USE OF EMFAC 2002 TO REPLACE CT-EMFAC
A USERS GUIDE

The California Air Resource Board (CARB) has released EMFAC 2002 as the latest version of the California Mobile Source Emission Inventory (Emission Factors) model. Caltrans still recommends use of the CO Protocol to the extent possible, but in cases where a project cannot be handled using a screening method in the Protocol, it is necessary to perform CALINE4 modeling. Emission factors using the most recent accepted version of EMFAC must be used when modeling is performed.

In the past, EMFAC 7F was used for CO analysis purposes, even after release and US EPA approval of EMFAC 7G or 2000. With release of the EMFAC 2002 model, and its imminent approval for conformity use by US EPA, it will no longer be acceptable to use EMFAC 7F, or CT-EMFAC since it is based on EMFAC 7F, to generate the emission factors needed to carry out CALINE4 modeling as described in Appendix B of the CO Protocol. EMFAC 2002 use will be required. This document provides a step-by-step approach for using EMFAC 2002 to develop the needed emission factors for the most common situation: where the default vehicle fleet mix used in the EMFAC 2002 model (by county and air basin, rather than a statewide average as in earlier versions of EMFAC) is appropriate for the project area.

CT-EMFAC was a user interface and composite emission factor system developed at Caltrans in the early 1990's to ease use of EMFAC 7F when setting up CO modeling using CALINE4. EMFAC 7F was a command-line-driven program at the time, and was difficult to use by itself for generating project- or location-specific emission factors needed for microscale modeling. CT-EMFAC was essentially a port of mainframe programs and data entry screens, used internally at Caltrans, to a PC (MS-DOS) environment with minimal changes. EMFAC 2002 has a Windows-based interface that allows a user to perform various types of analyses without invoking a command-line program, so it is no longer necessary to have a separate program like CT-EMFAC.

This document was developed by the California Department of Transportation (Caltrans), with assistance from the University of California, Davis. The EMFAC models are developed and maintained by the California Air Resources Board (CARB).

CARB staff comments on earlier drafts of this procedure have been incorporated with the following exception: CARB staff suggested that the “Impact Rate Detail” output (with a .RTL file extension) be used, which provides detailed emission factors for more than 50 combinations of vehicle classes, fuel types, and technology groups. However, this CT guide is intended as a quick-start procedure for CT staff to produce emission factors needed for typical roadway projects. In most such cases, the EMFAC defaults for the project area (county and air basin) would be used. Most project engineers would not have access to data on the percentage of vehicles in each of the vehicle classes, fuel types, and technology groups needed to apply the detailed emission factors, especially for analysis years that may be as much as 30+ years into the future.

This CT guide continues to recommend use of the "RTS" output option, which provides composite emission factors for vehicle classes that would likely be used by a great majority of CT users. Use of the more detailed output may be addressed in a future revision of this CT guide, dealing with situations where use of the EMFAC defaults and a simplified set of vehicle classes is not appropriate.

For questions and comments about this document, please contact Michael Brady ((916) 653-0158; mike_brady@dot.ca.gov) or David Ipps ((916) 651-8197; david_ipps@dot.ca.gov) at Caltrans.

Procedure for Using the ARB's New EMFAC-2002 Model To Produce Emission Factors for the CALINE4 Model

A. Installing the EMFAC-2002 Model on Your Computer

Skip Section A and proceed to Section B if you have already installed the EMFAC-2002 Model on your computer.

1. Visit the ARB's web site for Mobile Source Emission Inventory, at: http://www.arb.ca.gov/msei/msei.htm

2. Go to the "EMFAC-2002 Release" page by clicking on the link: EMFAC2002.

3. Scroll down on the page, and click on the link EMFAC2002 [3.8MB] under the Software section, to download the EMFAC installation software.

4. Make sure the button for "Save this program to disk" is checked, then click on "OK".

5. Click on "Save" to save the installing program 'EmfacInst.exe' at a location on your computer. Remember the folder path to that location.

6. After downloading is complete, find the saved file 'EmfacInst.exe' in your file folders (using e.g., Windows Explorer or My Computer, on your computer's desktop). Double-click on that file to start the installation.

7. Keep clicking on "Next" several times (to install the program at the default location on your computer) until the "Finish" button appears. Click on "Finish".

8. To complete the installation, click on "OK" to re-start your computer at this time, or click on "Cancel" to re-start at a later time. You will not be able to run EMFAC 2002 until the computer is re-started.

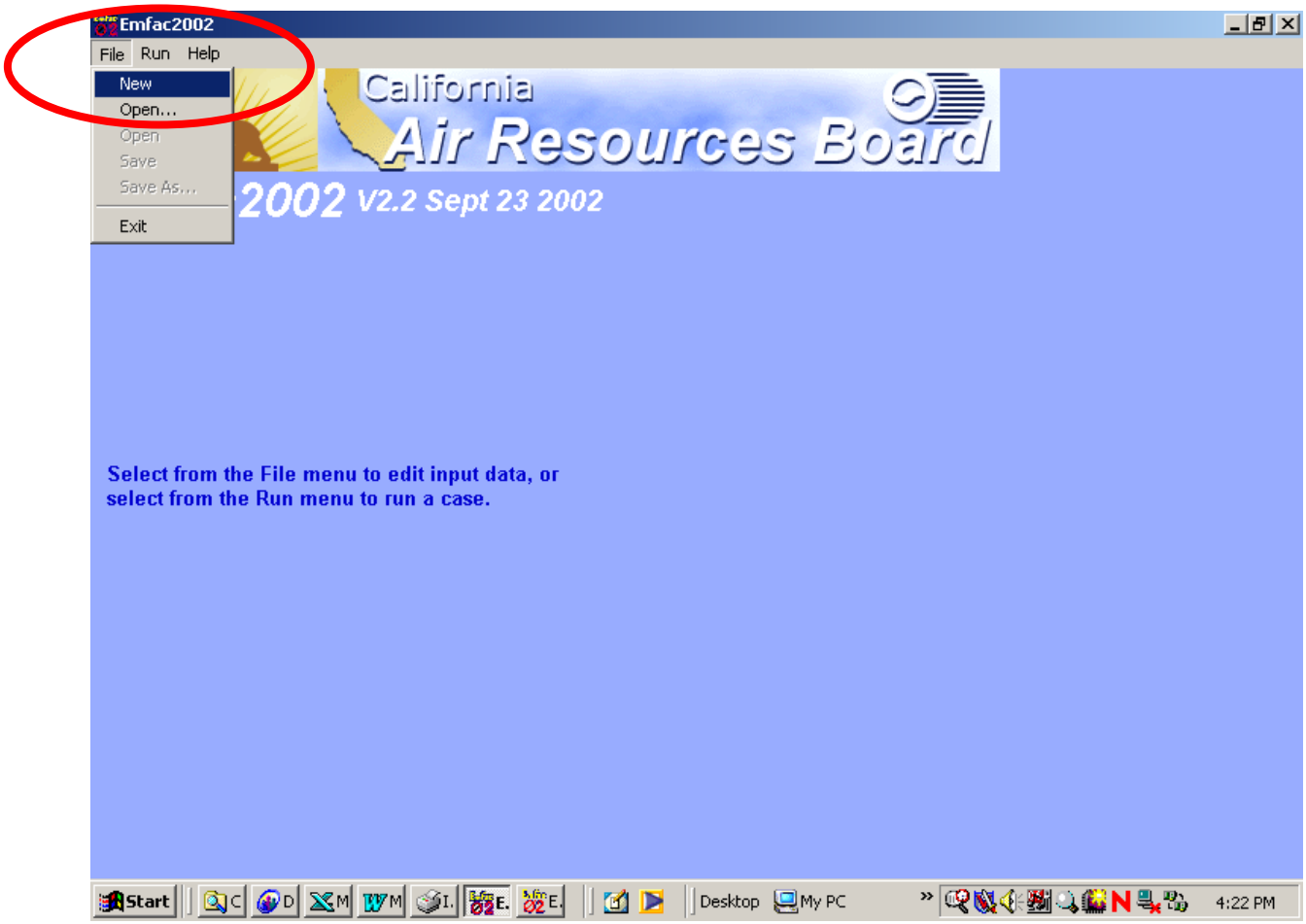
9. After re-starting your computer, proceed to Section B, Running the EMFAC-2002 Model.

