EMFAC2014 Volume II - Handbook for Project-level Analyses

v1.0.7

April 30, 2014

California Environmental Protection Agency

Air Resources Board

Mobile Source Analysis Branch

Air Quality Planning & Science Division

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1 Introduction

The California Air Resources Board (CARB) maintains the EMission FACtors (EMFAC) model to assess emissions from on-road vehicles including cars, trucks, and buses in California. The latest version, EMFAC2014, reflects the ARB's current understanding of how vehicles travel and how much they pollute in California. EMFAC2014 includes updated data on California's car and truck activity and emission factors. The model also reflects the emissions benefits of ARB's recent rulemakings. EMFAC2014 can be used to estimate emission inventories or emission rates to support a variety of regulatory or planning efforts.

EMFAC2014 Project-Level Assessment (EMFAC2014-PL) is the EMFAC2014 tool designed to support project-level assessments. EMFAC2014-PL is triggered when EMFAC2014 is run under the Emission Rate mode. Using EMFAC-PL, emission rates are estimated based on user-specified, project-specific conditions: ambient outdoor temperature and relative humidity, vehicle speeds, vehicle classes, geographic location, and analysis period (month, season, annual average). EMFAC2014-PL can provide emission rates by vehicle model year, or aggregated ones over model years for a vehicle class. It also can provide emission rates by fuel type or emission rates aggregated over fuel types.

ARB has developed this handbook as a guide to use EMFAC2014 in conducting project-level analyses such as a PM-hot spot analysis required in transportation conformity determinations. This handbook describes the general steps for using EMFAC to generate emission rates for project-level analyses, and uses five sample scenarios to illustrate the general approach. This handbook assumes users already have basic understanding on how to install and run EMFAC2014. For instructions on how to install and run EMFAC2014, please refer to EMFAC2014 User's Guide[1].

[1] ARB, May 2015. EMFAC2014 User's Guide. Available at http://www.arb.ca.gov/msei/downloads/emfac2014/emfac2014-vol1-users-guide-052015.pdf

1.1 What's New in EMFAC2014-PL?

EMFAC2014-PL design and data content differs dramatically from the previous version, EMFAC2011-PL. On the design side, EMFAC2014-PL provides improved functionality, a more user-friendly GUI and an easy-to-access data format. On the data contents side, the model incorporates most recent data and assumptions on emission factors, vehicle activity, and impacts from recently adopted rules.

EMFAC2014-PL is an integrated model that provides emission rates for both light duty vehicles (LDV) and heavy duty trucks (HD). With EMFAC2011-PL, users needed to follow different approaches depending on project complexity and had to work with different modules to assemble the results[2]. However, with EMFAC2014-PL, users can generate all of the necessary information for a project-level analysis with EMFAC2014-PL alone.

The input options in EMFAC-PL resemble those in EMFAC2011-LDV and were simplified to be more user-friendly. All user inputs are fed into the model through GUI controls. The outputs are in comma-separated values (csv) format that can be easily opened and edited in MS Excel.

EMFAC2014 incorporates updates for running exhaust emission rates for selected vehicle categories, speed correction factors for the LDV and HD fleets, tire wear and brake wear emission rates, and HD idle emission rates. It also uses new statewide odometer schedules based on newer smog check data to compute deterioration, and has updated speciation profiles for total organic gas (TOG) and particular matter (PM).

EMFAC2014 calculates default vehicle activity using a new fuel-based methodology (see EMFAC2014 Technical Documentation, Chapter 3.3). EMFAC2014-PL uses default vehicle activity when users request aggregated emission rates across model years, fuel types or vehicle classes. It should be noted that the default activities in EMFAC2014 includes different assumptions on age distribution, fuel type composition and vehicle class composition compared with those in previous EMFAC models. For detailed discussion on emission rate aggregation method, please refer to EMFAC2014 Technical Documentation, Chapter 5.2. The aggregation

[2] ARB, 2011. Handbook for Project Level Assessment. Available at http://www.arb.ca.gov/msei/emfac2011-pl-handbook-for-project-level-analyses-final-020713-2.pdf

method and activities used as weights for each emission process are also presented in Appendix D in this handbook.

EMFAC2014 reflects recently adopted EPA and ARB's rules, including:

- Advanced Clean Car regulation
- Assembly Bill No. 1493 (Pavley) regulation
- On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation
- Heavy-Duty Phase I GHG regulation
- ARB Heavy-Duty Tractor-Trailer GHG regulation

EMFAC2014 does not produce official GHG emissions and only estimates tailpipe CO2 emissions, so the Low Carbon Fuel Standard (LCFS) does not have a significant impact on CO2 emissions from EMFAC model. This is because most of the emissions benefits due to the LCFS are derived from the production cycle (upstream emission) of the fuel rather than the combustion cycle (tailpipe).

Another major update in EMFAC2014 is the incorporation of natural gas (NG) trucks. In EMFAC2014-PL, NG trucks including refuse trucks and urban transit buses are modeled separately. Users who are interested in NG truck emission rates can obtain results from EMFAC2014-PL when choosing to output by fuel type.

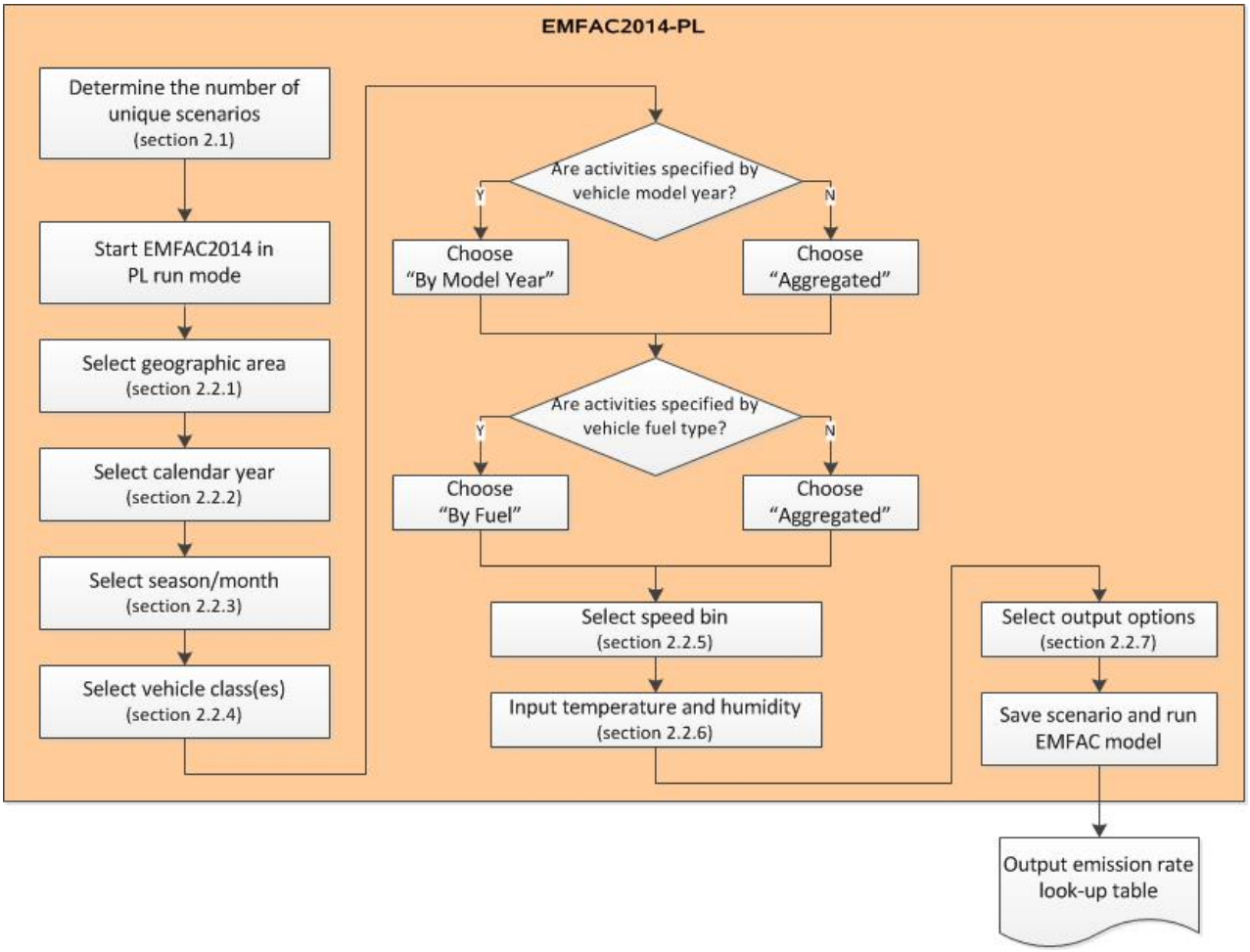
For a more detailed discussion on the methodology and data updates for EMFAC2014 model, please refer to EMFAC2014 technical documentation at http://www.arb.ca.gov/msei/downloads/emfac2014/emfac2014-vol3-technical-documentation-052015.pdf.

2 Approach to a Project Level Analysis

The figure below shows the general steps for using EMFAC2014-PL and points to the subsequent sections of this document that provide additional details.

In general, to use EMFAC2014-PL for a project-level analysis, users need to:

- determine the number of unique run scenarios based on the scope and resolution of the traffic activity data (a detailed discussion is provided in Section 2.1),
- gather project-specific input (Section 2.2),
- select desired aggregation scale, and
- execute the PL run and look up emission rate output for contents of interest (Section 2.3).



2.1 Determine the Number of EMFAC Runs

To use the EMFAC2014-PL efficiently, users need to first determine the number of runs needed that can sufficiently describe activity variation in a project. A single EMFAC2014-PL run allows users to select multiple areas or sub-areas, calendar years, vehicles, speed bins and meteorology conditions. However, when a project involves multiple areas or sub-areas, or includes multiple calendar years, it is likely that other inputs of interests, such as link speed or meteorology conditions may be different in each area or sub-area and may also vary by calendar year. Under these circumstances, users are recommended to run multiple scenarios, with each scenario characterizing a unique combination of fleet, speed bin and meteorology conditions for one area and calendar year. Compared to a single run with multiple areas and calendar years, the multi-run approach can eliminate unnecessary model runs, and reduces users' burden of having to filter out the desired results from massive outputs.

