EMFAC2021 Volume II- Handbook for Project-Level Analysis

March, 2021

Mobile Source Analysis Branch
Air Quality Planning and 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. CARB officially released EMFAC2021 (v1.0.0) to the public on Friday, January 15, 2021. EMFAC2021 is the latest emission inventory model that CARB uses to assess emissions from on-road motor vehicles including cars, trucks, and buses in California. This version of model reflects CARB's latest understanding of statewide and regional vehicle activities, emissions, and recently adopted regulations such as Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule, Advanced Clean Trucks (ACT), and Heavy Duty Omnibus, and will be used to inform upcoming planning and policy development.

EMFAC2021 Project-Level Assessment (EMFAC2021-PL) is a tool designed to support project-level assessments. EMFAC2021-PL is triggered when EMFAC2021 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, or annual average). EMFAC2021-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.

CARB has developed this handbook as a guide to use EMFAC2021 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 the EMFAC2021 software to generate emission rates for project-level analyses and uses five sample scenarios to illustrate the general approach. This handbook assumes users already have a basic understanding of how to install and run EMFAC2021. For instructions on how to install and run EMFAC2021, please refer to EMFAC2021 User's Guide.

EMFAC2021-PL design and data content are very similar to the previous version, EMFAC2017-PL. On the data contents side, the model incorporates most recent data and assumptions on emission factors, vehicle activity, and impacts from recently adopted rules. The input options in EMFAC2021-PL resemble those in EMFAC2017-PL and 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.

EMFAC2021-PL has a new feature to output PHEV emission rates based on total VMT (the sum of electric VMT and gasoline VMT) and total number of trips from both gasoline and electric portions. EMFAC2021-PL has also updated its evaporative emission module by implementing USEPA's MOVES approach. Different from previous EMFAC versions that generated evaporative emission rates for four modes of activities, the new module generates evaporative emission rates for three modes of activities: HOTSOAK, RUNNLOSS, and

DIURNAL. RESTLOSS that was generated in pervious EMFAC versions is now part of DIURNAL. More details can be found in Section 2.3.4.

EMFAC2021 incorporates updates for running exhaust emission rates, speed correction factors, idle and start emission rates for almost all vehicle categories. The particulate matter (PM) emission rates from brake wear (non-exhaust emission process) are also updated in EMFAC2021. Unlike EMFAC2017-PL that used emission rates of diesel vehicles for some natural gas heavy-duty vehicle classes, EMFAC2021-PL develops emission rates for all heavy-duty natural gas vehicles based on real-world data. EMFAC2021-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 EMFAC2021 include updated assumptions on age distribution, fuel type composition, and vehicle class composition. The aggregation method and activities used as weights for each emission process are presented in Appendix D in this handbook. EMFAC2021 reflects recently adopted federal and state regulations, such as including Final Safer Affordable Fuel-Efficient (SAFE) Vehicle Rule, Advanced Clean Truck (ACT), and Heavy Duty Omnibus. Details are discussed in Section 4.6 of EMFAC2021 technical documentation.

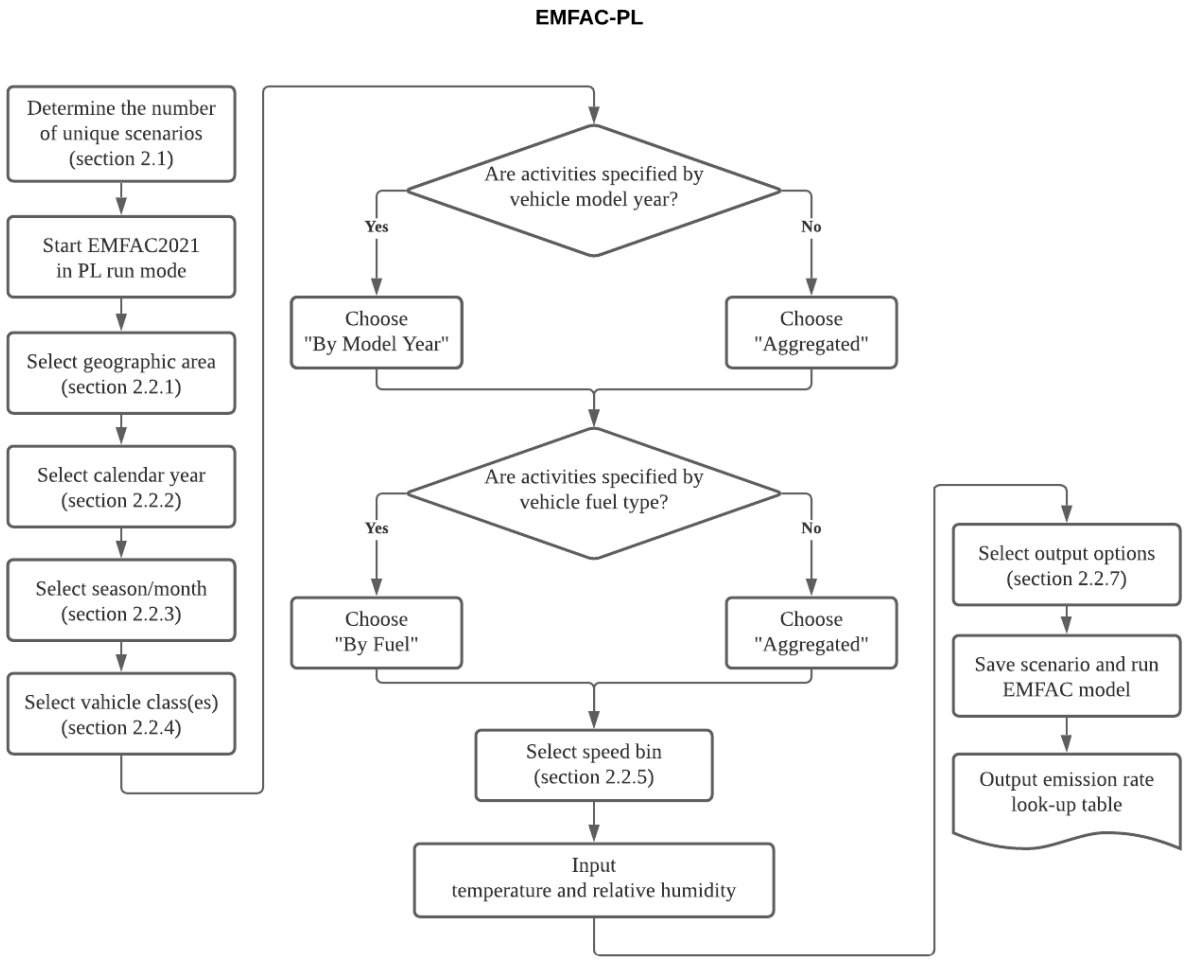
It is worth noting that unlike the "emission" mode, EMFAC2021-PL ("emission rate" mode) does not produce official GHG emissions and only provide estimates of tailpipe CO2 emission rates. Moreover, EMFAC2021 "emission" mode has added ammonia emissions, EMFAC2021-PL does not output ammonia emission rate, which can be easily back calculated based total emissions and VMT from the "emission" mode. For a more detailed discussion on the methodology and data updates for EMFAC2021 model, please refer to EMFAC2021 technical documentation.