B. Running the EMFAC-2002 Model as a Replacement for CT-EMFAC

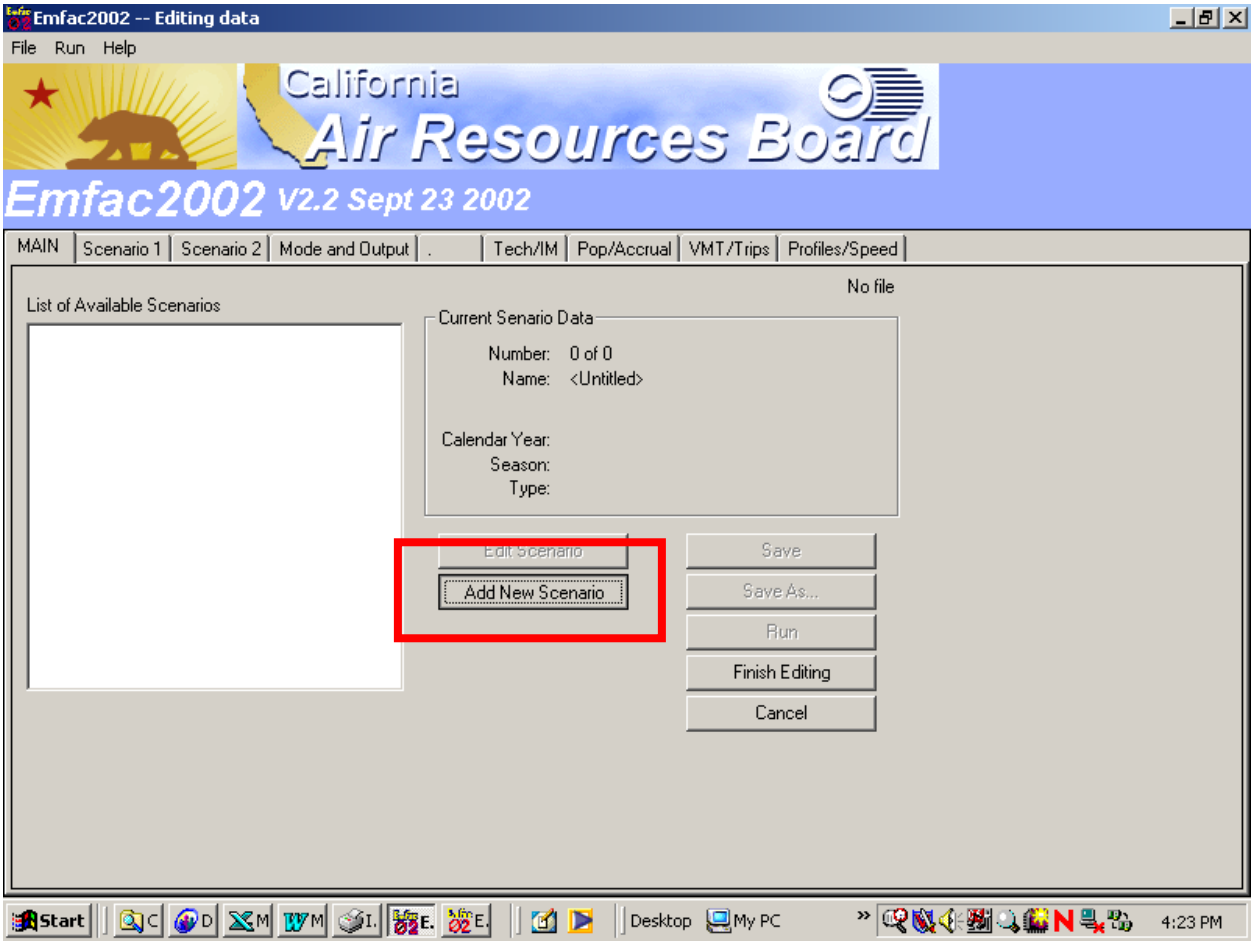
The following procedure shows the basic steps for using the model to replace CT-EMFAC in CO analysis. For other uses, including modeling of other pollutants in microscale analysis, please discuss procedures and practices further with CT Headquarters or ARB personnel. This procedure does not replace the documentation or user guides developed by the ARB, but rather is a quick start guide for analysis that historically would have relied upon the simplified interface of Caltrans' CT-EMFAC model. Users are encouraged to reference ARB's documentation to learn more about the capabilities of the model.

1. Start the Emfac2002 program by double-clicking on the file name 'Emfac2002.exe' after navigating to the program folder, by double-clicking on the 'Emfac 02' icon on the desktop if you created a shortcut there (during or after installation), or by locating 'Emfac 02' in your Start Menu and clicking on it. A window opens, with the logo for "California Air Resources Board" at the top. The words "Emfac 2002" appear under the logo. Make sure the version is "v2.2 Sept. 23, 2002" or later.

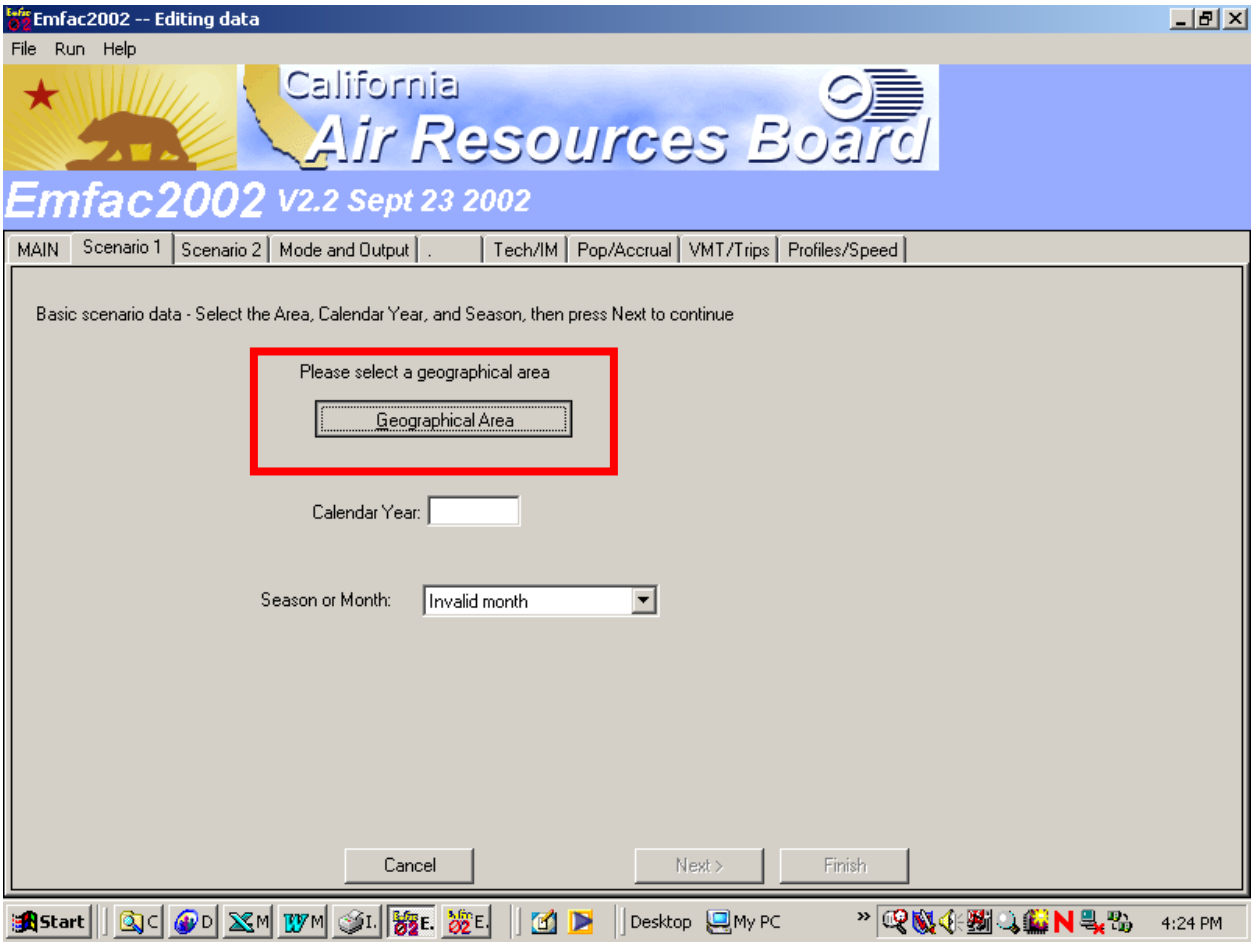
2. Click on "File" at the top tool bar, then in the pull-down menu, click on "New".