EMFAC2014-PL allows users to model one season (summer, winter or annual average) or one month in one run. Users who are interested in multiple seasons or month-to-month variation need to obtain results from multiple runs.

EMFAC2014 emission rates are not specified by hour of day, or day of a month. However, the main factors causing the temporal variation of emission rates for a particular vehicle type are meteorology conditions, that is, temperature and relative humidity. These meteorology conditions are used directly to define emission rates and *can be* specified by hour of day or day of month. EMFAC2014-PL accepts up to 24 sets of user-specified temperature and relative humidity combinations as input in one run. Therefore, users who are interested in temporal variation can prepare a list of unique temperature and humidity combinations under study. For example, in a typical project-level analysis where activities are specified by four time periods (morning peak, midday, evening peak and overnight), users should collect the temperature and relative humidity in each period and input the four pairs of values in one model run. If there are more than 24 sets of meteorology conditions of interest, multiple runs are needed.

2.2 Develop Scenario Inputs

2.2.1 Geographic Area

Upon starting a PL run, users first need to select the geographic area where the project is located. There are six region types: Statewide, Air Basin, Air District, MPO, County, and Sub-Area (GAI). Under each of these types, users can select one or multiple regions.

Regardless of which of the six region types are chosen, EMFAC2014-PL always generates emission rates at the GAI level and does not provide area-wide average emission rates for any geographic scale higher than GAI. When a project-level analysis involves more than one GAI, users are required to provide project-specific activities for each GAI separately.

For instance, Los Angeles County consists of two GAIs: the part located in the Mojave Desert Air Basin and the part located in the South Coast Air Basin. If a project is located in the port of Los Angeles, users only need to choose "Sub-Area" and pick "Los Angeles (SC)" to generate the emission rates. If a project is located in both GAIs of the Los Angeles County, users should choose "County" and pick "Los Angeles". Emission rates will be generated separately for the two parts of the county and users should prepare the project activities in each GAI separately to match the relevant emission rates.

The GAI selection matters in that, 1) different regions have different I/M (smog check) programs, which affect exhaust and evaporative emission rates; 2) different regions designate the same month to either summer or winter season differently, and HDT idle emission rates vary by season; 3) different regions have different RVP schedules and RVP affects evaporative emission rates; 4) exhaust emissions in El Dorado (LT) and placer (LT) are corrected for altitude.

2.2.2 Calendar Year

EMFAC2014 is designed to analyze calendar years from 2000 to 2050. It allows users to select multiple calendar years in single run. However, if other inputs, such as project travel speed, temperature or humidity, changes from one year to another, users should consider separate annual runs.

2.2.3 Season or Month

EMFAC2014 can only model one season (summer, winter, or annual) or one month in a single run. Season or month selection affects emission rates because seasonal fuel composition

differences lead to difference in fuel Reid Vapor Pressure (RVP), and RVP affects evaporative emissions. In addition, idle emissions rates also vary by season.

2.2.4 Vehicles

EMFAC2014-PL provides output in one of four vehicle categorization schemes: EMFAC2011, EMFAC2007, truck/non-truck, or truck1/truck2/non-truck. Vehicle classifications based on these four categorization schemes are presented in Appendix C.

The vehicle classes are listed by the vehicle categorization schemes. Under each scheme, users may choose one or more vehicle classes, and emission rates will be generated only for the selected vehicle classes. For example, if users select the EMFAC2007 scheme, then they may select from the 13 vehicle classes defined in EMFAC2007: LDA, LDT1, LDT2, MDV, MCY, LHD1, LHD2, MHDT, HHDT, MH, OBUS, SBUS, and UBUS. Emission rates will be aggregated to the scale of the chosen categorization scheme. For example, if users choose truck/non-truck, and select both "truck" and "non-truck" entries, the output will include aggregated emission rates for "truck" and "non-truck".

We suggest that users choose vehicle categorization closest to the characteristics of their project-level activity data. For instance, if for a project the activities are specified for MHDT and HHDT, which are EMFAC2007 classes, then users should choose the EMFAC2007 categorization scheme and select these two vehicle classes.

EMFAC2014-PL allows users the choice to output emission rates by model year or to output emission rates aggregated over model years. If the project-level activity data are specified by model year or age, users can choose the "By Model Year" option. If a project involves vehicles of a particular model year or model years, users can choose the specific model years after checking the "By Model Year" option. However, if a project involves multiple vehicle model years and users do not have the distribution of activities by model year, the "aggregated" option should be checked. EMFAC2014-PL will assume the default assumptions on activity distribution by model year in the aggregation.

In a similar manner, users may choose to output the data by fuel type or to aggregate over fuel type. If the project activity data are specified by fuel type, users may choose the "By Fuel" option and aggregate the emission rates for a particular fuel. In addition to the conventional fuel type, like gasoline and diesel, EMFAC2014-PL includes electric and natural gas as two other fuel types.

Special attention should be given to modeling bus fleets. Starting with EMFAC2011, additional bus categories were added to the vehicle class definitions:

- "Motor coaches" are heavy diesel buses with a specific body type used for interregional transportation, such as tour buses. Motor coaches are regulated under the Truck and Bus regulation.
- "All other buses" refer to *diesel* buses that are not school buses, urban buses or motor coaches. Rental shuttles and church buses fall in this category.
- While "OBUS" under EMFAC2007 vehicle classes refers to all other buses except school buses and urban buses, "OBUS" under the EMFAC2011 vehicle classes refers to the gasoline buses that are not school buses or urban buses.
- Urban transit buses (UBUS) in California consist of natural gas buses, gasoline buses and diesel buses.

2.2.5 Speed Bin

In EMFAC2014-PL, speeds are characterized in the form of speed bins at 5mph intervals. Therefore, users are required to provide project-specific VMT according to these speed bins. At least one speed bin needs to be selected. For projects assessed at a single speed, users can pick an appropriate speed bin as suggested below. For projects with a range of speeds, users need to distribute the VMT into each speed bin to match the corresponding emission rates.

The speed bin is defined by the upper range of each bin. For example, the "5 mph" speed bin refers to 0~5 mph, the "10 mph" speed bin refer to 5~10 mph, and so on. The speed correction factors for a speed bin are computed using the midpoint value of the speed range except for the higher speed bins (70 mph and above) where the speed correction curves are flattened. This is illustrated in the middle column of Table 2.2.5.1. For example, as is illustrated in the table, the activities paired with the emission rates for the 55 mph speed bin (far left column) are those at speeds between 50 and 55 mph (corresponding far right column).

Table 2.2.5.1 Speed Bin Definition

Speed Bin	Speed Value to compute SCF	Definition
5	2.5*	Speed <=5.0
10	7.5	5.0 < Speed <= 10.0
15	12.5	10.0 < Speed <= 15.0
20	17.5	15.0 < Speed <= 20.0
25	22.5	20.0 < Speed <= 25.0
30	27.5	25.0 < Speed <= 30.0
35	32.5	30.0 < Speed <= 35.0
40	37.5	35.0 < Speed <= 40.0
45	42.5	40.0 < Speed <= 45.0
50	47.5	45.0 < Speed <= 50.0
55	52.5	50.0 < Speed <= 55.0
60	57.5†	55.0 < Speed <= 60.0
65	62.5	60.0 < Speed <= 65.0
70	67.5	65.0 < Speed <= 70.0
75	67.5	70.0 < Speed <= 75.0
80	67.5	75.0 < Speed <= 80.0
85	67.5	80.0 < Speed <= 85.0
90	67.5	Speed >85.0

*For HD vehicles, speed correction factors for speed bin 5 are computed at the speed of 5 mph.

†For HD vehicles, speed correction factors for speed bins 60 and above are computed at the speed of 55 mph.

Therefore, if a project accesses link speed at 50 mile per hour, users are suggested to use the 50 mph speed bin for a rough estimate, or to compute the weighted average of emission rates at 50 mph bin and 55 mph bin for a more accurate estimate.

That is,

$$ER_{user} = ER_{lowerbin} * \left(\frac{Speed_{upperbin} - Speed_{user}}{5}\right) + ER_{upperbin} * \left(\frac{Speed_{user} - Speed_{lowerbin}}{5}\right)$$

Where the $Speed_{upperbin}$ refers to the midpoint speed for the upper speed bin used in the calculation, and the $Speed_{lowerbin}$ refers to the midpoint speed for the lower speed bin used in the calculation. In the above example, the upper bin is 55 mph and the lower bin is 50 mph, therefore the $Speed_{upperbin}$ is 52.5 mph and the $Speed_{lowerbin}$ is 47.5 mph, that is,

$$ER_{50} = ER_{50mph\ bin} * \left(\frac{52.5 - 50}{5}\right) + ER_{55mph\ bin} * \left(\frac{50 - 47.5}{5}\right)$$

$$= 0.5 \cdot ER_{50mph\ bin} + 0.5 \cdot ER_{55mph\ bin}$$

2.2.6 Ambient Outdoor Temperature and Humidity

In EMFAC2014-PL, users need to specify the project-specific outdoor ambient temperature and relative humidity conditions under which the project is assessed. At least one pair of temperature and relatively humidity values needs to be provided. The value of temperature can be any integer from -20 to 120 (F)[3]. The value of relative humidity can be any integer from 0 to 100 (%). EMFAC2014-PL accepts up to 24 pairs of temperature and humidity values in a single run, which enables analyses of hour-of-day variation with a single run.

[3] In EMFAC2014 default California meteorology data, the temperature range is (16.7F, 106.9F) and the relative humidity range is (13.4%, 100%)

2.2.7 Output Options

At the last input step, users can choose the pollutants for which emission rates are to be included in the output.

Users can also choose whether to split the output by GAI and calendar year. When a run includes multiple GAI or calendar year, this option effectively controls the size of the output data table.

