
Formaldehyde	VOC
Acetaldehyde	VOC
Benzene	VOC
EVAP	--
CO2	CO2
N20	CO2
CH4	VOC

Figure VI.2. Base Adjustment Spreadsheet for the IVE model

Base Adjustments: Name Here

Description	Fuel	Weight	Air/Fuel Control	Exhaust	Evaporative	Age	Index	COst	VOCst	EVAPst
Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV	<79K km	0			
Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV	80-161K km	1	1.100	1.2	1.200
Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV	>161K km	2			
Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV	<79K km	3			
Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV	80-161K km	4			
Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV	>161K km	5			
Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV	<79K km	6			
Auto/Sml Truck	Petrol	Heavy	Carburetor	None	PCV	80-161K km	7			
Auto/Sml Truck	Petrol	Heavy	Carburetor	None	PCV	>161K km	8			
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way	PCV	<79K km	9			
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way	PCV	80-161K km	10			
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way	PCV	>161K km	11			
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way	PCV	<79K km	12			
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way	PCV	80-161K km	13			
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way	PCV	>161K km	14			
Auto/Sml Truck	Petrol	Heavy	Carburetor	2-Way	PCV	<79K km	15			
Auto/Sml Truck	Petrol	Heavy	Carburetor	2-Way	PCV	80-161K km	16			
Auto/Sml Truck	Petrol	Heavy	Carburetor	2-Way	PCV	>161K km	17			
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way/EGR	PCV	<79K km	18			
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way/EGR	PCV	80-161K km	19			
Auto/Sml Truck	Petrol	Light	Carburetor	2-Way/EGR	PCV	>161K km	20			
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way/EGR	PCV	<79K km	21			
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way/EGR	PCV	80-161K km	22			
Auto/Sml Truck	Petrol	Medium	Carburetor	2-Way/EGR	PCV	>161K km	23			

Davis: Insert the actual/IVE start or running base emission rate ratio for the technologies measured. Save as a tab delimited text file and use in the ive model.

Method 2. Automated Method for estimating correction factors

1. Estimate Emissions from your Testing. Take the second by second processed speed and emissions data from your test for a vehicle type. Make sure the data are processed, time-aligned, and error free. Group the vehicles according to similar vehicle types and process them in the speedanalysis software that calculates the binned emissions results for you.

2. Input the output from speedanalysis into the Type sheets in the BERAFtemplate for each category of vehicle tests.

3. Run the IVE model for site-specific LA4 cycle and input the data into the BERAFtemplate for each category of vehicle tests.

4. The adjustment for each type is calculated for you. See the BERAFtemplate worksheet for more detailed instructions.

VIII. Frequently Asked Questions

A. <u>GENERAL QUESTIONS</u>

Q. When I open up the IVE model, nothing happens. What is wrong?

A. After you have downloaded the IVE model and have double-clicked on it, you may have to wait up to a minute for the program to open. If it still does not open, you may need to download or update the Java engine in your computer. For information on how to do this, refer to Section I.B and I.C of the User's Manual.

Q. Where can I find more information and ask questions?

A. Visit the website www.issrc.org/ive for the latest information. Email ive_feedback@issrc.org for any questions you may have.

B. <u>ACTIVITY QUESTIONS</u>

Q. What are start emissions and soak distributions?
(Located in the LOCATION FILE)

A. We define starts as the event of turning on your vehicle after it has been turned off. So, stops when you are idling at a signal light but do not turn off your engine do not count as a start. The idle time would be included in the driving pattern data in the running emissions section. Typical starts from a vehicle would occur when you first start your car in the morning, when you go to lunch, run errands, etc. Most areas typically see anywhere from 7 to 10 starts per day per vehicle.

The soak distribution defines how long the engine has been turned off when it starts. The soak bins are defined by the length of time the engine has been off. For example, the value entered in the 0.25 category refers to the fraction of starts that occur after the vehicle has been turned off for 0.25 hours (15 minutes). After 18 hours, all starts have the same emissions and are therefore lumped into a single category. If you want to model a vehicle that is turned off at 17:00 hours, starts at 8:00 hours the next day, drives for one hour and turns off at 9:00 hours, then starts up again at 12:00 hours, the soak distribution would contain 0.5 in the 15 hour bin and 0.5 in the 3 hour bin. The fraction in the soak distribution boxes must always add up to one.

An interesting situation developed in one of our studies in India. Here, motorists are encouraged to turn their engines off during signal lights. Since signal lights typically last no more than a minute, it became an interesting question whether to treat these engine stops and restarts as true stops for modeling purposes. At the present in the supplied India files, they are not treated as stops due to their short durations. However, studies are planned for in the future to determine the impact of these ultra-short stops.

Q. How can the soak distribution be calculated?
(Located in the LOCATION FILE, below the VKT driving pattern data)

A. Instruments have been developed that can be placed in a vehicle to record when the vehicle starts. This information provides both the number of starts per day per vehicle, the time of day the starts occur, and how long the vehicle was sitting before the start. These instruments are called VOCE units. The methodology is described in the IVE field study document located on the website. An alternate method if monitoring equipment is not available is to ask drivers to keep a log of the time of each engine start for a week and provide that data for analysis.

Q. How do soak distributions and starts influence emissions?

A. Start patterns have a large impact on emissions (see the results of Pune, India and other areas: start emissions can count for half of all vehicle emissions). Because the engine and any catalyst on the vehicle is cold when the engine is first turned on, the vehicle will emit more emissions than if it was not started until the engine is fully warmed up. These excess emissions are defined as start emissions. In the IVE model, start emissions are categorized by how long the engine has been turned off at the time it is started (which correlates to how much the engine has cooled off and therefore how much start emissions there will be) and also the time of day when it is started (the ambient temperature affects how much start emissions will occur also). The data collected in these studies using VOCE units provide all of this information needed to fill out the start (soak) distributions for a particular area.

C. <u>FLEET QUESTIONS</u>

Q. What is the purpose of the Group 1 and Group 2 designation?
(located on the FLEET PAGE, and LOCATION PAGE)

A. Group 2 should be ignored.

Q. What if you would like to estimate emissions from only a portion of the fleet?

A. If you export the results, it will show the individual emissions from each technology. Alternatively, you can create a file for each type of the fleet, say one file for all 2 wheeled vehicles. Then you can run the IVE program using this fleet. For many locations, we have already created fleet files for the individual vehicle groups, which you can download from the website. You can also make your own by inputting the values in the IVE model or creating them in excel and exporting them. See section V of this User's Manual for more information on creating Fleet files. You may also need to adjust the distance or time in the location file to correspond to the amount of driving for the vehicle class of interest.

Q. How do you estimate total vehicle kilometer (VKT) in my city, since we don't know the actual number of vehicles on road, whereas we know only actual number of vehicles registered?

A. There are several methods for estimating the vehicle kilometers traveled (VKT) in an area. An estimate of annual average travel per vehicle can be calculated from the odometer reading and age of the vehicle. The government usually has available registration data for estimating the number of vehicles used in an area. Some assumptions, such as sales or scrappage rates, may need to be applied to this data.

Another way to develop an estimate of VKT is through visual observation of the number of vehicles that travel on different roadways during all hours of the day. This, combined with the length of roadways in an area, can be a first approximation of obtaining vehicle kilometers traveled. Refer to the IVE Field Study report in the Attachment D for more information.

Q. What is meant by small, medium and large passenger vehicles and trucks?

A. You can find a complete description of each technology in Attachment A. Small light duty vehicles refer to engines of less than 1.5 liters, medium of between 1.5 and 3, and large of greater than 3 liters in size.

Index