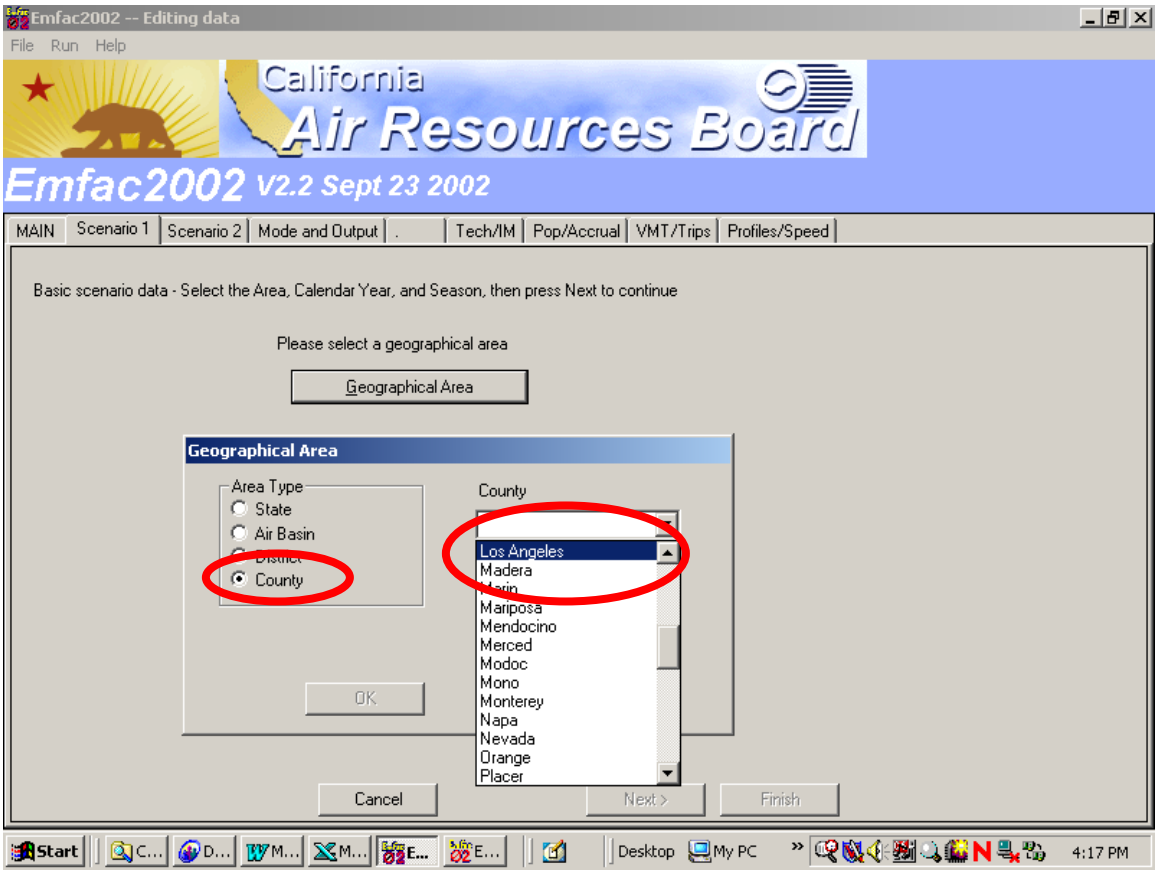
3. A screen with multiple tabs appears. Click on "Add New Scenario" near the center of the screen.



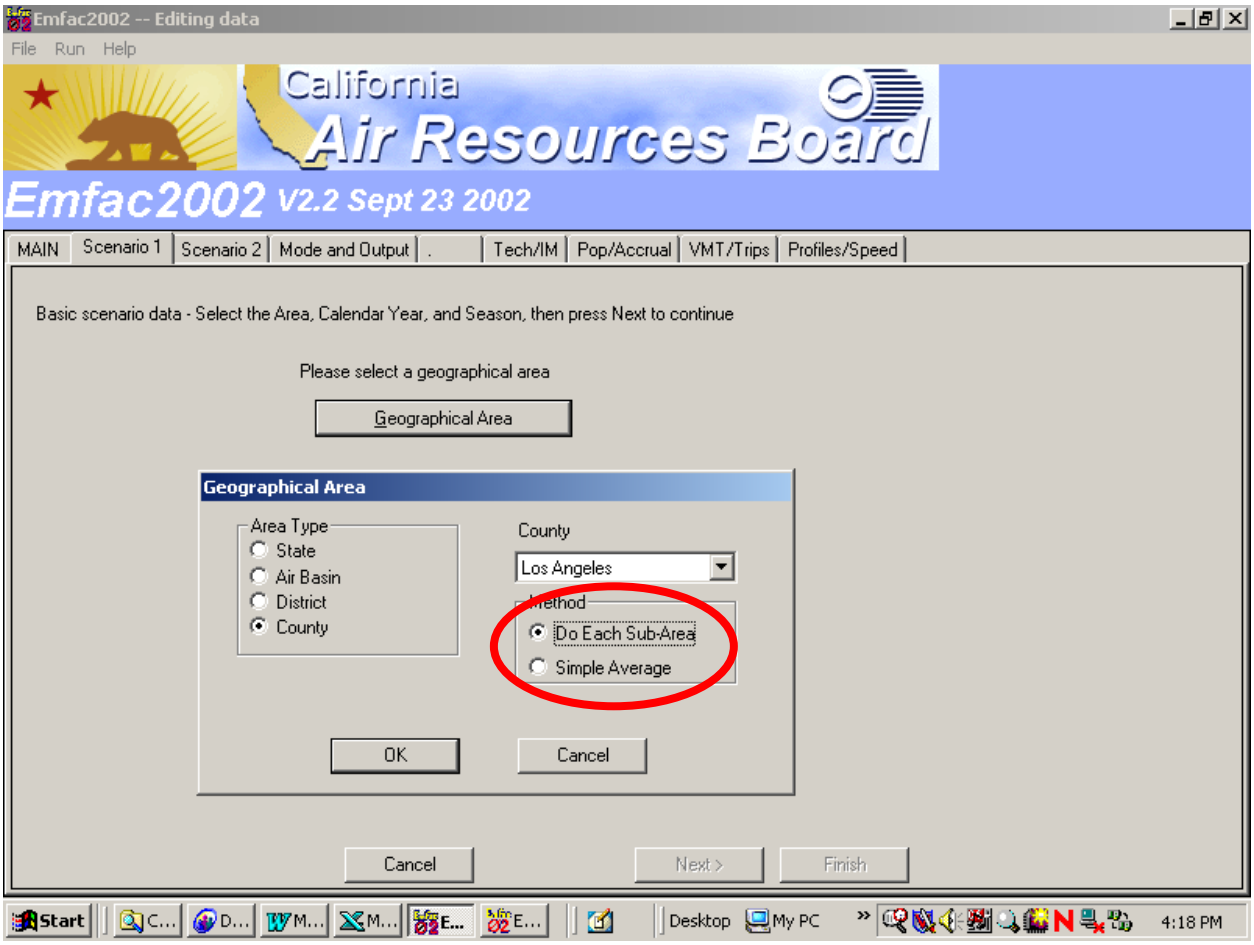
4. You are now in a screen under the tab “Scenario 1”. Click on “Geographical Area”.