Table 2.2.7.1 summarize the user options and default assumption for each input data discussed above.

Table 2.2.7.1 Input Data User Options and Default Assumptions

Input Data	User's Option or Default
Geographic Area	-
- Geographic Scope	Multiple scales, multiple selection
- Aggregation Scale	Always by sub-area
Calendar Year	Multiple selection
Vehicles	-
-Vehicle class aggregation	Multiple scales, multiple selection
-Fuel type aggregation	Optional
-Model year aggregation	Optional
Pollutants	Multiple selection
Temperature	Any integer, up to 24 entries
Relative humidity	Any integer, up to 24 entries
RVP	Default only
Speed	Multiple selection of speed bins
pop by vehicle/fuel/age	Default data used for aggregated emission rates
VMT by vehicle/fuel/age	Default data used for aggregated emission rates
Trips by vehicle/fuel/hour	Default data used for aggregated emission rates
VMT hourly distribution	Not used in PL. User prepare this data to conduct hourly analysis.
Speed Fractions by hour	Not used in PL. User prepare this data to conduct hourly analysis.

2.3 Use Emission Rate Outputs

Upon completion of a model run, emission rate outputs are generated in one or more csv files. The naming of the csv files consists of a scenario name and a time stamp. The csv file contains emission rates by calendar year, season or month, sub area, selected vehicle classification, temperature, relative humidity, process, speed bin or soak time, and pollutants.

Table 2.3.1 Summary of Columns in CSV output Files

Column Name	Description
calendar_year	Calendar Year between 2000 -2050
season_month	Annual, summer, winter or one of the twelve months
sub_area (GAI)	Sub Area as defined in Appendix B
vehicle_class	Vehicle class selected based on user-selected categorization, refers Appendix C
fuel*	Gasoline, diesel, or other fuel types
model_year*	Model years
temperature	Temperature in Fahrenheit
relative_humidity	Relative humidity in percentage
process	Emission process
speed_time	For running exhaust (RUNEX), the “speed_time” column provides the speed bin ranging from 5 mph to 90 mph. For the start process, this field provides the soak time prior to vehicle starting in minutes, ranging from 5 minutes to 720 minutes. For other processes, where emissions rates do not depend on speed bin or soak time, this field is blank.
emission_rate	Emissions per unit of activity

* These fields depend on user’s choice

In EMFAC2014-PL, emission rates are always specified by process. A project-level analysis should combine these emission rates with the appropriate activities. Table 2.3.2 shows, for each process, the associated emission rate units and associated activity.

Table 2.3.2 EMFAC2014-PL Emission Rate and Activity Units by Process

Process Name	Process type	Unit	Associated Activity
RUNEX	Running Exhaust	gram/veh-mile	VMT by Speed Bin
IDLEX	Idle Exhaust	gram/veh-idle hour	Number of Idle Hours
STREX	Start Exhaust	gram/veh-start	Number of starts
HOTSOAK	Hot Soak Evaporative	gram/veh-start	Number of starts
RUNLOSS	Running Loss Evaporative	gram/veh-hour	Vehicle running hour
PRESTLOSS	Partial Day Running Loss Evaporative	gram/veh-hour	Vehicle Population
MDRESTLOSS	Multi-Day Running Loss Evaporative	gram/veh-hour	Vehicle Population
PDIURN	Partial Day Diurnal Loss Evaporative	gram/veh-hour	Vehicle Population
MDDIURN	Multi-Day Diurnal Loss Evaporative	gram/veh-mile	Vehicle Population
PMBW	Brake Wear	gram/veh-mile	VMT over all speed bin
PMTW	Tire Wear	gram/veh-mile	VMT over all speed bin

2.3.1 RUNEX: Running Exhaust Emission Rates

Running Exhaust (RUNEX) emissions refers to the emissions that come out of the vehicle tailpipe while the vehicle is traveling on the road, including at speed and idling that occurs at part of the normal driving, such as at intersections. RUNEX emission rates in a PL output are specified by temperature, relatively humidity and speed bin.

2.3.2 IDLEX: Idle Exhaust Emission Rates

Idle Exhaust (IDLEX) emissions refer to the emissions during extended idling events by heavy duty trucks, where the engine was turned on and off with no appreciable distance traveled. Extended idle may occur during loading or unloading goods, or to power accessories. Idle

exhaust is calculated only for heavy-duty trucks. For light duty vehicles, the idle events during normal vehicle operation are already accounted for, i.e. RUNEX emission rates are based on driving cycles that include normal idling events. IDLEX emission rates do not vary by temperature and humidity, and are not related to speed bins.

In EMFAC2014-PL, idle emission rates represent emissions *from the main engine only*; emissions from auxiliary power systems (APS) are excluded. The reason for this is that an APS is operated independently from the truck's main engine and behaves very differently. For users interested in project level APS emissions, APS emission rates are provided in Appendix E. Note that, in EMFAC2014 (not PL), the emission inventory estimation procedure for APS emissions is to include them as part of total HHDT idle emissions rather than as an independent process.

Idle emission rates are in units of grams per vehicle idle hour. To estimate idle emissions from an HD fleet, idle emission rates should be coupled with the total number of hours that the HD fleets engage in idling in the analysis time frame.

2.3.3 STREX: Start Exhaust Emission Rates

Start Exhaust (STREX) emissions are the extra emissions that occur when a vehicle is starting because the emissions-control equipment has not yet reached its optimal operating temperature. Start exhaust emissions are independent of running exhaust emissions. The magnitude of start emissions is dependent on the soak time, that is, the duration between the last engine-off event and the current engine-on event. In general, the longer the soak time is, the higher the STREX emissions. EMFAC2014-PL estimates start emission rates using 18 different soak time bins, ranging from 5 minutes to 720 minutes. Starts after the vehicle engine has been shut-off for more than 720 minutes (12 hours) are considered cold starts and are assumed to have the same STREX emission rates.

Please note in EMFAC2014-PL, STREX emissions are from gasoline vehicles only. The diesel HD start emission process is a new addition to the EMFAC2014 emission inventory modeling but is

not currently included in the PL model. More details on HD start emission rates can be found in section 3.2.3.6 of the EMFAC2014 Technical Support Document[4].

Please also note that, given the different definitions of start events, for MHDT, HHDT, OBUS and SBUS, STREX emission rates only represent those of the gasoline sub-fleets, even when users select to generate aggregated emission rates across fuel types. Therefore, if users are interested in start emissions, the analysis should be conducted by fuel type, including preparing vehicle activities by fuel type and generate emission rates by fuel type using EMFAC2014-PL.

To estimate start emissions for a project, users need to prepare the number of starts by soak time bin. This includes the cases where a project has a known typical soak time, or a known soak time distribution.

2.3.4 Evaporative Emission Rates

Evaporative emissions include four major processes: *hot soak*, *running loss*, *diurnal* (both partial-day and multi-day diurnal), and *resting loss* (both partial day and multi-day resting loss).

Hot Soak. *Hot soak* emissions are the hydrocarbon (HC) emissions that emanate from a vehicle within 35 minutes after the engine is turned off (ARB. 2000)[5]. Hot soak emission rates are in the unit of gram per vehicle start and should be combined with the number of starts to estimate total emissions.

Running Loss. *Running loss* emissions are the HC emissions that emanate from components of the vehicle other than the vehicle tailpipe while the engine is on. Running loss emission rates in EMFAC2014PL are in the unit of gram per running hour, that is, per hour that the vehicle is operating. To estimate total running loss emissions, the emission rates should be coupled with the total number of vehicle operating hours within the analysis period.

[4] EMFAC2014 Technical Support Document. Available at http://www.arb.ca.gov/msei/downloads/emfac2014/emfac2014-vol3-technical-documentation-052015.pdf

[5] ARB, 2000. EMFAC2000 Technical Support Documentation. Available at http://www.arb.ca.gov/msei/onroad/doctable_test.htm

Diurnal and Resting Loss. *Diurnal* emissions are the HC emissions from a sitting vehicle as the ambient temperature rises. Resting Loss emissions are the HC emissions from a sitting vehicle as the ambient temperature declines or remains constant. Depending on the duration of the engine soak time, diurnal and resting loss are each divided into partial day (soak time less than 24 hours) or multi-day (soak time greater than 24 hours).

The calculation of total diurnal and resting loss emissions is illustrated in the equation below as a product of population and the sum of partial day emission rates and multi-day emission rates.

$$Total\ Diurnal\ and\ RestingLoss\ Emissions\ in\ a\ particular\ hour = (ER_{PD} + ER_{MD}) * Population$$

Where,

$$ER_{PD} = \begin{cases} ER_{PDIURN} & if\ temperature\ rises \\ ER_{PRESTLOSS} & if\ temperature\ delines\ or\ \ remains\ constant \end{cases}$$

$$ER_{MD} = \begin{cases} ER_{MDDIURN} & if\ temperature\ rises \\ ER_{MDRESTLOSS} & if\ temperature\ delines\ or\ \ remains\ constant \end{cases}$$

As is indicated in the equation, the specific partial day diurnal emission rate (ER_{PD}) or multi-day diurnal emission rate (ER_{MD}) depends on whether the ambient temperature is rising (diurnal emission rate) or falling (resting loss emission rate).

Both diurnal and resting loss emission rates are expressed in units of grams per vehicle hour.

In order to estimate total diurnal and resting loss emissions from a project, the user should select the partial day and multi-day diurnal or resting loss emission rates depending on the ambient temperature trend for each hour (i.e. whether temperatures are rising or falling over time). Where temperatures are rising, then diurnal is used; and where temperatures are falling, then resting loss is used. The partial day and multi-day emission rates are then multiplied by the fleet total population, and summed over their associated hours within the analysis period.

Like start emission rates, evaporative emission rates for MHDT, HHDT, SBUS and OBUS categories only represent the gasoline sub-fleets. Users are advised to conduct the analysis by fuel type if they are interested in evaporative emissions.