2 Approach to a Project Level Analysis

The figure below shows the general steps for using EMFAC2021-PL and points to the subsequent sections of this document that provide additional details.

In general, to use EMFAC2021-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 EMFAC2021-PL efficiently, users need to first determine the number of runs needed that can sufficiently describe activity variation in a project. A single EMFAC2021-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.

EMFAC2021-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 variations need to obtain results from multiple runs.

EMFAC2021 emission rates are not specified by the 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 meteorological conditions, that is, temperature and relative humidity. These meteorology conditions are used directly to define emission rates and *can be* specified by the hour of day or the day of month. EMFAC2021-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 is chosen, EMFAC2021-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 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 Reid Vapor Pressure (RVP) schedules and RVP affects evaporative emission rates; 4) exhaust emission rates are corrected for altitude in El Dorado (LT) and Placer (LT) ; and 5) evaporative emission rates are corrected for altitude in all GAIs.

2.2.2 Calendar Year

EMFAC2021 is designed to analyze calendar years from 2000 to 2050. It allows users to select multiple calendar years in a 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

EMFAC2021 can only model one season (summer planning episode, winter planning episode, or annual) or one month in a single run. Season or month selection affects emission rates because seasonal fuel composition differences lead to a 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

EMFAC2021-PL provides output in one of four vehicle categorization schemes: EMFAC202x, 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.

EMFAC2021-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. EMFAC2021-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 fuel types in EMFAC2017, EMFAC2021-PL adds Plug-in Hybrid Electric Vehicle (PHEV) fuel type.

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

- "Motor Coach" are heavy diesel interstate tour buses regulated under the Truck and Bus regulation.
- "All other buses" refer to diesel and natural gas 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 and EMFAC202x vehicle classes refers to the gasoline and electric buses that are not school buses or urban buses.
- "UBUS" refers to urban transit buses with all fuel types operating by transit agencies.

2.2.5 Speed Bin

In EMFAC2021-PL, speeds are characterized in the form of speed bins at 5 mph 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 refers 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 2.2-1. 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 2.2-1: Speed Bin Definition

Speed Bin*†	Speed Value to compute SCF	Definition
5	2.5*	Speed <= 5
10	7.5	5 < Speed <= 10
15	12.5	10 < Speed <= 15
20	17.5	15 < Speed <= 20
25	22.5	20 < Speed <= 25
30	27.5	25 < Speed <= 30
35	32.5	30 < Speed <= 35
40	37.5	35 < Speed <= 40
45	42.5	40 < Speed <= 45
50	47.5	45 < Speed <= 50
55	52.5	50 < Speed <= 55
60	57.5†	55 < Speed <= 60
65	62.5	60 < Speed <= 65
70	67.5	65 < Speed <= 70
75	67.5	70 < Speed <= 75
80	67.5	75 < Speed <= 80
85	67.5	80 < Speed <= 85
90	67.5	Speed > 85

*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 miles 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,

$$ER_{\text{user}} = ER_{\text{lower bin}} \times \left(\frac{\text{Speed}_{\text{upper bin}} - \text{Speed}_{\text{user}}}{5}\right) + ER_{\text{upper bin}} \times \left(\frac{\text{Speed}_{\text{user}} - \text{Speed}_{\text{lower bin}}}{5}\right)$$

Where the $\text{Speed}_{\text{upper bin}}$ refers to the midpoint speed for the upper speed bin used in the calculation, and the $\text{Speed}_{\text{lower bin}}$ 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 $Speed_{upper\ bin}$ is 52.5 mph and the $Speed_{lower\ bin}$ is 47.5 mph, that is,

$$ER_{50} = ER_{50\ \text{mph bin}} \times (\frac{52.5 - 50}{5}) + ER_{55\ \text{mph bin}} \times (\frac{50 - 47.5}{5})$$
$$= 0.5 \cdot ER_{50\ \text{mph bin}} + 0.5 \cdot ER_{55\ \text{mph bin}}$$

2.2.6 Ambient Outdoor Temperature and Humidity

In EMFAC2021-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 relative humidity values needs to be provided. The value of temperature can be any integer from -20 to 120 (F)[1]. The value of relative humidity can be any integer from 0 to 100 (%). EMFAC2021-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.

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 2.2-2 summarizes the user options and default assumptions for each input data discussed above.