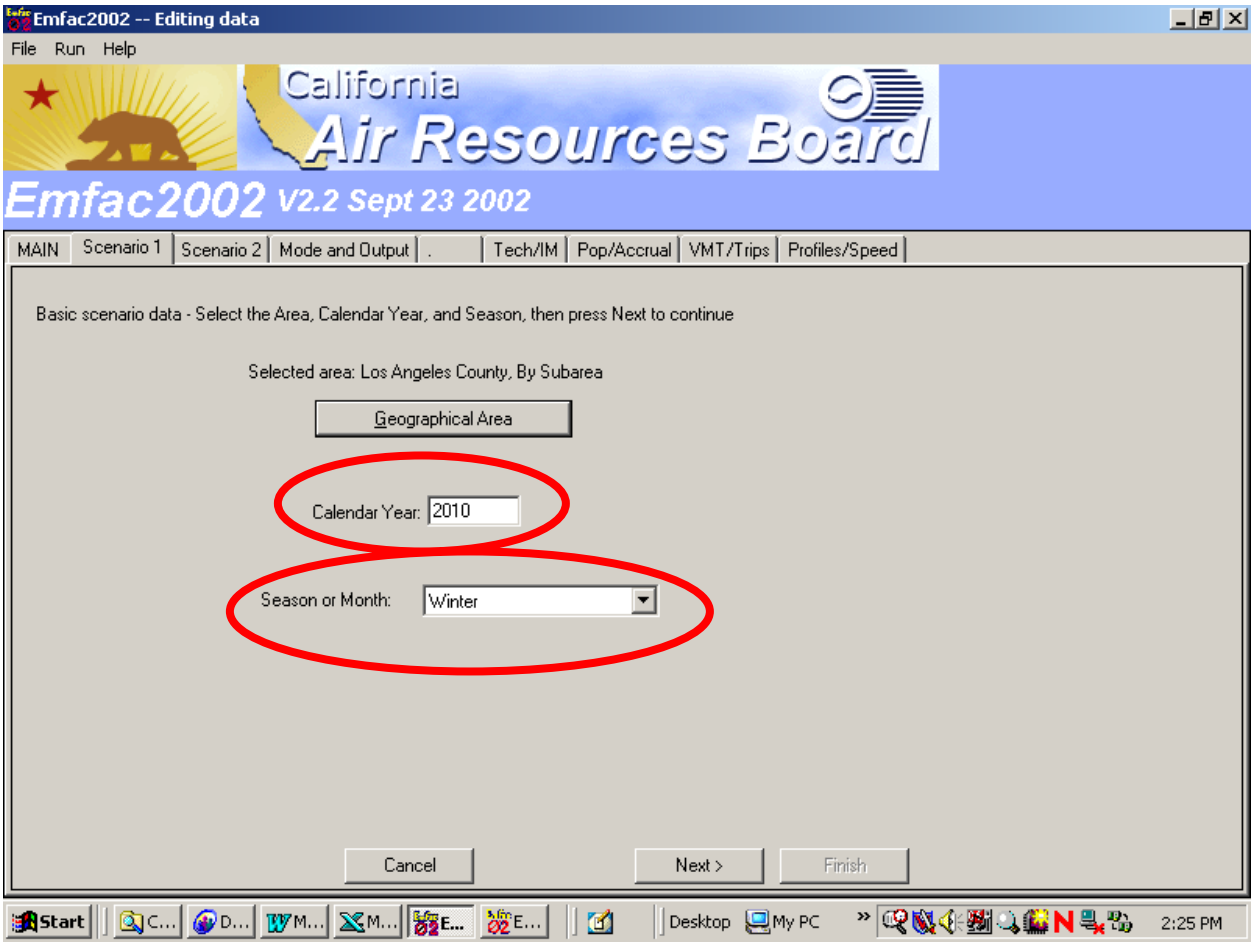
5. In the "Geographical Area" dialog box, under the "Area Type" list, check the button for "County". Under "County", click on the down arrow and then click on the county for which you wish to obtain emission factors. (For the remainder of this guide, "Los Angeles" County will be used as an example.)



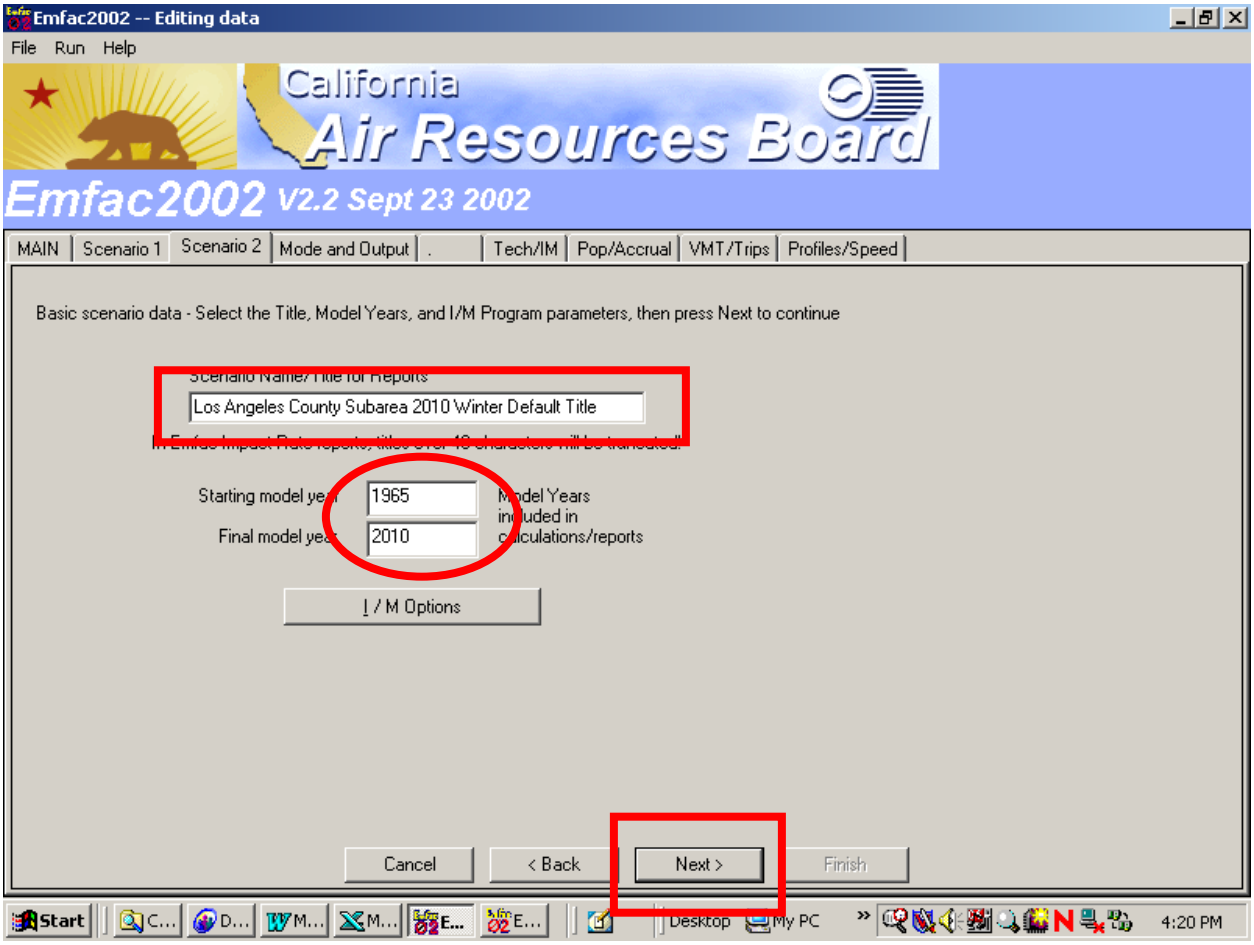
6. For counties that are in only one air basin, there is no need to select the buttons under "Method", which are dimmed out. But for counties such as Los Angeles that are divided into more than one air basin, click the button for "Do Each Sub-Area" under "Method" so that the output will provide emission factors for each air basin portion of the county. [Note: In this example, the output will contain emission factors for both the South Coast Air Basin portion and the Mojave Desert Air Basin portion. When using the output, be careful to use the factors for the portion corresponding to your project area.] Then click on "OK".



7. Back under the "Scenario 1" tab, in the space for "Calendar Year", type in the year (e.g. 2010) you wish to analyze. If the analysis year is after 2040, enter 2040; EMFAC cannot produce results for years after that. Under "Season or Month", click on the down arrow to show a list of months and seasons. Click on "Winter" if you are obtaining carbon monoxide (CO) emission factors, since winter is normally the high CO season. Then click on "Next".