2.3.5 Brake Wear and Tire Wear Emission Rates

Brake wear and tire wear PM emission rates are in units of grams per vehicle mile and should be based on total fleet VMT in the analysis time frame. In EMFAC2014-PL, brake wear and tire wear emission rates do not vary by speed bin so the associated VMT should be the total VMT over all speed bins.

3 Sample Scenarios

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3.1 Scenario 1: Arterial Link with Default Fleet Mix

Project Details

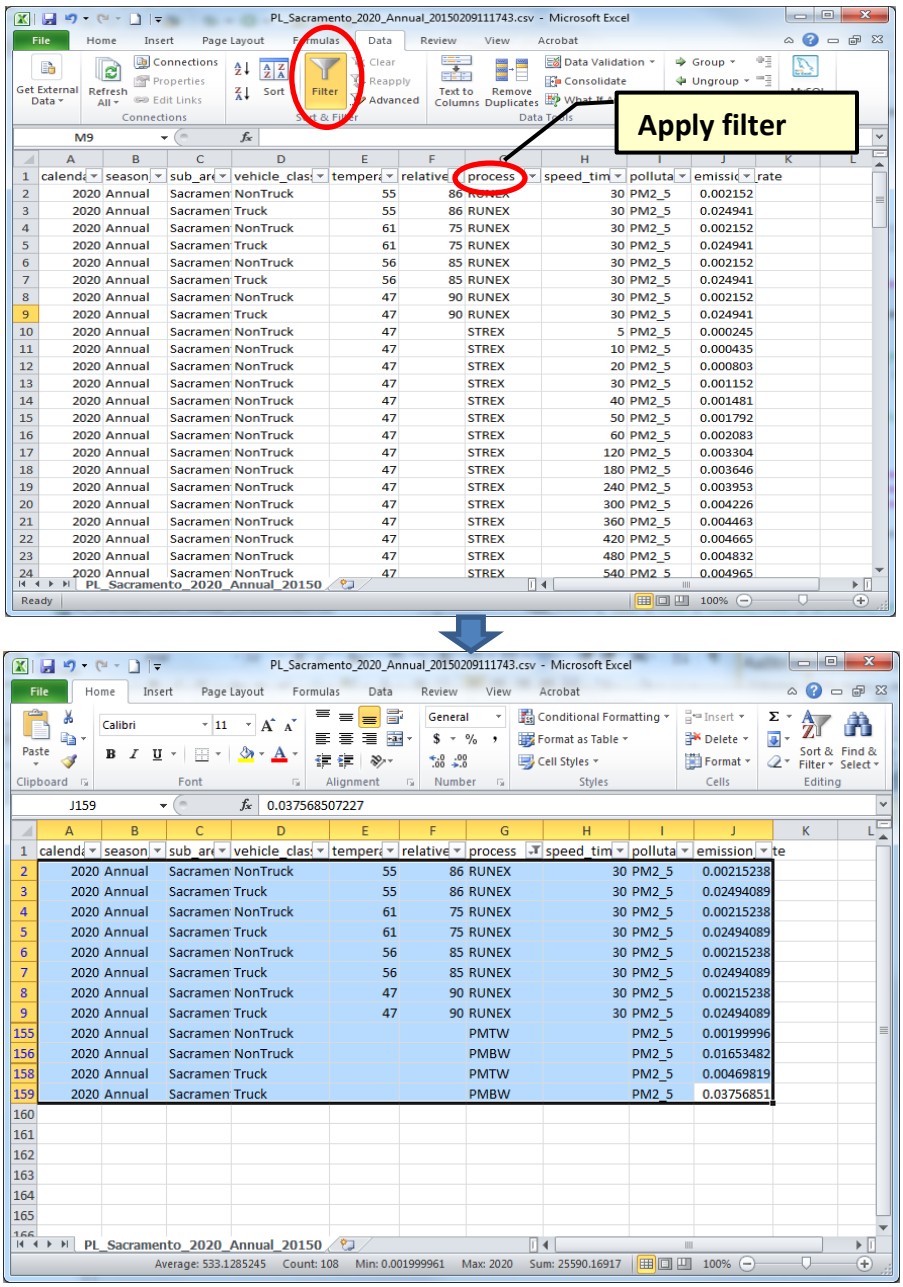
- The project is for a lane expansion on an existing arterial
- Location: Sacramento, CA
- The project is expected to be completed in 2019
  - Year of expected peak emissions (analysis year): 2020
- Area is in nonattainment of the annual PM2.5 NAAQS and the 2006 24-hour PM2.5 NAAQS
- Assessment performed for four periods of a day: Morning peak, Midday, Evening peak, and Overnight
- VMT split between Truck and Non-Truck is known
- Average link speed: 30 mph, same for any period
- Meteorology data for the four periods available

Using EMFAC2014-PL

- Select Emission Rates-Project-Level Assessment (PL)
- Select county: Sacramento
- Select Calendar year: 2020
- Select Annual
- Select "Truck –NonTruck" and highlight all entries
- Select Model Year option: "aggregated"
- Select Fuel option: "Aggregated"
- Select speed bin 30
- Input four sets of temperature and relative humidity values representing four period of a day
- Select Pollutant: PM2.5

Filtering Output

For a typical link project analysis on PM, emissions consists of running exhuast, brake wear and tire wear. Users can filter the output by process to obtain emission rates for RUNEX, PMTW and PMBW.



3.2 Scenario 2: Transit Bus-Only Link

Project Details

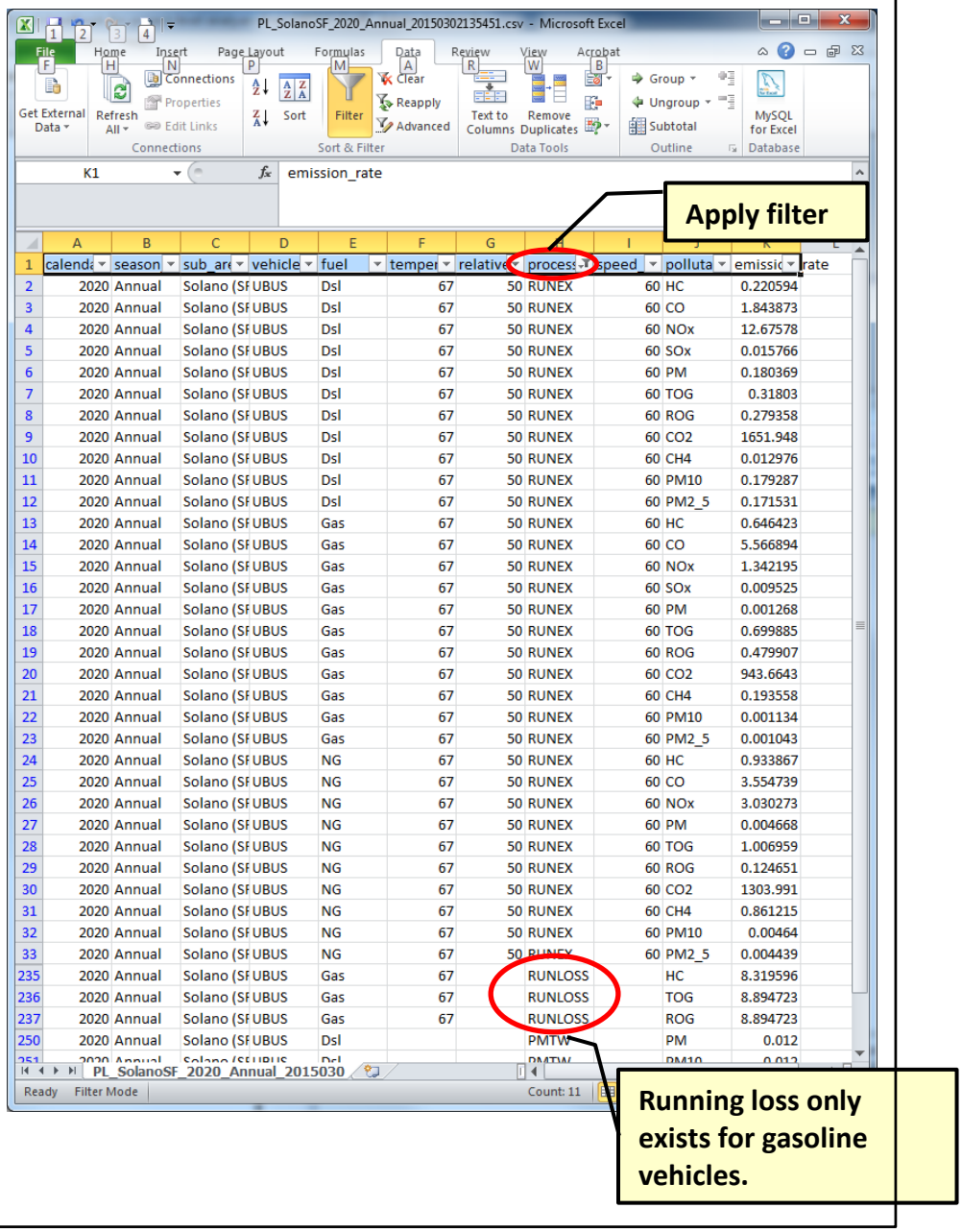
- This project is for a transit bus-only link in Solano county in San Francisco Bay Area Air Basin
- Analysis year: 2020
- Average link speed: 60 mph
- Vehicles: UBUS including gasoline, diesel and natural gas
- VMT distribution by fuel type is known
- Meteorology data for a typical set of temperature and relative humidity (67F, 50%)

Using EMFAC2014-PL

- Select Emission Rates-Project-Level Assessment (PL)
- Select sub-area: Solano (SF)
- Select Calendar year: 2020
- Select Annual
- Select “EMFAC2011 Vehicle Class” and highlight “UBUS”
- Select Model Year option: “aggregated”
- Select Fuel option: “By Fuel”
- Select speed bin 60
- Input one set of temperature and relative humidity values: 67,50
- Select all Pollutants

Filtering Output

For a typical link project, emissions consists of running exhuast, brake wear, tire wear and running loss. Users can filter the output by process to obtain emission rates for RUNEX, PMTW, PMBW and RUNLOSS.