Table 2.2-2: Input Data User Options and Default Assumptions

Input Data	User's Option or Default
Geographic Area	-
-Geographic Scope	Multiple scales, multiple selections
-Aggregation Scale	Default: by sub-area
Calendar Year	Multiple selections
Vehicles	-
-Vehicle class aggregation	Multiple scales, multiple selections
-Fuel type aggregation	Optional
-Model year aggregation	Optional
Pollutants	Multiple selections
Temperature	Any integer, up to 24 entries
Relative humidity	Any integer, up to 24 entries
RVP	Default only
Speed	Multiple selections 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

[1]In EMFAC2021 default California meteorology data, the temperature range is (16.7F, 106.9F) and the relative humidity range is (13.4%, 100%)

Input Data	User's Option or Default
Trips by vehicle/fuel/hour	Default data used for aggregated emission rates
VMT hourly distribution	Not used in PL. Users prepare this data to conduct hourly analysis.
Speed Fractions by hour	Not used in PL. Users 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. As shown in Table 2.3-1, 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. Refer to 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 EMFAC2021-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 the emission rate units and associated activity for each process.

Table 2.3-2: EMFAC2021-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	Running hours
DIURNAL	Diurnal Evaporative	gram/veh-hour	Cold soak hours
PMBW	Brake Wear	gram/veh-mile	VMT by 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 refer 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 as part of normal driving, such as at intersections. RUNEX emission rates in a PL output are specified by temperature, relative humidity, and speed bin.

2.3.2 IDLEX: Idle Exhaust Emission Rates

Idle Exhaust (IDLEX) emissions refer to the emissions during extended idling events (i.e., a continuous segment of vehicle activity that meets three criteria: all instantaneous vehicle speeds being lower than 5 mph, the total distance of less than 1 mile, and the total duration of more than 5 minutes) by heavy duty trucks. 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 EMFAC2021-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 EMFAC2021 (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 excess 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. EMFAC2021-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 with soak time of 720 minutes.

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

In EMFAC2021-PL, evaporative emissions are produced in three modes of vehicle operations: hot soak, running loss, and diurnal. Evaporative emissions are generated as gasoline fuels evaporate and escape from the vehicle's fuel system.

Hot soak emissions are the hydrocarbon (HC) emissions that are emitted from a vehicle while the engine is still hot after the vehicle stopped operating until the fuel tank temperature cools down to a non-operation level. 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 emissions are the HC emissions that are emitted while the vehicle engine is on. Running loss emission rates in EMFAC2021-PL are in the unit of gram per running hour, which is evaporative emission 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.

Diurnal emissions are the HC emissions from a sitting vehicle while the ambient temperature changes. The emissions occur when the amount of fuel vapors generated in the fuel tank exceeds the capacity of the carbon canister and they are vented out to the atmosphere. Diurnal emission rates are in the unit of gram per cold soak hours.

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.

Unlike the previous EMFAC models (EMFAC2017 and older), evaporative emission rates from EMFAC2021 do not depend on the user's input temperature values. The new module introduced in EMFAC2021 requires a diurnal temperature profile (or a complete set of hourly temperatures of the day) internally, so that it can estimate evaporative emissions from cold soak, operating, hot soak modes over the course of the day. The evaporative emission rates are thus estimated using the hourly diurnal temperature values of each GAI and season (or month) that are stored in the internal database of EMFAC2021.

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. In EMFAC2021-PL, brake wear emission rates have been updated for most vehicle categories based recent testing data and they vary by speed bin, except light heavy-duty trucks (LHD1 and LHD2) which constant brake wear emission rates across different speed bins. Tire wear emission rates are the same as previous versions of EMFAC and they do not change with speed. Therefore, the associated VMT of tire wear should be the total VMT over all the speed bins.

3 Sample Scenarios

3.1 Scenario 1: Arterial Link with Default Fleet Mix

Project Details

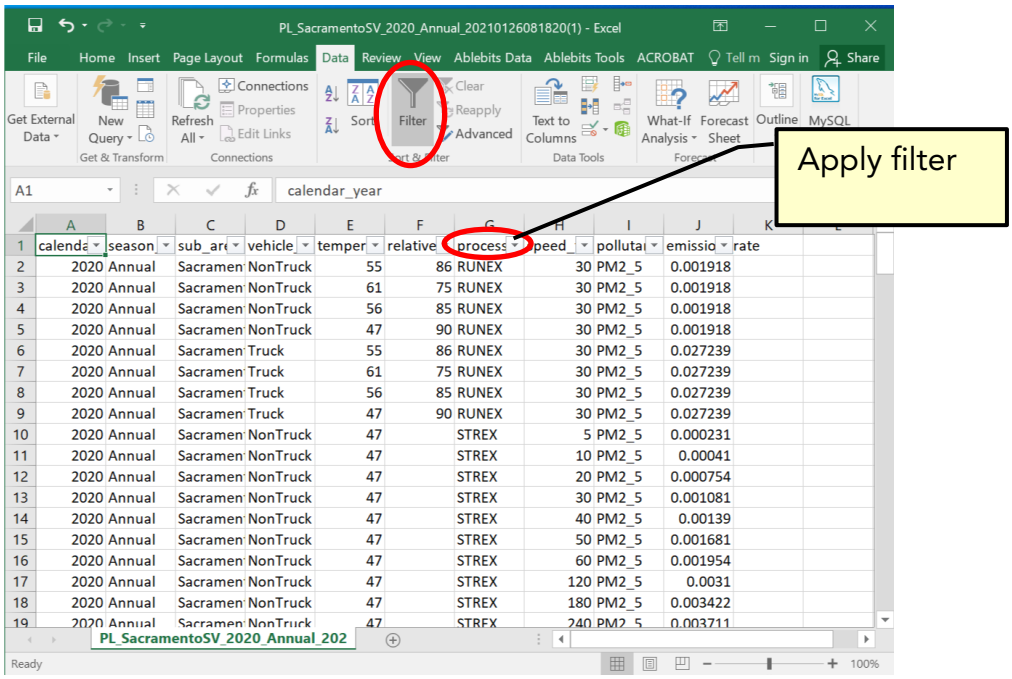
- The project is for a lane expansion on an existing arterial
- Location: Sacramento, CA
- The project is expected to be completed in 2019
- Year of expected peak emissions (analysis year): 2020
- Area is in nonattainment of the annual PM2.5 NAAQS and the 2006 24-hour PM2.5 NAAQS
- Assessment performed 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