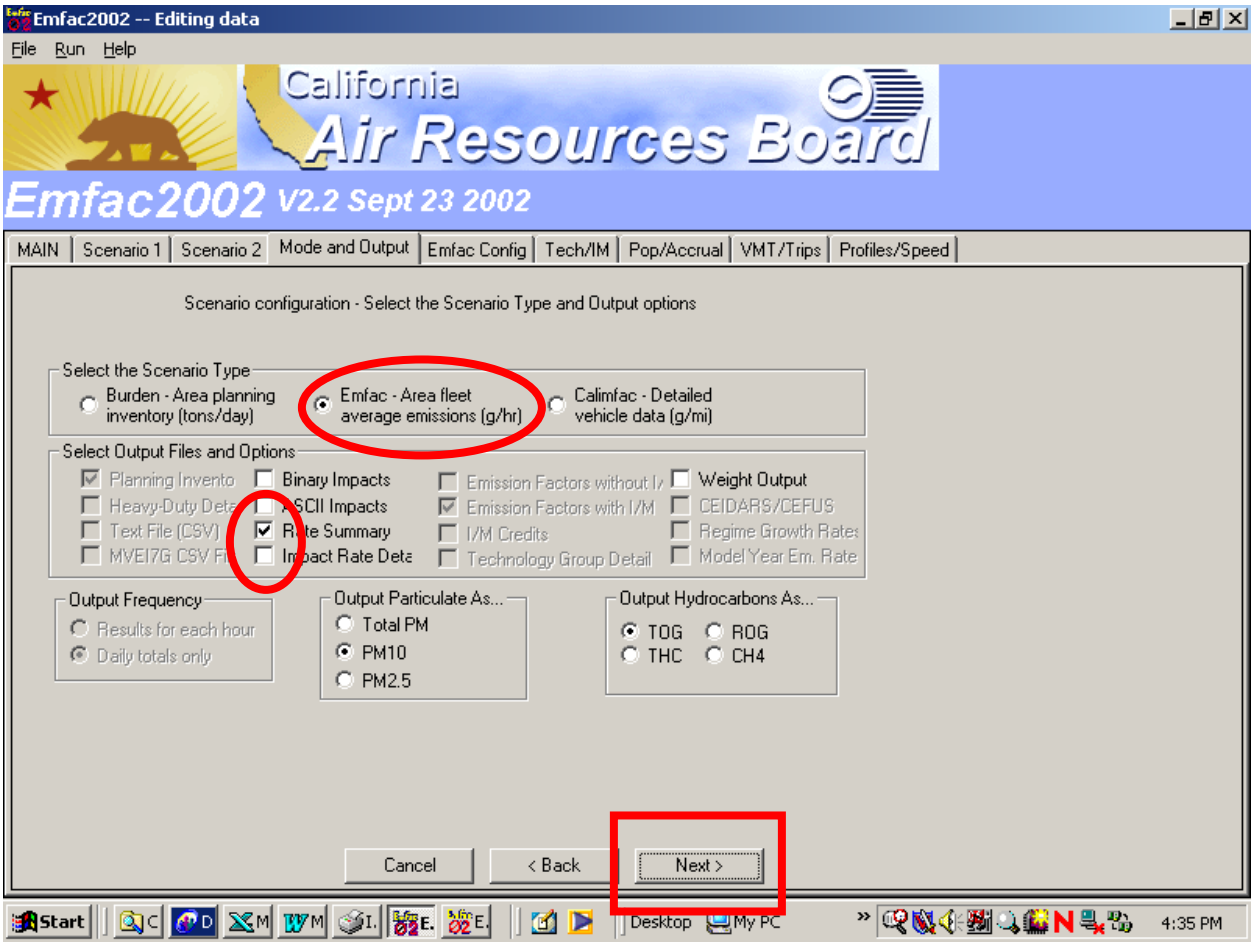


8. Now you are in the "Scenario 2" screen. Under "Scenario Name/Title for Reports", correct or customize the name/title if you wish. Use the default for "Starting Model Year." and "Final Model Year." Then click on "Next".



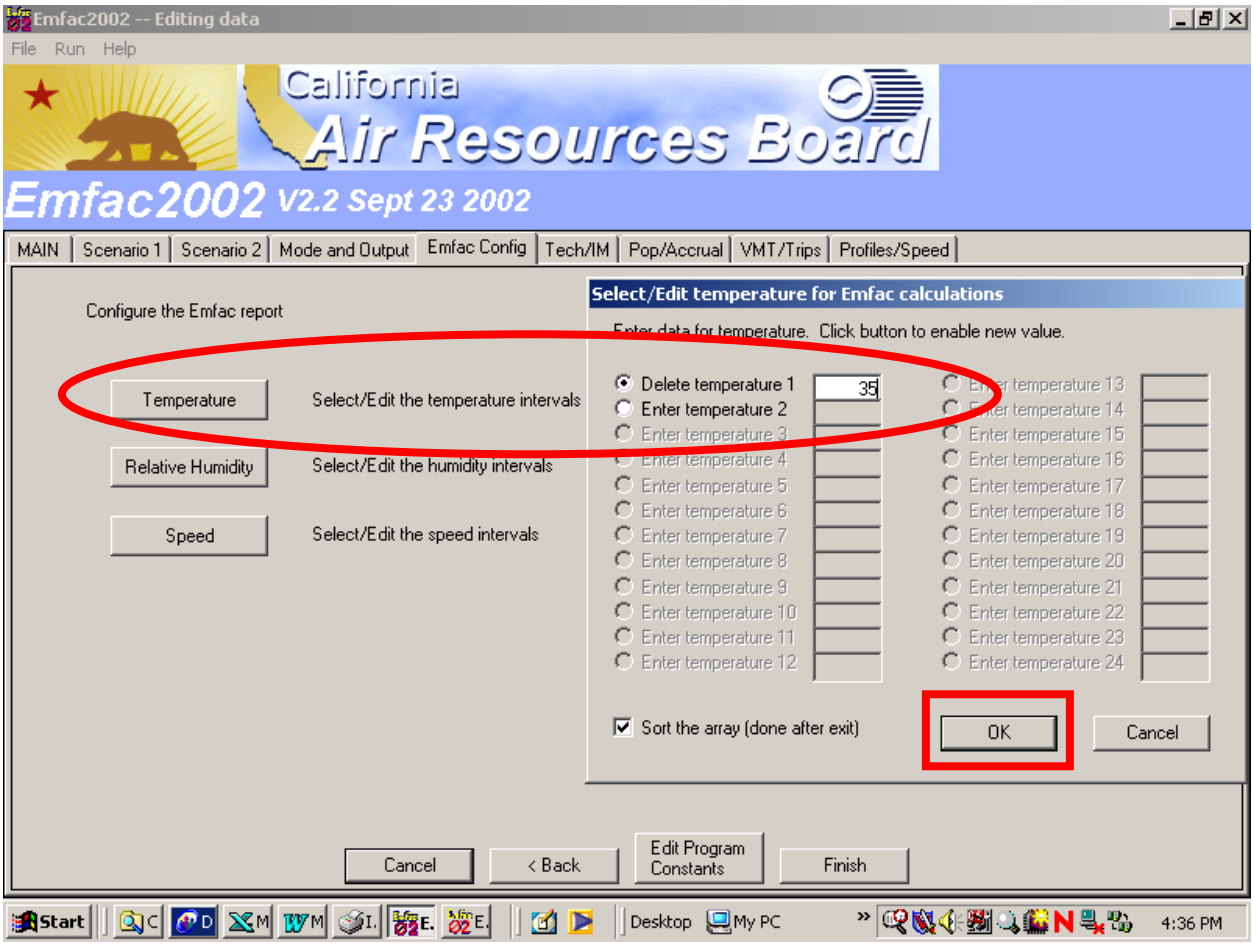
9. Now you are in the "Mode and Output" screen. Click on the button for "Emfac – Area fleet average emissions (g/hr)". Then click on the button for "Rate Summary", and remove the check in the button for "Impact Rate Detail". Then click on "Next".

   Users who want more detailed rates may wish to choose the "Impact Rate Detail" output (leave that box checked), which is less aggregated and in a CSV format. Please refer to CARB documentation for guidance regarding interpretation of the results. Impact rate details will normally be required only if the EMFAC default fleet (for the county and air basin the project is in) isn't appropriate for a project. Until a standard procedure is developed, consult with the MPO/RTPA and air district to establish the correct adjustments to fleet data and compositing procedures for such cases.