	A	B	C	D	E	F	G	H	I	J	K
1	calenda	season	sub_are	vehicle	fuel	temper	relative	process	speed	polluta	emissio
2	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	HC	0.220594
3	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	CO	1.843873
4	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	NOx	12.67578
5	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	SOx	0.015766
6	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	PM	0.180369
7	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	TOG	0.31803
8	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	ROG	0.279358
9	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	CO2	1651.948
10	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	CH4	0.012976
11	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	PM10	0.179287
12	2020	Annual	Solano (Sf	UBUS	Dsl	67	50	RUNEX	60	PM2_5	0.171531
13	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	HC	0.646423
14	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	CO	5.566894
15	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	NOx	1.342195
16	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	SOx	0.009525
17	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	PM	0.001268
18	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	TOG	0.699885
19	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	ROG	0.479907
20	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	CO2	943.6643
21	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	CH4	0.193558
22	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	PM10	0.001134
23	2020	Annual	Solano (Sf	UBUS	Gas	67	50	RUNEX	60	PM2_5	0.001043
24	2020	Annual	Solano (Sf	UBUS	NG	67	50	RUNEX	60	HC	0.933867
25	2020	Annual	Solano (Sf	UBUS	NG	67	50	RUNEX	60	CO	3.554739
26	2020	Annual	Solano (Sf	UBUS	NG	67	50	RUNEX	60	NOx	3.030273
27	2020	Annual	Solano (Sf	UBUS	NG	67	50	RUNEX	60	PM	0.004668
28	2020	Annual	Solano (Sf	UBUS	NG	67	50	RUNEX	60	TOG	1.006959
29	2020	Annual	Solano (Sf	UBUS	NG	67	50	RUNEX	60	ROG	0.124651
30	2020	Annual	Solano (Sf	UBUS	NG	67	50	RUNEX	60	CO2	1303.991
31	2020	Annual	Solano (Sf	UBUS	NG	67	50	RUNEX	60	CH4	0.861215
32	2020	Annual	Solano (Sf	UBUS	NG	67	50	RUNEX	60	PM10	0.00464
33	2020	Annual	Solano (Sf	UBUS	NG	67	50	RUNEX	60	PM2_5	0.004439
235	2020	Annual	Solano (Sf	UBUS	Gas	67		RUNLOSS		HC	8.319596
236	2020	Annual	Solano (Sf	UBUS	Gas	67		RUNLOSS		TOG	8.894723
237	2020	Annual	Solano (Sf	UBUS	Gas	67		RUNLOSS		ROG	8.894723
250	2020	Annual	Solano (Sf	UBUS	Dsl			PMTW		PM	0.012

3.3 Scenario 3: Inter-Regional Bus Terminal - All Other Buses DSL

Project Details

- This project is for an inter-regional diesel bus terminal. Diesel trucks do not produce evaporative emissions so the main process under study at the terminal is idle emission process.
- Located in Sacramento county
- Analysis year: 2016
- Fleet consists of model year 2008 and 2014
- Population is specified by model year
- Temperature and humidity available, but they do not affect idle emissions.

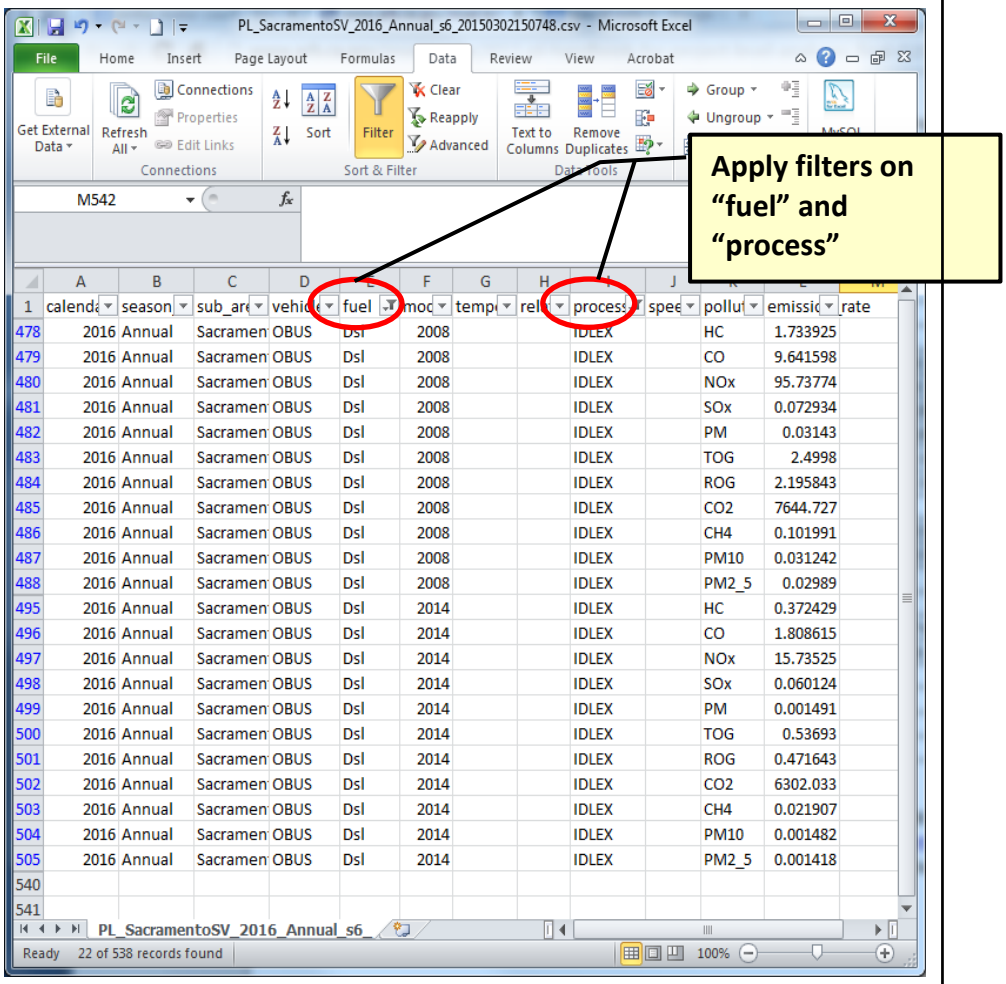
Using EMFAC2014-PL

- Select Emission Rates-Project-Level Assessment (PL)
- Select county: Sacramento
- Select Calendar year: 2016
- Select Annual
- Select "EMFAC2007 Vehicle Class" and highlight "OBUS"*
- Select Model year option "By Model Year" and highlight 2008 and 2014
- Select Fuel option: "By Fuel"
- Select any one speed bin, for instance, 5 mph
- Input a set of valid temperature and relative humidity values.
- Select all Pollutants

*User may alternatively choose "EMFAC2011 Vehicle Class" and highlight "All Other Buses" or "Motor coaches" depending on the type of fleet. Both of these categories contain diesel buses only.

Filtering Output

Users can apply filter first on the fuel type to select diesel vehicle and next on process to select idle emissions (IDLEX).



	calenda	season	sub_ar	vehic	fuel	moc	temp	rel	process	spee	pollu	emissic	rate
478	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		HC	1.733925	
479	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		CO	9.641598	
480	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		NOx	95.73774	
481	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		SOx	0.072934	
482	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		PM	0.03143	
483	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		TOG	2.4998	
484	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		ROG	2.195843	
485	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		CO2	7644.727	
486	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		CH4	0.101991	
487	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		PM10	0.031242	
488	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		PM2_5	0.02989	
495	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		HC	0.372429	
496	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		CO	1.808615	
497	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		NOx	15.73525	
498	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		SOx	0.060124	
499	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		PM	0.001491	
500	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		TOG	0.53693	
501	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		ROG	0.471643	
502	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		CO2	6302.033	
503	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		CH4	0.021907	
504	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		PM10	0.001482	
505	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		PM2_5	0.001418	
540													
541													

3.4 Scenario 4: Urban Bus Terminal - Idle Emissions

Project Details

- This project to evaluate the idling emissions from urban buses at a bus terminal. Note that EMFAC does not model extended idle emissions for urban buses, therefore we suggest using running emissions at the lowest speed bin – 5 mph to approximate idle emission rates.*
- Located in Sacramento county
- Analysis year: 2016
- Fleet consists of model year 2008 and 2014
- Population by fuel type available
- Population is specified by model year
- Temperature and humidity available (70F, 70%)