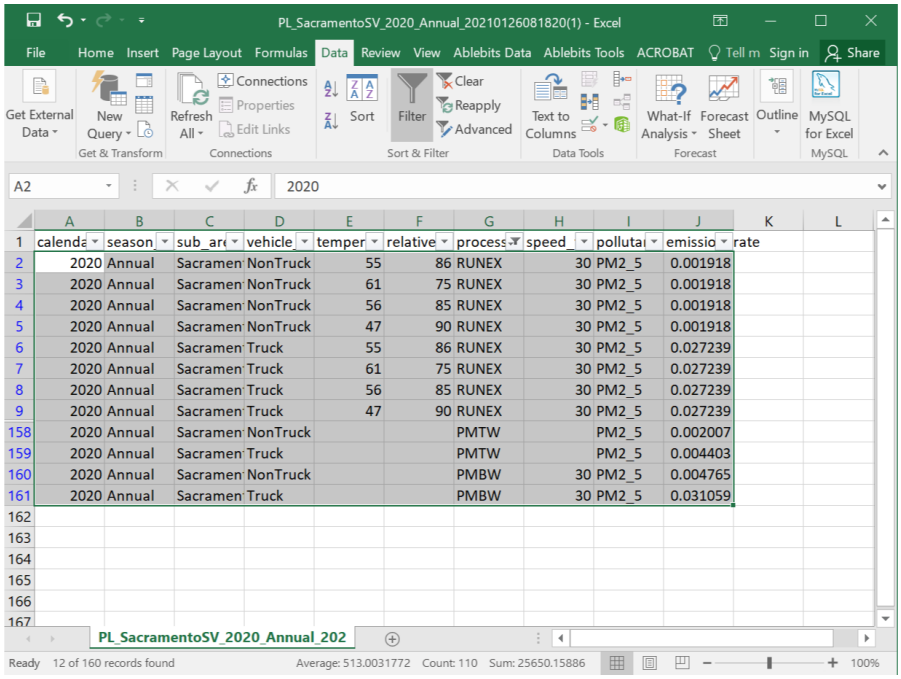
Using EMFAC2021-PL

- 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 periods of a day
- Select Pollutant: PM2.5

Filtering Output

For a typical link project analysis on PM, emissions consist of running exhaust, 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

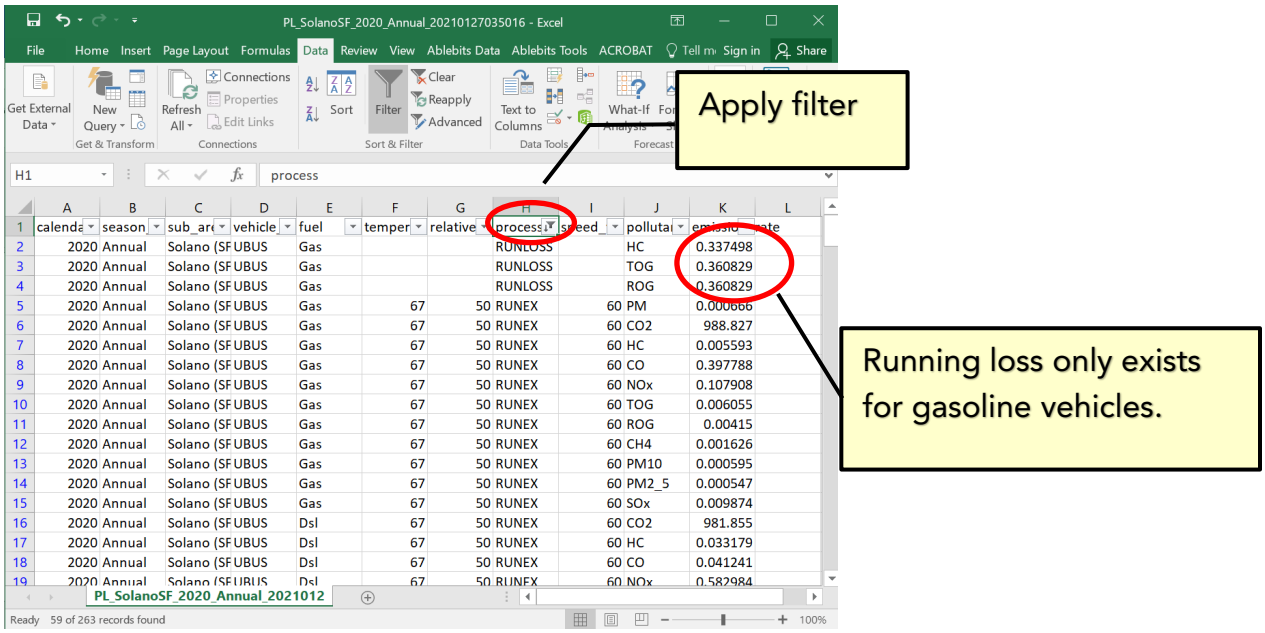
- This project is for a transit bus-only link in Solano county in San Francisco Bay Area Air Basin
- Analysis year: 2020
- Average link speed: 60 mph
- Vehicles: UBUS including gasoline, diesel, and natural gas
- VMT distribution by fuel type is known
- Meteorology data for a typical set of temperature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

Using EMFAC2021-PL

- Select Emission Rates-Project-Level Assessment (PL)
- Select sub-area: Solano (SF)
- Select Calendar year: 2020
- Select Annual
- Select "EMFAC202x 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 consist of running exhaust, brake wear, tire wear, and running loss. Users can filter the output by process to obtain emission rates for RUNEX, PMTW, PMBW, and RUNLOSS.