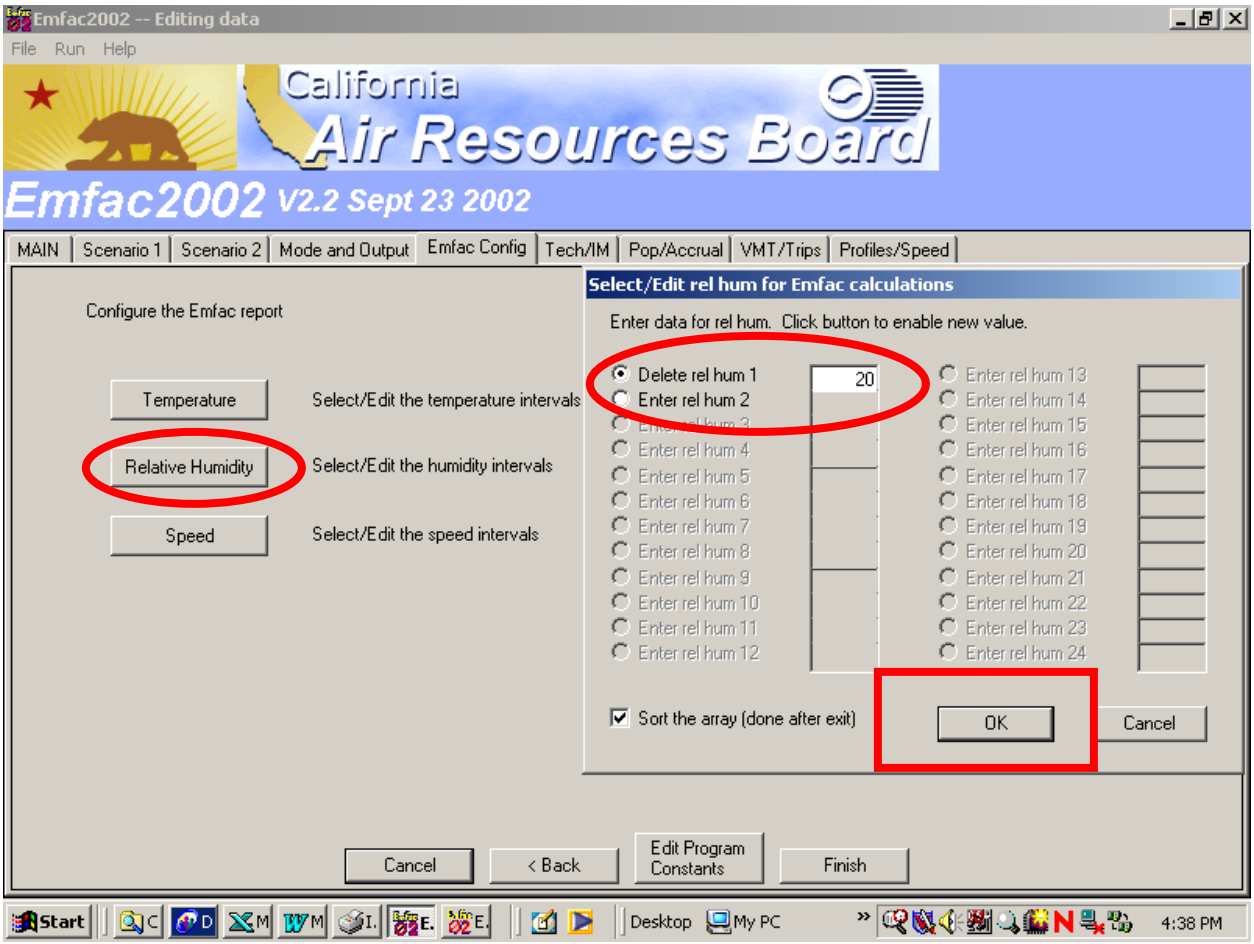
10. Now you are in the "Emfac Config" screen, in which you would enter the input value for each of the listed variables, temperature, relative humidity, and speed. EMFAC produces several pages of tabular output for each combination of relative humidity and temperature, the length of those tables is directly proportional to the number of vehicle speeds that EMFAC is reporting emission rates for; to reduce the output generated by the model to a couple of pages rather than hundreds, you will specify a single temperature, a single relative humidity, and a handful of speeds.

    First, click on "Temperature". Obtain from published sources the lowest January mean minimum temperature for the air basin, and make the needed adjustment to estimate the worst-case CO temperature (see the CO Protocol, Section B.3.3, for details). Keep clicking on the button for "Delete Temperature 1" until all temperatures (other than the last value) have been removed from the screen. Type the worst-case temperature (e.g. "35") in the first line to replace the remaining default value. Then click on "OK".

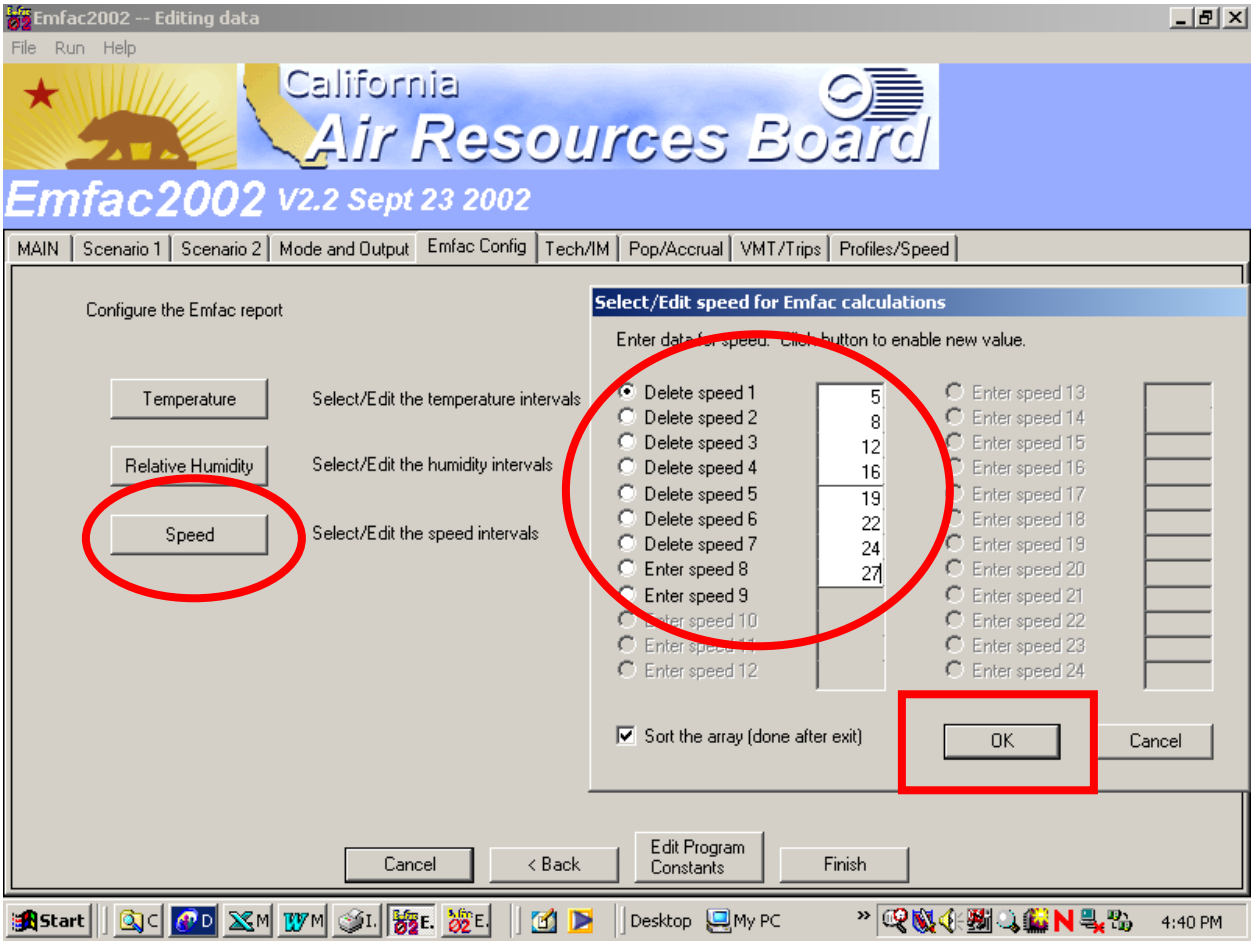


11. Back in the "Emfac Config" screen, click on "Relative Humidity". CO emission rates are not affected by humidity at the temperatures used for winter-season hot-spot analysis; so use any reasonable value such as 20 or 30 percent. Note that realistic values may be quite high in areas subject to persistent valley fog. Note also that other pollutants are sensitive to humidity – this comment only applies to CO.