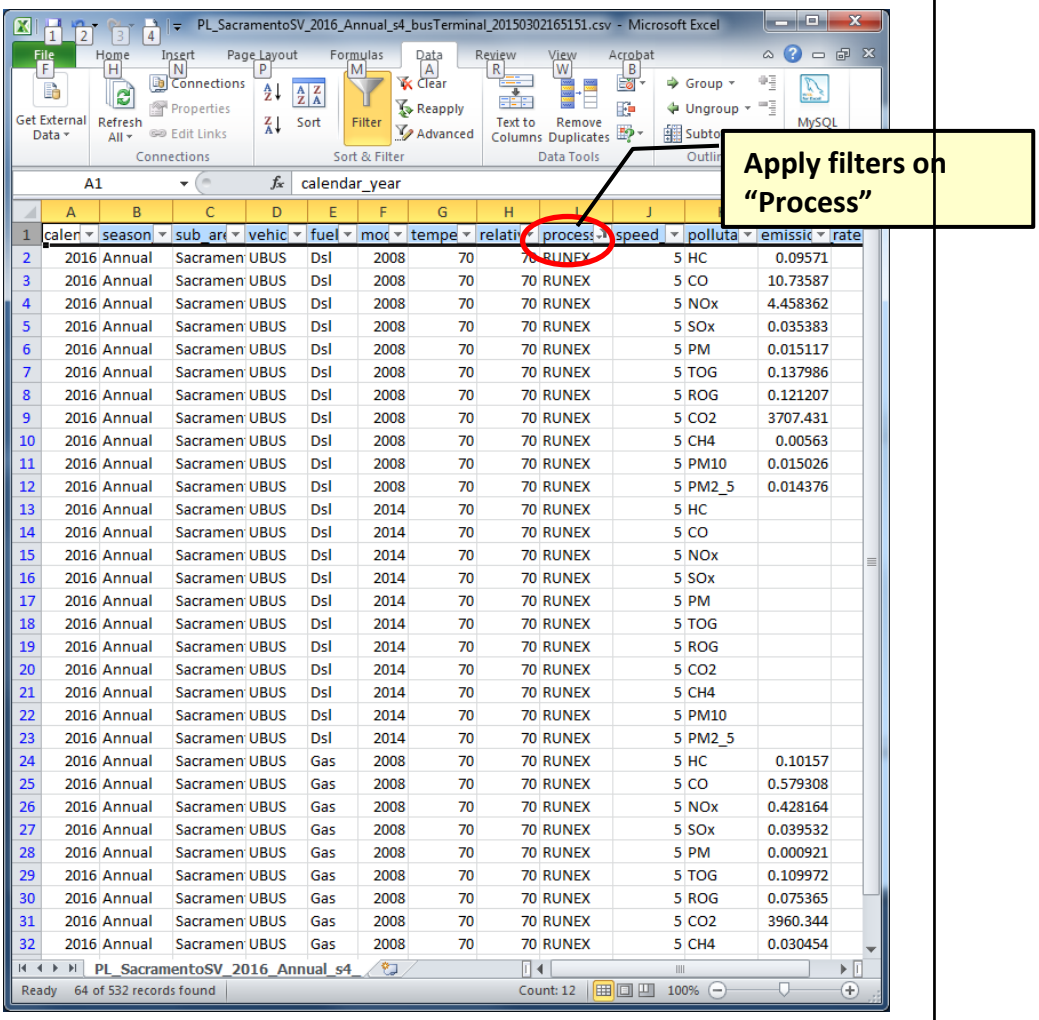
*Note that idle emissions exist for gasoline OBUS and SBUS.

Using EMFAC2014-PL

- Select Emission Rates-Project-Level Assessment (PL)
- Select county: Sacramento
- Select Calendar year: 2016
- Select Annual
- Select "EMFAC2007 Vehicle Class" and highlight "UBUS"
- Select Model year option "By Model Year" and highlight 2008 and 2014
- Select Fuel option: "By Fuel"
- Select Speed Bin: 5 mph
- Input temperature and relative humidity :70,70
- Select all Pollutants

Filtering Output

Users can apply filter on “process” to select running exhaust emissions (RUNEX). Multiplying the running 5 mph bin emission rates (gram/mile) by 2.5 (mph/hr) will produce the approximated idle emission ratesin gram per hour. (As discussed in Section 2.2.5, for UBUS, the speed value used to calculated the speed correction factor for 5 mph speed bin is 2.5 mph.)



calen	season	sub_ar	vehic	fuel	moc	tempe	relati	process	speed	pollutа	emissic	rate
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	HC	0.09571	
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	CO	10.73587	
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	NOx	4.458362	
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	SOx	0.035383	
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	PM	0.015117	
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	TOG	0.137986	
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	ROG	0.121207	
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	CO2	3707.431	
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	CH4	0.00563	
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	PM10	0.015026	
2016	Annual	Sacramen	UBUS	Dsl	2008	70	70	RUNEX	5	PM2_5	0.014376	
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	HC		
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	CO		
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	NOx		
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	SOx		
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	PM		
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	TOG		
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	ROG		
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	CO2		
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	CH4		
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	PM10		
2016	Annual	Sacramen	UBUS	Dsl	2014	70	70	RUNEX	5	PM2_5		
2016	Annual	Sacramen	UBUS	Gas	2008	70	70	RUNEX	5	HC	0.10157	
2016	Annual	Sacramen	UBUS	Gas	2008	70	70	RUNEX	5	CO	0.579308	
2016	Annual	Sacramen	UBUS	Gas	2008	70	70	RUNEX	5	NOx	0.428164	
2016	Annual	Sacramen	UBUS	Gas	2008	70	70	RUNEX	5	SOx	0.039532	
2016	Annual	Sacramen	UBUS	Gas	2008	70	70	RUNEX	5	PM	0.000921	
2016	Annual	Sacramen	UBUS	Gas	2008	70	70	RUNEX	5	TOG	0.109972	
2016	Annual	Sacramen	UBUS	Gas	2008	70	70	RUNEX	5	ROG	0.075365	
2016	Annual	Sacramen	UBUS	Gas	2008	70	70	RUNEX	5	CO2	3960.344	
2016	Annual	Sacramen	UBUS	Gas	2008	70	70	RUNEX	5	CH4	0.030454	

3.5 Scenario 5: Park-n-Ride Parking Lot Emissions

Project Details

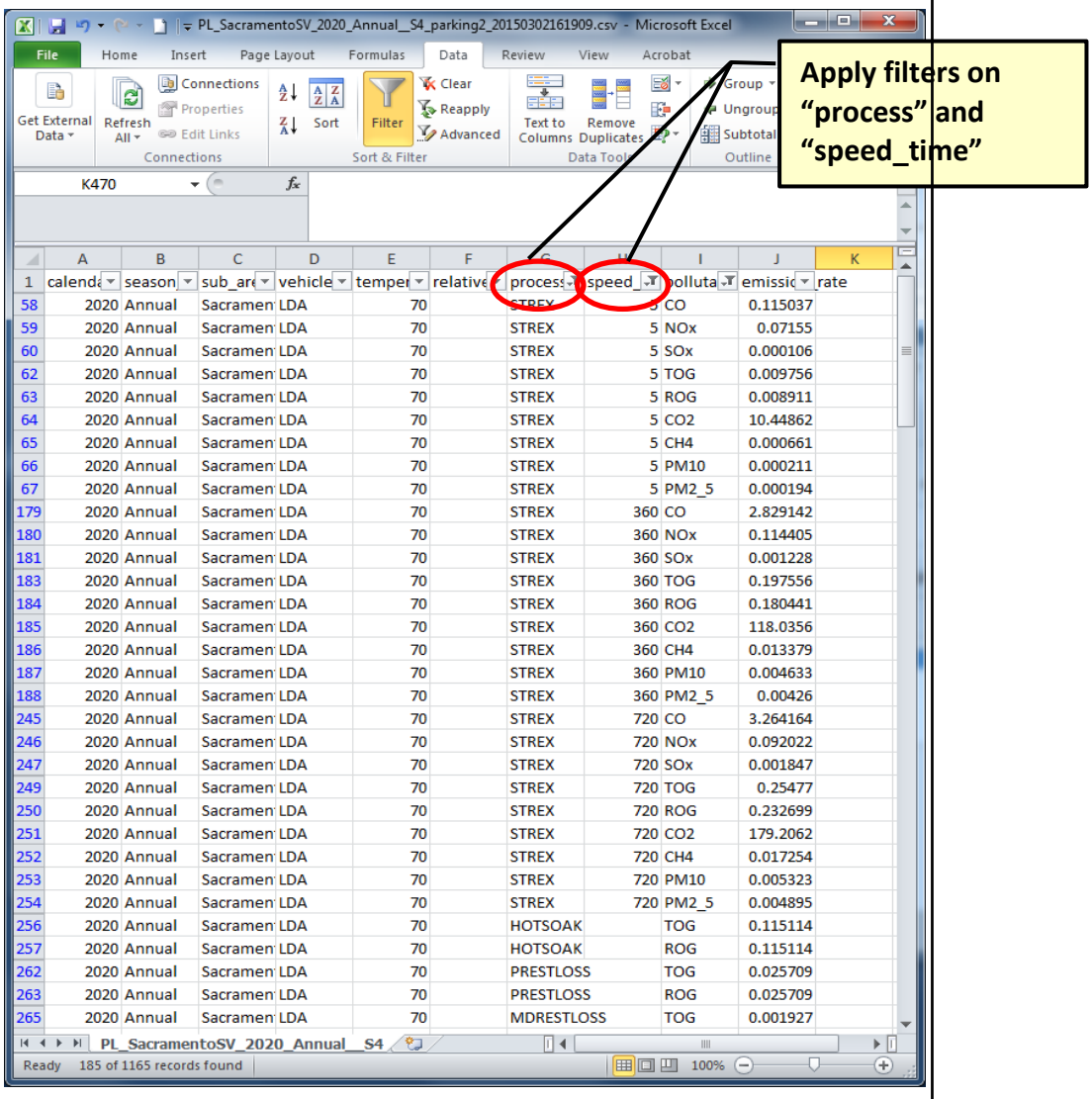
- This project is for a park-n-ride parking lot
- Located in Sacramento county
- Analysis year: 2020
- Vehicle activities including population, number of starts and soak time distributions are collected for fleets defined using EMFAC2007 language: LDA, LDT1, LDT2, MDV and MCY
- Soak time intervals are 5, 360 and 720 minutes
- Population by model year unknown
- Population by fuel type unknown
- Temperature and relative humidity: (70F, 70%)

Using EMFAC2014-PL

- Select Emission Rates-Project-Level Assessment (PL)
- Select sub-area: Solano (SF)
- Select Calendar year: 2020
- Select Annual
- Select "EMFAC2007 Vehicle Class" and highlight LDA, LDT1, LDT2, MDV and MCY
- Select Model year option "Aggregated"
- Select Fuel option: "Aggregated"
- Select any speed bin, say, 5.
- Input temperature and relative humidity :70,70
- Select all Pollutants

Filtering Output

A parking lot project may involve the following emissions processes: STREX, HOTSOAK, PRESTLOSS, PDIURN, MDRESTLOSS and MDDIURN. Users can apply filter first on the "process" field to select the relevant processes, and then filter "Speed_time" field to select soak time intervals 5, 360, 720 and blanks (blanks are needed for evaperative emissions).