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.

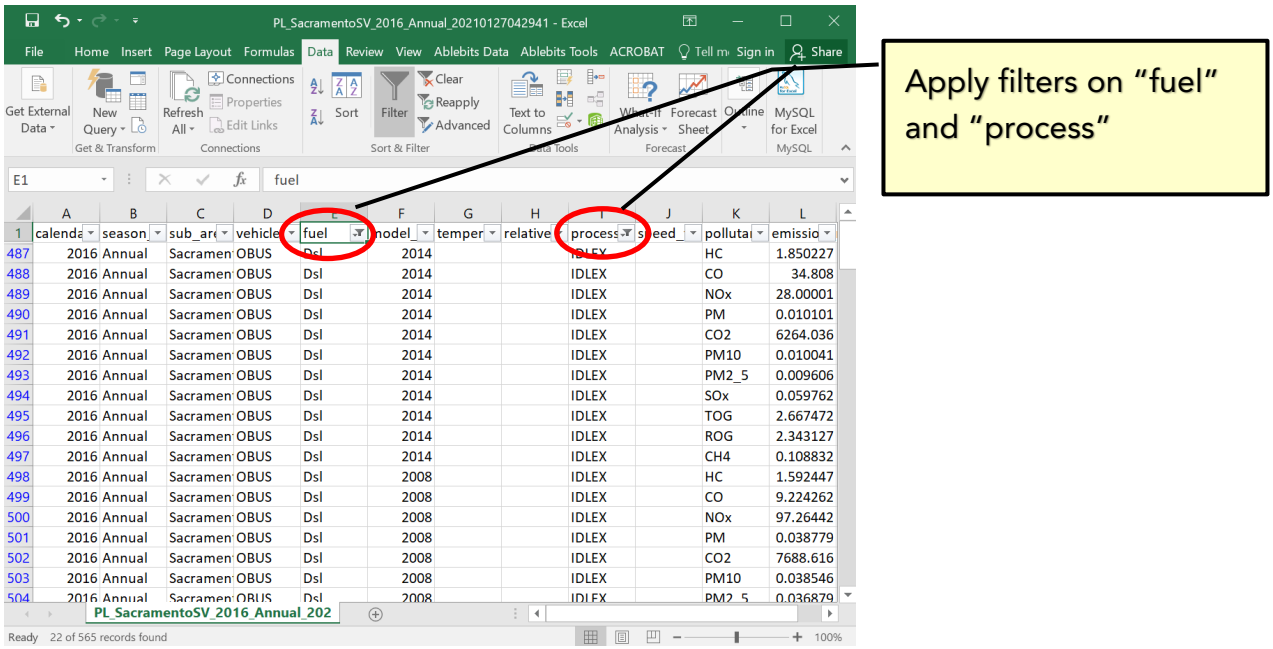
Using EMFAC2021-PL

- 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 "EMFAC202x Vehicle Class" and highlight "All Other Buses" or "Motor Coach" 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).



	A	B	C	D	E	F	G	H	I	J	K	L
1	calenda	season	sub_ar	vehicle	fuel	model_	temper	relative	process	speed_	pollutai	emissio
487	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		HC	1.850227
488	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		CO	34.808
489	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		NOx	28.00001
490	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		PM	0.010101
491	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		CO2	6264.036
492	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		PM10	0.010041
493	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		PM2_5	0.009606
494	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		SOx	0.059762
495	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		TOG	2.667472
496	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		ROG	2.343127
497	2016	Annual	Sacramen	OBUS	Dsl	2014			IDLEX		CH4	0.108832
498	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		HC	1.592447
499	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		CO	9.224262
500	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		NOx	97.26442
501	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		PM	0.038779
502	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		CO2	7688.616
503	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		PM10	0.038546
504	2016	Annual	Sacramen	OBUS	Dsl	2008			IDLEX		PM2_5	0.036879

3.4 Scenario 4: Urban Bus Terminal-Idle Emissions

Project Details

- This project evaluates 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%)