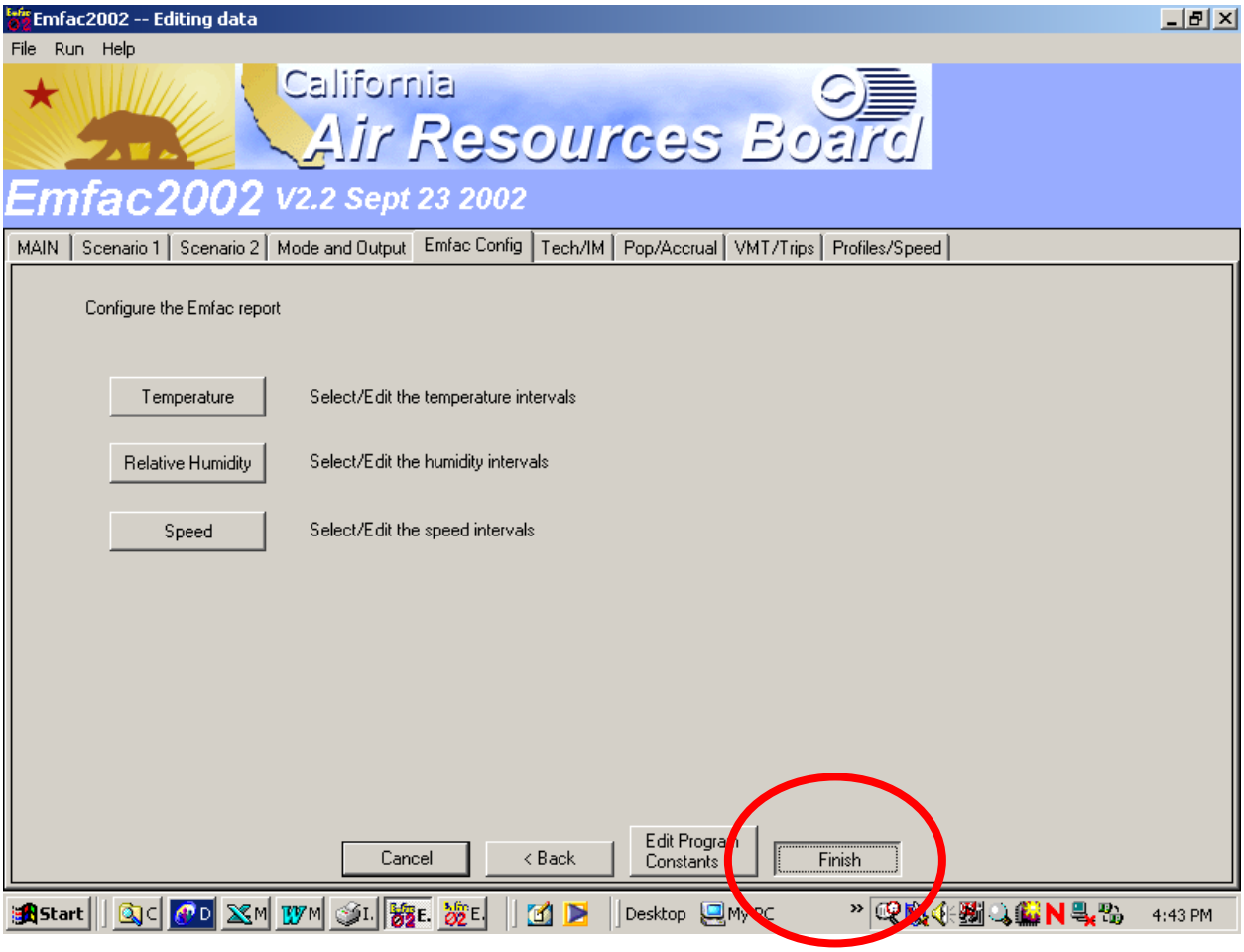
    Similar to the "Temperature" box, keep clicking on the first button until all values (other than the last value) have been removed from the screen. Type the % relative humidity (e.g. "20") in the first line to replace the remaining default value. Then click on "OK".



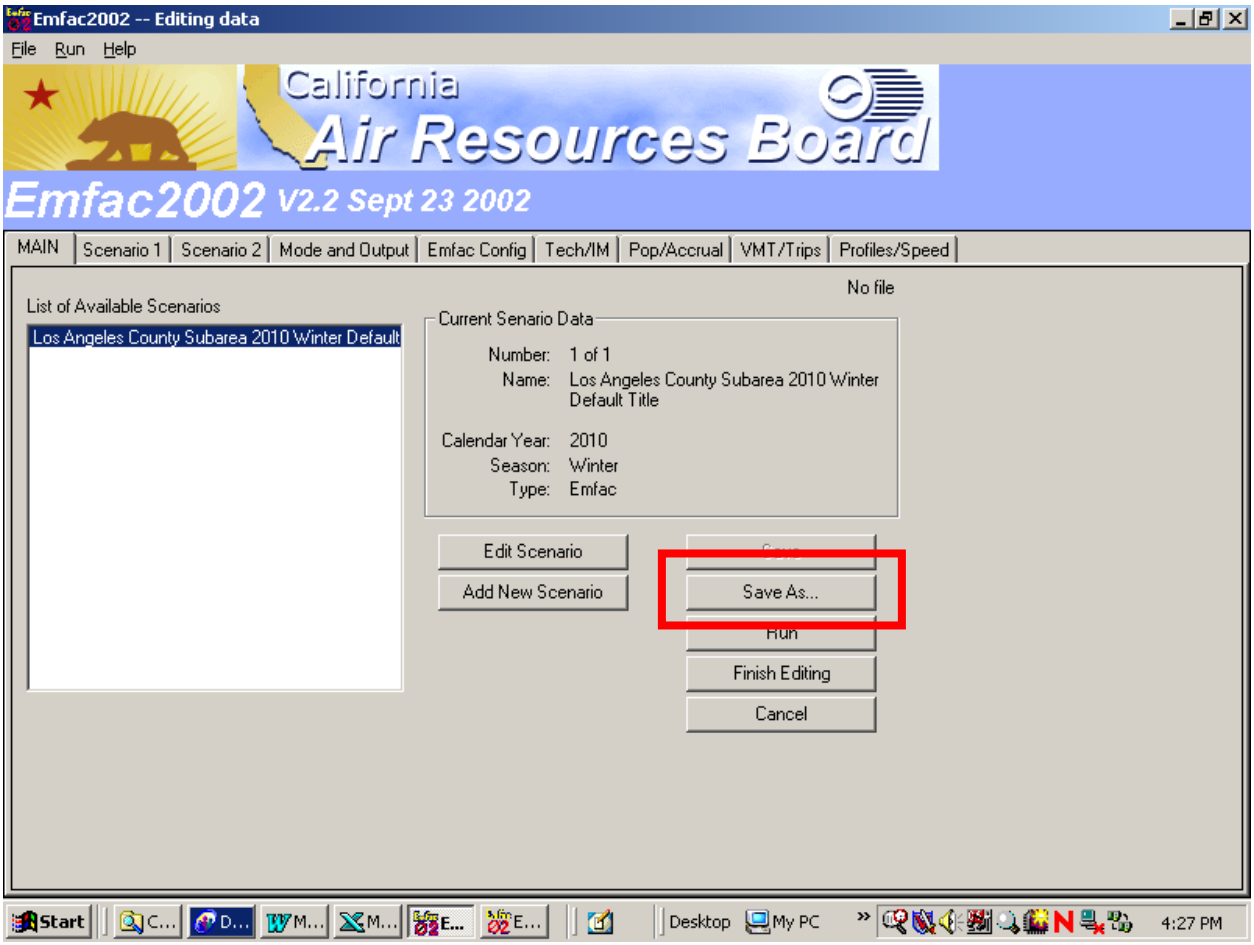
12. Back again in the "Emfac Config" screen, now click on "Speed". Use the CO Protocol, Section B.4.6 and Tables B.13 & B.14, to look up the approach and departure speeds. There should be at least eight average speeds (four approach speeds and four departure speeds) at a typical intersection. Keep clicking on the first button until there are only (in this example) eight lines remaining. Type the eight average speeds (after being rounded to whole numbers) in the lines to replace the default values. In this example, the eight speed values are 5, 8, 12, 16, 19, 22, 24, and 27. Then click on "OK".