Appendix A Summary of run parameters for generating emission rates

Tab	Run Parameters	Description
Area	Area Type	One of the area types can be picked.
	Area	One or more areas can be selected for one run.
Time	Calendar Year	Between 2000 and 2050. One or more calendar years can be selected for one run.
	Season/Month	One of the three seasons (annual, summer, winter) or one of the 12 months can be selected for one run.
Vehicles	Vehicle Class type	Output by EMFAC2011 vehicle class or EMFAC2007 vehicle class or Truck/non-Truck or Truck1/Truck2/non-Truck.
	Vehicle Class	One or more vehicle classes can be picked for one run.
	Model Year	Aggregated or by model year in output. One or more model years can be selected if by model year is picked.
	Fuel	Aggregated or by fuel in output.
	Speed	One or more speeds can be selected.
Meteorology	Temperature	Temperature in Fahrenheit.
	Relative Humidity	Relative humidity.
Output	Pollutants	Pollutants in output.
	Output Directory	Where to save output files.

Appendix B Definition of Areas

Sub-Area	County Name	Air Basin Name	Air District Name	MPO	MPO Name
Alameda (SF)	ALAMEDA	SAN FRANCISCO BAY AREA	BAY AREA AQMD	MTC	Metropolitan Transportation Commission
Alpine (GBV)	ALPINE	GREAT BASIN VALLEYS	GREAT BASIN UNIFIED APCD		
Amador (MC)	AMADOR	MOUNTAIN COUNTIES	AMADOR COUNTY APCD		
Butte (SV)	BUTTE	SACRAMENTO VALLEY	BUTTE COUNTY AQMD	BCAG	Butte County Association of Governments
Calaveras (MC)	CALAVERAS	MOUNTAIN COUNTIES	CALAVERAS COUNTY APCD		
Colusa (SV)	COLUSA	SACRAMENTO VALLEY	COLUSA COUNTY APCD		
Contra Costa (SF)	CONTRA COSTA	SAN FRANCISCO BAY AREA	BAY AREA AQMD	MTC	Metropolitan Transportation Commission
Del Norte (NC)	DEL NORTE	NORTH COAST	NORTH COAST UNIFIED AQMD		
El Dorado (LT)	EL DORADO	LAKE TAHOE	EL DORADO COUNTY APCD	TMPO	Tahoe Metropolitan Planning Organization
El Dorado (MC)	EL DORADO	MOUNTAIN COUNTIES	EL DORADO COUNTY APCD	SACOG	Sacramento Area Council of Governments
Fresno (SJV)	FRESNO	SAN JOAQUIN VALLEY	SAN JOAQUIN VALLEY UNIFIED APCD	COFCG	Fresno Council of Governments
Glenn (SV)	GLENN	SACRAMENTO VALLEY	GLENN COUNTY APCD		
Humboldt (NC)	HUMBOLDT	NORTH COAST	NORTH COAST UNIFIED AQMD		
Imperial (SS)	IMPERIAL	SALTON SEA	IMPERIAL COUNTY APCD	SCAG	Southern California Association of Governments
Inyo (GBV)	INYO	GREAT BASIN VALLEYS	GREAT BASIN UNIFIED APCD		
Kern (MD)	KERN	MOJAVE DESERT	KERN COUNTY APCD	KCOG	Kern Council of Governments
Kern (SJV)	KERN	SAN JOAQUIN VALLEY	SAN JOAQUIN VALLEY UNIFIED APCD	KCOG	Kern Council of Governments
Kings (SJV)	KINGS	SAN JOAQUIN VALLEY	SAN JOAQUIN VALLEY UNIFIED APCD	KCAG	Kings County Association of Governments
Lake (LC)	LAKE	LAKE COUNTY	LAKE COUNTY AQMD		
Lassen (NEP)	LASSEN	NORTHEAST PLATEAU	LASSEN COUNTY APCD		
Los Angeles (MD)	LOS ANGELES	MOJAVE DESERT	ANTELOPE VALLEY AQMD	SCAG	Southern California Association of Governments
Los Angeles (SC)	LOS ANGELES	SOUTH COAST	SOUTH COAST AQMD	SCAG	Southern California Association of Governments
Madera (SJV)	MADERA	SAN JOAQUIN VALLEY	SAN JOAQUIN VALLEY UNIFIED APCD	MCTC	Madera County Transportation Commission
Marin (SF)	MARIN	SAN FRANCISCO BAY AREA	BAY AREA AQMD	MTC	Metropolitan Transportation Commission
Mariposa (MC)	MARIPOSA	MOUNTAIN COUNTIES	MARIPOSA COUNTY APCD		
Mendocino (NC)	MENDOCINO	NORTH COAST	MENDOCINO COUNTY AQMD		

Merced (SJV)	MERCED	SAN JOAQUIN VALLEY	SAN JOAQUIN VALLEY UNIFIED APCD	MCAG	Merced County Association of Governments
Modoc (NEP)	MODOC	NORTHEAST PLATEAU	MODOC COUNTY APCD		
Mono (GBV)	MONO	GREAT BASIN VALLEYS	GREAT BASIN UNIFIED APCD		
Monterey (NCC)	MONTEREY	NORTH CENTRAL COAST	MONTEREY BAY UNIFIED APCD	AMBAG	Association of Monterey Bay Governments
Napa (SF)	NAPA	SAN FRANCISCO BAY AREA	BAY AREA AQMD	MTC	Metropolitan Transportation Commission
Nevada (MC)	NEVADA	MOUNTAIN COUNTIES	NORTHERN SIERRA AQMD		
Orange (SC)	ORANGE	SOUTH COAST	SOUTH COAST AQMD	SCAG	Southern California Association of Governments
Placer (LT)	PLACER	LAKE TAHOE	PLACER COUNTY APCD	TMPO	Tahoe Metropolitan Planning Organization
Placer (MC)	PLACER	MOUNTAIN COUNTIES	PLACER COUNTY APCD	SACOG	Sacramento Area Council of Governments
Placer (SV)	PLACER	SACRAMENTO VALLEY	PLACER COUNTY APCD	SACOG	Sacramento Area Council of Governments
Plumas (MC)	PLUMAS	MOUNTAIN COUNTIES	NORTHERN SIERRA AQMD		
Riverside (MD/MDAQMD)	RIVERSIDE	MOJAVE DESERT	MOJAVE DESERT AQMD	SCAG	Southern California Association of Governments
Riverside (MD/SCAQMD)	RIVERSIDE	MOJAVE DESERT	SOUTH COAST AQMD	SCAG	Southern California Association of Governments
Riverside (SC)	RIVERSIDE	SOUTH COAST	SOUTH COAST AQMD	SCAG	Southern California Association of Governments
Riverside (SS)	RIVERSIDE	SALTON SEA	SOUTH COAST AQMD	SCAG	Southern California Association of Governments
Sacramento (SV)	SACRAMENTO	SACRAMENTO VALLEY	SACRAMENTO METROPOLITAN AQMD	SACOG	Sacramento Area Council of Governments
San Benito (NCC)	SAN BENITO	NORTH CENTRAL COAST	MONTEREY BAY UNIFIED APCD	AMBAG	Association of Monterey Bay Governments
San Bernardino (MD)	SAN BERNARDINO	MOJAVE DESERT	MOJAVE DESERT AQMD	SCAG	Southern California Association of Governments
San Bernardino (SC)	SAN BERNARDINO	SOUTH COAST	SOUTH COAST AQMD	SCAG	Southern California Association of Governments
San Diego (SD)	SAN DIEGO	SAN DIEGO	SAN DIEGO COUNTY APCD	SANDAG	San Diego Association of Governments
San Francisco (SF)	SAN FRANCISCO	SAN FRANCISCO BAY AREA	BAY AREA AQMD	MTC	Metropolitan Transportation Commission
San Joaquin (SJV)	SAN JOAQUIN	SAN JOAQUIN VALLEY	SAN JOAQUIN VALLEY UNIFIED APCD	SJCOG	San Joaquin Council of Governments
San Luis Obispo (SCC)	SAN LUIS OBISPO	SOUTH CENTRAL COAST	SAN LUIS OBISPO COUNTY APCD	SLOCOG	San Luis Obispo Council of Governments
San Mateo (SF)	SAN MATEO	SAN FRANCISCO BAY AREA	BAY AREA AQMD	MTC	Metropolitan Transportation Commission
Santa Barbara (SCC)	SANTA BARBARA	SOUTH CENTRAL COAST	SANTA BARBARA COUNTY APCD	SBCAG	Santa Barbara County Association of Governments
Santa Clara (SF)	SANTA CLARA	SAN FRANCISCO BAY AREA	BAY AREA AQMD	MTC	Metropolitan Transportation Commission

Santa Cruz (NCC)	SANTA CRUZ	NORTH CENTRAL COAST	MONTEREY BAY UNIFIED APCD	AMBAG	Association of Monterey Bay Governments
Shasta (SV)	SHASTA	SACRAMENTO VALLEY	SHASTA COUNTY AQMD	SCRTPA	Shasta Regional Transportation Agency
Sierra (MC)	SIERRA	MOUNTAIN COUNTIES	NORTHERN SIERRA AQMD		
Siskiyou (NEP)	SISKIYOU	NORTHEAST PLATEAU	SISKIYOU COUNTY APCD		
Solano (SF)	SOLANO	SAN FRANCISCO BAY AREA	BAY AREA AQMD	MTC	Metropolitan Transportation Commission
Solano (SV)	SOLANO	SACRAMENTO VALLEY	YOLO/SOLANO AQMD	MTC	Metropolitan Transportation Commission
Sonoma (NC)	SONOMA	NORTH COAST	NORTHERN SONOMA COUNTY APCD	MTC	Metropolitan Transportation Commission
Sonoma (SF)	SONOMA	SAN FRANCISCO BAY AREA	BAY AREA AQMD	MTC	Metropolitan Transportation Commission
Stanislaus (SJV)	STANISLAUS	SAN JOAQUIN VALLEY	SAN JOAQUIN VALLEY UNIFIED APCD	StanCOG	Stanislaus Council of Governments
Sutter (SV)	SUTTER	SACRAMENTO VALLEY	FEATHER RIVER AQMD	SACOG	Sacramento Area Council of Governments
Tehama (SV)	TEHAMA	SACRAMENTO VALLEY	TEHAMA COUNTY APCD		
Trinity (NC)	TRINITY	NORTH COAST	NORTH COAST UNIFIED AQMD		
Tulare (SJV)	TULARE	SAN JOAQUIN VALLEY	SAN JOAQUIN VALLEY UNIFIED APCD	TCAG	Tulare County Association of Governments
Tuolumne (MC)	TUOLUMNE	MOUNTAIN COUNTIES	TUOLUMNE COUNTY APCD		
Ventura (SCC)	VENTURA	SOUTH CENTRAL COAST	VENTURA COUNTY APCD	SCAG	Southern California Association of Governments
Yolo (SV)	YOLO	SACRAMENTO VALLEY	YOLO/SOLANO AQMD	SACOG	Sacramento Area Council of Governments
Yuba (SV)	YUBA	SACRAMENTO VALLEY	FEATHER RIVER AQMD	SACOG	Sacramento Area Council of Governments