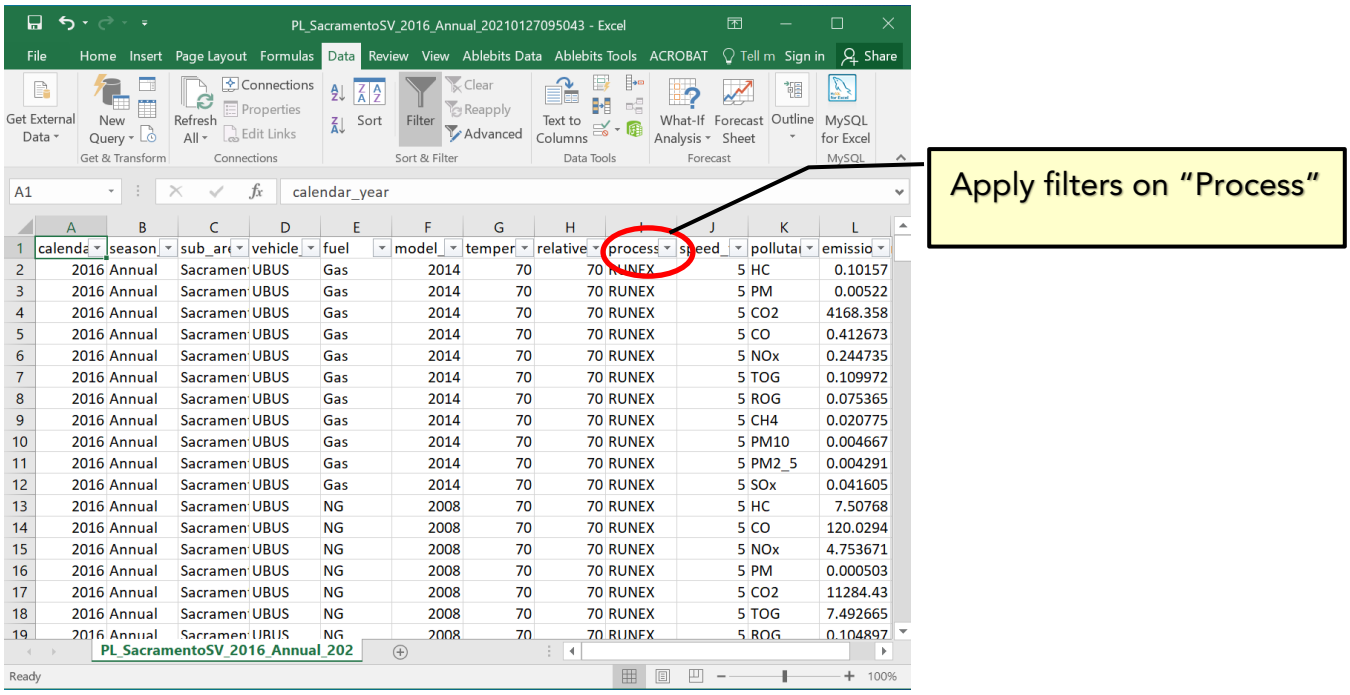
*Note that idle emissions exist for gasoline OBUS and SBUS.

Using EMFAC2021-PL

- Select Emission Rates-Project-Level Assessment (PL)
- Select county: Sacramento
- Select Calendar year: 2016
- Select Annual
- Select "EMFAC202x 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 RUNEX 5 mph bin emission rates (gram/mile) by 2.5 (mph/hr) will produce the approximated idle emission rates in gram per hour. (As discussed in Section 2.2.5, for UBUS, the speed value used to calculate the speed correction factor for 5 mph speed bin is 2.5 mph.)



calenda	season	sub_ar	vehicle	fuel	model	temper	relative	process	speed	pollutа	emissio
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	HC	0.10157
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	PM	0.00522
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	CO2	4168.358
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	CO	0.412673
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	NOx	0.244735
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	TOG	0.109972
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	ROG	0.075365
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	CH4	0.020775
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	PM10	0.004667
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	PM2_5	0.004291
2016	Annual	Sacramen	UBUS	Gas	2014	70	70	RUNEX	5	SOx	0.041605
2016	Annual	Sacramen	UBUS	NG	2008	70	70	RUNEX	5	HC	7.50768
2016	Annual	Sacramen	UBUS	NG	2008	70	70	RUNEX	5	CO	120.0294
2016	Annual	Sacramen	UBUS	NG	2008	70	70	RUNEX	5	NOx	4.753671
2016	Annual	Sacramen	UBUS	NG	2008	70	70	RUNEX	5	PM	0.000503
2016	Annual	Sacramen	UBUS	NG	2008	70	70	RUNEX	5	CO2	11284.43
2016	Annual	Sacramen	UBUS	NG	2008	70	70	RUNEX	5	TOG	7.492665
2016	Annual	Sacramen	UBUS	NG	2008	70	70	RUNEX	5	ROG	0.104897

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

Project Details

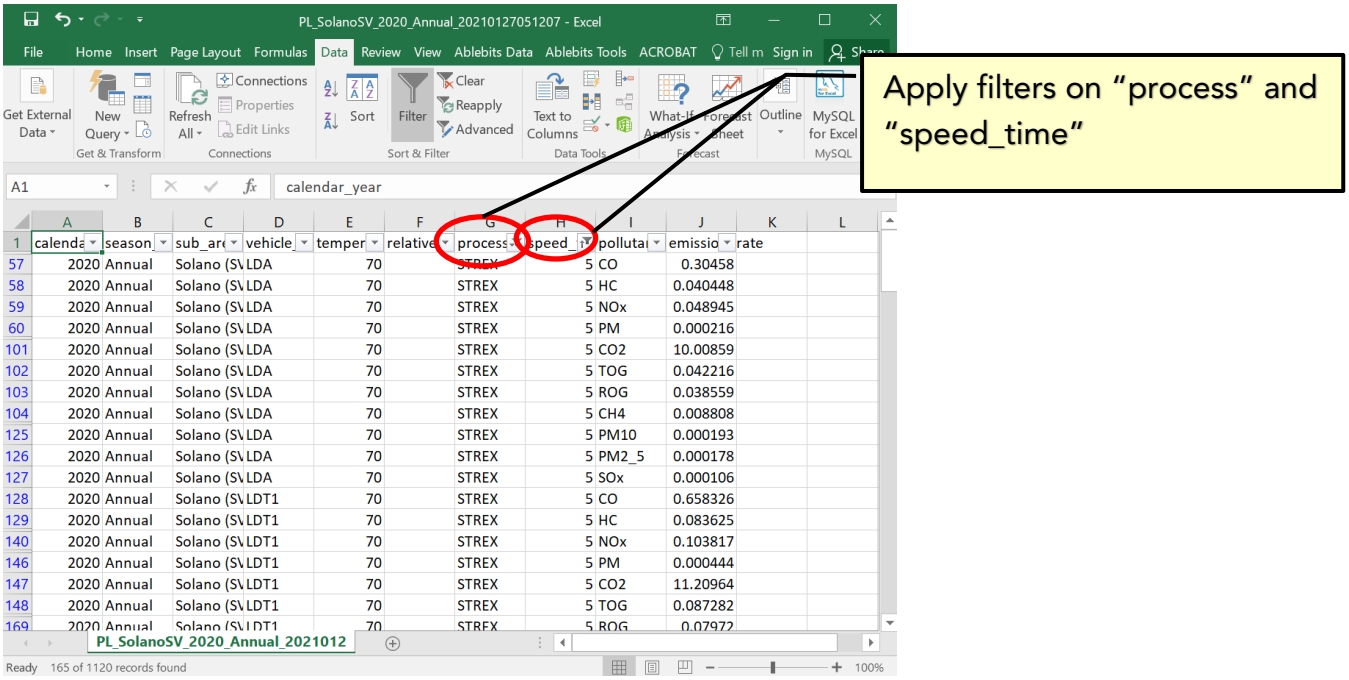
- This project is for a park-n-ride parking lot
- Located in Sacramento county
- Analysis year: 2020
- Vehicle activities including population, number of starts and soak time distributions are collected for fleets defined using EMFAC202x categories: LDA, LDT1, LDT2, MDV, and MCY
- Soak time intervals are 5, 360, and 720 minutes
- Population by model year unknown
- Population by fuel type unknown
- Temperature and relative humidity: (70F, 70%)