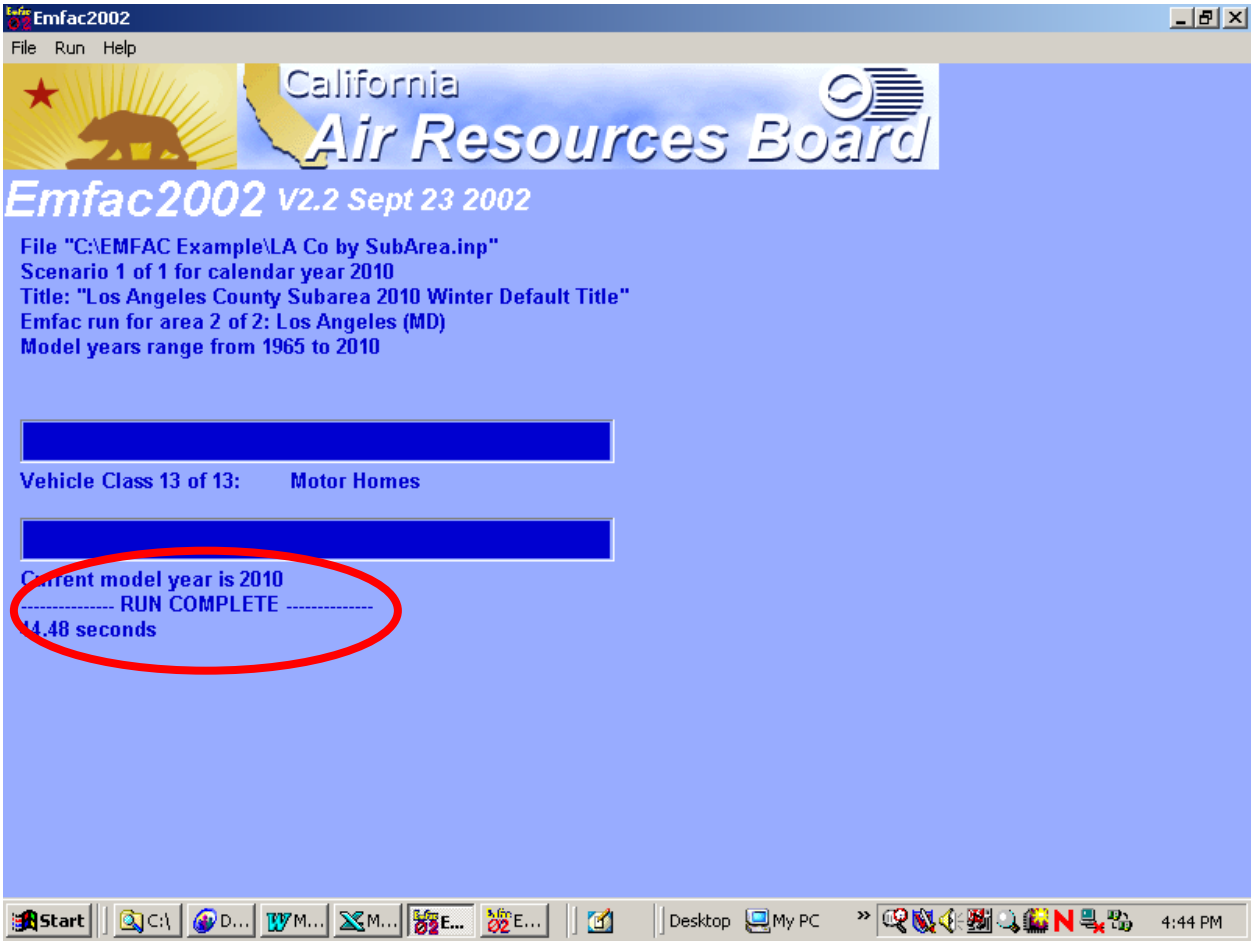
13. Back again in the "Emfac Config" screen, click on "Finish".



14. Now you are in the "MAIN" screen. Click on "Save As". This step allows you to save the input data file on your computer so you can replicate the analysis or make changes more easily. Select a folder path, and type in a new file name. Then click on "Save". The input file will have a file extension of '.INP'.



15. Back in the “MAIN” screen, click on “Run”. It will take about a minute for the program to run on a modern (Pentium 4, around 1 gHz) computer. Look for the indicator "----- RUN COMPLETE ----" to appear when running is done. The output file will be automatically sent to the same folder where you saved your input file. The output file has the same name as the input file, except that the file extension will be ‘.RTS’.



C. Using the EMFAC-2002 Output

1. Open the output file (.RTS) with a spreadsheet program such as Microsoft Excel. Change the default font to a constant-size (non-proportional) type font such as 'Courier', so that the data columns line up for easy reading (in Excel, left-click on the upper-left corner of the sheet, then click on the font's drop-down arrow and click on "Courier"). The first page of your output should look similar to the sample output on the next page. Note that the output contains emission factors for each subarea (air basin) of the county. In this example, the factors for the South Coast Air Basin are listed first, as indicated by "Los Angeles (SC)" before the Table number. The factors for the Mojave Desert Air Basin are listed in the second half of the output, as indicated by "Los Angeles (MD)".

2. The emission factors needed are under "Table 1: Running Exhaust Emissions (grams/mile)". When doing a CO analysis, look for the data table under the heading, "Pollutant Name: Carbon Monoxide", which should be the second pollutant under Table 1. Be careful not to use the table for "Carbon **Di**oxide" by error. Emission factors are tabulated for each of the (eight) input average speeds. There should be seven columns of emission factors: six for the six types of vehicles (such as LDA, for light-duty autos), and a last column entitled "ALL", which provides the composite emission factors for all six vehicle types, based on a default vehicle mix.

3. In most cases, the emission factors under the "ALL" column would be used for input to the Caline4 model. When the vehicle mix in the project area is expected to deviate from the county or subarea average, the user should consider the need to edit the vehicle population by vehicle class through the "Edit Program Constants" function of the model. [Please refer to the California Air Resources Board's User's Guide for the EMFAC2002 model for assistance in using the "Edit Program Constants" function.] For example, since emissions for a truck lane project should represent concentrated heavy-duty truck travel, the population should be weighted toward the truck fleet that is likely to use the facility. If you do not have the detailed fleet data needed to use the "Edit Program Constants" function, you may find it possible to calculate your own composite emission factors by applying your relative weightings to the emission factors of individual vehicle types (from the first six columns).

4. Connection to the Caline4 model – The output emission factors from the above EMFAC run should be entered into the CL4 model's 'Emission Factor' column under the 'Link Activity' tab.

Sample Output from EMFAC2002

```
Title     : Los Angeles County Subarea 2010
Winter Default Title
Version   : Emfac2002 V2.2 Sept 23
2002
Run Date : 02/20/03 16:41:58
Scen Year: 2010 -- Model Years: 1965 to 2010
Season    : Winter
Area      : Los Angeles (SC)
*****************************************************************************
     Year:2010 -- Model Years 1965 to 2010 Inclusive --  Winter
     Emfac2002 Emission Factors: V2.2 Sept 23 2002

     Los Angeles (SC)                    Los Angeles (SC)              Los Angeles (SC)

                            Table   1:  Running Exhaust Emissions (grams/mile)

     Pollutant Name: Total Organic Gases       Temperature:  35F  Relative Humidity:  20%
```

Speed MPH	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
5	0.601	0.929	1.078	2.013	6.266	6.853	0.844
8	0.475	0.742	0.859	1.659	4.925	5.872	0.674
12	0.357	0.564	0.651	1.310	3.657	4.907	0.513
16	0.277	0.442	0.509	1.058	2.789	4.227	0.403
19	0.234	0.375	0.431	0.914	2.315	3.855	0.342
22	0.200	0.324	0.371	0.798	1.951	3.575	0.296
24	0.183	0.297	0.339	0.734	1.755	3.432	0.271
27	0.161	0.264	0.300	0.654	1.515	3.274	0.240

```
     Pollutant Name: Carbon Monoxide           Temperature:  35F  Relative Humidity:  20%
```

Speed MPH	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
5	6.550	11.399	11.488	18.873	50.415	47.178	9.208
8	5.897	10.054	9.986	14.798	38.980	41.824	8.061
12	5.205	8.670	8.474	11.015	28.548	36.613	6.898
16	4.662	7.623	7.358	8.476	21.674	33.062	6.032
19	4.327	7.001	6.707	7.116	18.049	31.254	5.522
22	4.042	6.486	6.177	6.086	15.337	30.062	5.103
24	3.876	6.192	5.879	5.541	13.915	29.575	4.865
27	3.656	5.814	5.500	4.888	12.228	29.283	4.560

(Additional pages omitted)