Appendix C Vehicle Categories

EMFAC2011 Veh & Tech	EMFAC2011 Vehicle	EMFAC2007 Vehicle	Truck / Non-Truck Category	Truck 1 / Truck 2 / Non-Truck Category	Description
LDA - DSL	LDA	LDA	Non-Trucks	Non-Trucks	Passenger Cars
LDA - GAS			Non-Trucks	Non-Trucks	
LDT1 - DSL	LDT1	LDT1	Non-Trucks	Non-Trucks	Light-Duty Trucks (GVWR < 6000 lbs and ETW <= 3750 lbs)
LDT1 - GAS			Non-Trucks	Non-Trucks	
LDT2 - DSL	LDT2	LDT2	Non-Trucks	Non-Trucks	Light-Duty Trucks (GVWR < 6000 lbs and ETW 3751-5750 lbs)
LDT2 - GAS			Non-Trucks	Non-Trucks	
LHD1 - DSL	LHD1	LHDT1	Trucks	Truck 1	Light-Heavy-Duty Trucks (GVWR 8501-10000 lbs)
LHD1 - GAS			Trucks	Truck 1	
LHD2 - DSL	LHD2	LHDT2	Trucks	Truck 1	Light-Heavy-Duty Trucks (GVWR 10001-14000 lbs)
LHD2 - GAS			Trucks	Truck 1	
MCY - GAS	MCY	MCY	Non-Trucks	Non-Trucks	Motorcycles
MDV - DSL	MDV	MDV	Non-Trucks	Non-Trucks	Medium-Duty Trucks (GVWR 6000 - 8500 lbs)
MDV - GAS			Non-Trucks	Non-Trucks	
MH - DSL	MH	MH	Non-Trucks	Non-Trucks	Motor Homes
MH - GAS			Non-Trucks	Non-Trucks	
T6 Ag - DSL	T6 Ag	MHDT	Trucks	Truck 2	Medium-Heavy Duty Diesel Agriculture Truck
T6 CAIRP heavy - DSL	T6 CAIRP heavy		Trucks	Truck 2	Medium-Heavy Duty Diesel CA International Registration Plan Truck with GVWR>26000 lbs
T6 CAIRP small - DSL	T6 CAIRP small		Trucks	Truck 2	Medium-Heavy Duty Diesel CA International Registration Plan Truck with GVWR<=26000 lbs
T6 instate construction heavy - DSL	T6 instate construction heavy		Trucks	Truck 2	Medium-Heavy Duty Diesel instate construction Truck with GVWR>26000 lbs
T6 instate construction small - DSL	T6 instate construction small		Trucks	Truck 2	Medium-Heavy Duty Diesel instate construction Truck with GVWR<=26000 lbs
T6 instate heavy - DSL	T6 instate heavy		Trucks	Truck 2	Medium-Heavy Duty Diesel instate Truck with GVWR>26000 lbs
T6 instate small - DSL	T6 instate small		Trucks	Truck 2	Medium-Heavy Duty Diesel instate Truck with GVWR<=26000 lbs
T6 OOS heavy - DSL	T6 OOS heavy		Trucks	Truck 2	Medium-Heavy Duty Diesel Out-of-state Truck with GVWR>26000 lbs
T6 OOS small - DSL	T6 OOS small		Trucks	Truck 2	Medium-Heavy Duty Diesel Out-of-state Truck with GVWR<=26000 lbs
T6 Public - DSL	T6 Public		Trucks	Truck 2	Medium-Heavy Duty Diesel Public Fleet Truck
T6 utility - DSL	T6 utility		Trucks	Truck 2	Medium-Heavy Duty Diesel Utility Fleet Truck
T6TS - GAS	T6TS		Trucks	Truck 2	Medium-Heavy Duty Gasoline Truck

Appendix C : Vehicle Categories (continued)

EMFAC2011 Veh & Tech	EMFAC2011 Vehicle	EMFAC2007 Vehicle	Truck / Non-Truck Category	Truck 1 / Truck 2 / Non-Truck Category	Description
T7 Ag - DSL	T7 Ag	HHDT	Trucks	Truck 2	Heavy-Heavy Duty Diesel Agriculture Truck
T7 CAIRP - DSL	T7 CAIRP		Trucks	Truck 2	Heavy-Heavy Duty Diesel CA International Registration Plan Truck
T7 CAIRP construction - DSL	T7 CAIRP construction		Trucks	Truck 2	Heavy-Heavy Duty Diesel CA International Registration Plan Construction Truck
T7 NNOOS - DSL	T7 NNOOS		Trucks	Truck 2	Heavy-Heavy Duty Diesel Non-Neighboring Out-of-state Truck
T7 NOOS - DSL	T7 NOOS		Trucks	Truck 2	Heavy-Heavy Duty Diesel Neighboring Out-of-state Truck
T7 other port - DSL	T7 other port		Trucks	Truck 2	Heavy-Heavy Duty Diesel Drayage Truck at Other Facilities
T7 POAK - DSL	T7 POAK		Trucks	Truck 2	Heavy-Heavy Duty Diesel Drayage Truck in Bay Area
T7 POLA - DSL	T7 POLA		Trucks	Truck 2	Heavy-Heavy Duty Diesel Drayage Truck near South Coast
T7 Public - DSL	T7 Public		Trucks	Truck 2	Heavy-Heavy Duty Diesel Public Fleet Truck
T7 Single - DSL	T7 Single		Trucks	Truck 2	Heavy-Heavy Duty Diesel Single Unit Truck
T7 single construction - DSL	T7 single construction		Trucks	Truck 2	Heavy-Heavy Duty Diesel Single Unit Construction Truck
T7 SWCV - DSL	T7 SWCV		Trucks	Truck 2	Heavy-Heavy Duty Diesel Solid Waste Collection Truck
T7 SWCV - NG					
T7 tractor - DSL	T7 tractor		Trucks	Truck 2	Heavy-Heavy Duty Diesel Tractor Truck
T7 tractor construction - DSL	T7 tractor construction		Trucks	Truck 2	Heavy-Heavy Duty Diesel Tractor Construction Truck
T7 utility - DSL	T7 utility		Trucks	Truck 2	Heavy-Heavy Duty Diesel Utility Fleet Truck
T7IS - GAS	T7IS		Trucks	Truck 2	Heavy-Heavy Duty Gasoline Truck
PTO - DSL	PTO		Trucks	Truck 2	Power Take Off
SBUS - DSL	SBUS	SBUS	Non-Trucks	Non-Trucks	School Buses
SBUS - GAS			Non-Trucks	Non-Trucks	
UBUS - DSL	UBUS	UBUS	Non-Trucks	Non-Trucks	Urban Buses
UBUS - NG			Non-Trucks	Non-Trucks	
UBUS - GAS			Non-Trucks	Non-Trucks	
Motor Coach - DSL	Motor Coach	OBUS	Non-Trucks	Non-Trucks	Motor Coach
OBUS - GAS	OBUS		Non-Trucks	Non-Trucks	Other Buses
All Other Buses - DSL	All Other Buses		Non-Trucks	Non-Trucks	All Other Buses

Appendix D EMFAC2014-PL Emission Rate Aggregation (units and activity)

Process type	Unit	Vehicle Specific Activity	Equation used to aggregated
Running Exhaust	grams/vehicle-mile	Daily VMT (over all speeds)	$\frac{\sum[ER] \bullet [VMT]}{\sum[VMT]}$
Start Exhaust	grams/vehicle-start	Number of starts per day	$\frac{\sum[ER] \bullet [\#Starts]}{\sum[\#Starts]}$
Idle Exhaust	grams/vehicle-idle hours	Number of Idle Hours per day	$\frac{\sum[ER] \bullet [Idle\ Hours]}{\sum[Idle\ Hours]}$
Hot Soak Evaporative	grams/vehicle-start	Number of starts per day	$\frac{\sum[ER] \bullet [\#Starts]}{\sum[\#Starts]}$
Running Loss Evaporative	grams/vehicle-hour	Number of starts per day*	$\frac{\sum[ER] \bullet [\#Starts]}{\sum[\#Starts] \bullet [Operation\ Hours]}$
Resting/Diurnal Loss Evaporative	grams/vehicle-hour	Vehicle Population	$\frac{\sum[ER] \bullet [Population]}{\sum[Population]}$
Brake Wear	grams/vehicle-mile	Daily VMT (over all speeds)	$\frac{\sum[ER] \bullet [VMT]}{\sum[VMT]}$
Tire Wear	grams/vehicle-mile	Daily VMT (over all speeds)	$\frac{\sum[ER] \bullet [VMT]}{\sum[VMT]}$

Appendix E Project Level APS Emission Rates

Model Year Range	HC (g/hr-veh)	CO (g/hr-veh)	NOX (g/hr-veh)	PM (g/hr-veh)	CO2 (g/hr-veh)	TOG (g/hr-veh)	ROG (g/hr-veh)	Sox (g/hr-veh)
pre 2007	3.2	6.2	12.1	0.87	2228	4.61	4.05	0.02
2007+	3.2	6.2	12.1	0.13	2228	4.61	4.05	0.02