Using EMFAC2021-PL

- Select Emission Rates-Project-Level Assessment (PL)
- Select sub-area: Solano (SF)
- Select Calendar year: 2020
- Select Annual
- Select "EMFAC202x 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, and DIURN. 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 evaporative emissions).



	A	B	C	D	E	F	G	H	I	J	K	L
1	calenda	season	sub_ar	vehicle	temper	relative	process	speed_	pollutai	emissio	rate	
57	2020	Annual	Solano (SV	LDA	70		STREX	5	CO	0.30458		
58	2020	Annual	Solano (SV	LDA	70		STREX	5	HC	0.040448		
59	2020	Annual	Solano (SV	LDA	70		STREX	5	NOx	0.048945		
60	2020	Annual	Solano (SV	LDA	70		STREX	5	PM	0.000216		
101	2020	Annual	Solano (SV	LDA	70		STREX	5	CO2	10.00859		
102	2020	Annual	Solano (SV	LDA	70		STREX	5	TOG	0.042216		
103	2020	Annual	Solano (SV	LDA	70		STREX	5	ROG	0.038559		
104	2020	Annual	Solano (SV	LDA	70		STREX	5	CH4	0.008808		
125	2020	Annual	Solano (SV	LDA	70		STREX	5	PM10	0.000193		
126	2020	Annual	Solano (SV	LDA	70		STREX	5	PM2_5	0.000178		
127	2020	Annual	Solano (SV	LDA	70		STREX	5	SOx	0.000106		
128	2020	Annual	Solano (SV	LDT1	70		STREX	5	CO	0.658326		
129	2020	Annual	Solano (SV	LDT1	70		STREX	5	HC	0.083625		
140	2020	Annual	Solano (SV	LDT1	70		STREX	5	NOx	0.103817		
146	2020	Annual	Solano (SV	LDT1	70		STREX	5	PM	0.000444		
147	2020	Annual	Solano (SV	LDT1	70		STREX	5	CO2	11.20964		
148	2020	Annual	Solano (SV	LDT1	70		STREX	5	TOG	0.087282		
169	2020	Annual	Solano (SV	LDT1	70		STREX	5	ROG	0.07972		

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 Category Type	Output by EMFAC202x vehicle category, EMFAC2011 vehicle category, EMFAC2007 vehicle category, Truck/non-Truck, or Truck1/Truck2/non-Truck.
	Vehicle Category	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		

Sub-Area	County Name	Air Basin Name	Air District Name	MPO	MPO Name
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

Sub-Area	County Name	Air Basin Name	Air District Name	MPO	MPO Name
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 BERNARDIO	MOJAVE DESERT	MOJAVE DESERT AQMD	SCAG	Southern California Association of Governments
San Bernardino (SC)	SAN BERNARDIO	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

Sub-Area	County Name	Air Basin Name	Air District Name	MPO	MPO Name
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	SBCG	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	AMBG	Association of Monterey Bay Governments
Shasta (SV)	SHASTA	SACRAMENTO VALLEY	SHASTA COUNTY AQMD	SCRTA	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

Sub-Area	County Name	Air Basin Name	Air District Name	MPO	MPO Name
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 Class Categorization

EMFAC202x veh & fuel	EMFAC202x Vehicle Class	Description	EMFAC2011 Vehicle Class	EMFAC2007 Vehicle Class	EMFAC2007 Vehicle Code	Truck / Non-Truck	Truck1 / Truck2 /Non-Truck
LDA-Dsl	LDA	Passenger Cars	LDA	LDA	LDA	Non-Truck	Non-Truck
LDA-Gas							
LDA-Elec							
LDA-Phe							
LDT1-Dsl	LDT1	Light-Duty Trucks (GVWR* <6000 lbs and ETW** <= 3750 lbs)	LDT1	LDT1	T1	Non-Truck	Non-Truck
LDT1- Gas							
LDT1-Elec							
LDT1-Phe							
LDT2-Dsl	LDT2	Light-Duty Trucks (GVWR <6000 lbs and ETW 3751-5750 lbs)	LDT2	LDT2	T2	Non-Truck	Non-Truck
LDT2-Gas							
LDT2-Elec							
LDT2-Phe							
MDV-Dsl	MDV	Medium-Duty Trucks (GVWR 5751-8500 lbs)	MDV	MDV	T3	Non-Truck	Non-Truck
MDV-Gas							
MDV-Elec							
MDV-Phe							
MH-Dsl	MH	Motor Homes	MH	MH	MH	Non-Truck	Non-Truck
MH-Gas							
MCY-Gas	MCY	Motorcycles	MCY	MCY	MC	Non-Truck	Non-Truck
LHD1 – Dsl	LHD1	Light-Heavy-Duty Trucks (GVWR 8501-10000 lbs)	LHDT1	LHDT1	T4	Truck	Truck1
LHD1-Gas							
LHD1-Elec							
LHD2 – Dsl	LHD2	Light-Heavy-Duty Trucks (GVWR 10001-14000 lbs)	LHDT2	LHDT2	T5	Truck	Truck1
LHD2-Gas							
LHD2-Elec							
T6 Public Class 4-Dsl	T6 Public Class 4	Medium-Heavy Duty Public Fleet Truck (GVWR 14001-16000 lbs)	T6 Public	MHDT	T6	Truck	Truck2
T6 Public Class 4-Elec							
T6 Public Class 4-NG							

EMFAC202x veh & fuel	EMFAC202x Vehicle Class	Description	EMFAC2011 Vehicle Class	EMFAC2007 Vehicle Class	EMFAC2007 Vehicle Code	Truck / Non-Truck	Truck1 / Truck2 /Non-Truck
T6 Public Class 5-Dsl	T6 Public Class 5	Medium-Heavy Duty Public Fleet Truck (GVWR 16001-19500 lbs)	T6 Public	MHDT	T6	Truck	Truck2
T6 Public Class 5-Elec							
T6 Public Class 5-NG							
T6 Public Class 6-Dsl	T6 Public Class 6	Medium-Heavy Duty Public Fleet Truck (GVWR 19501-26000 lbs)	T6 Public	MHDT	T6	Truck	Truck2
T6 Public Class 6-Elec							
T6 Public Class 6-NG							
T6 Public Class 7-Dsl	T6 Public Class 7	Medium-Heavy Duty Public Fleet Truck (GVWR 26001-33000 lbs)	T6 Public	MHDT	T6	Truck	Truck2
T6 Public Class 7-Elec							
T6 Public Class 7-NG							
T6 Utility Class 5-Dsl	T6 Utility Class 5	Medium-Heavy Duty Utility Fleet Truck (GVWR 16001-19500 lbs)	T6 Utility	MHDT	T6	Truck	Truck2
T6 Utility Class 5-Elec							
T6 Utility Class 5-NG							
T6 Utility Class 6-Dsl	T6 Utility Class 6	Medium-Heavy Duty Utility Fleet Truck (GVWR 19501-26000 lbs)	T6 Utility	MHDT	T6	Truck	Truck2
T6 Utility Class 6-Elec							
T6 Utility Class 6-NG							
T6 Utility Class 7-Dsl	T6 Utility Class 7	Medium-Heavy Duty Utility Fleet Truck (GVWR 26001-33000 lbs)	T6 Utility	MHDT	T6	Truck	Truck2
T6 Utility Class 7-Elec							

EMFAC202x veh & fuel	EMFAC202x Vehicle Class	Description	EMFAC2011 Vehicle Class	EMFAC2007 Vehicle Class	EMFAC2007 Vehicle Code	Truck / Non-Truck	Truck1 / Truck2 /Non-Truck
T6 Utility Class 7-NG							
T6 Instate Tractor Class 6-Dsl	T6 Instate Tractor Class 6	Medium-Heavy Duty Tractor Truck (GVWR 19501-26000 lbs)	T6 Instate small	MHDT	T6	Truck	Truck2
T6 Instate Tractor Class 6-Elec							
T6 Instate Tractor Class 6-NG							
T6 Instate Delivery Class 4-Dsl	T6 Instate Delivery Class 4	Medium-Heavy Duty Delivery Truck (GVWR 14001-16000 lbs)	T6 Instate small	MHDT	T6	Truck	Truck2
T6 Instate Delivery Class 4-Elec							
T6 Instate Delivery Class 4-NG							
T6 Instate Delivery Class 5-Dsl	T6 Instate Delivery Class 5	Medium-Heavy Duty Delivery Truck (GVWR 16001-19500 lbs)	T6 Instate small	MHDT	T6	Truck	Truck2
T6 Instate Delivery Class 5-Elec							
T6 Instate Delivery Class 5-NG							
T6 Instate Delivery Class 6-Dsl	T6 Instate Delivery Class 6	Medium-Heavy Duty Delivery Truck (GVWR 19501-26000 lbs)	T6 Instate small	MHDT	T6	Truck	Truck2
T6 Instate Delivery Class 6-Elec							

EMFAC202x veh & fuel	EMFAC202x Vehicle Class	Description	EMFAC2011 Vehicle Class	EMFAC2007 Vehicle Class	EMFAC2007 Vehicle Code	Truck / Non-Truck	Truck1 / Truck2 /Non-Truck
T6 Instate Delivery Class 6-NG							
T6 Instate Other Class 4-Dsl	T6 Instate Other Class 4	Medium-Heavy Duty Other Truck (GVWR 14001-16000 lbs)	T6 Instate small	MHDT	T6	Truck	Truck2
T6 Instate Other Class 4-Elec							
T6 Instate Other Class 4-NG							
T6 Instate Other Class 5 -Dsl	T6 Instate Other Class 5	Medium-Heavy Duty Other Truck (GVWR 16001-19500 lbs)	T6 Instate small	MHDT	T6	Truck	Truck2
T6 Instate Other Class 5-Elec							
T6 Instate Other Class 5-NG							
T6 Instate Other Class 6 – Dsl	T6 Instate Other Class 6	Medium-Heavy Duty Other Truck (GVWR 19501-26000 lbs)	T6 Instate small	MHDT	T6	Truck	Truck2
T6 Instate Other Class 6-Elec							
T6 Instate Other Class 6-NG							
T6 Instate Tractor Class 7-Dsl	T6 Instate Tractor Class 7	Medium-Heavy Duty Tractor Truck (GVWR 26001-33000 lbs)	T6 Instate heavy	MHDT	T6	Truck	Truck2
T6 Instate Tractor Class 7 –Elec							
T6 Instate Tractor Class 7-NG							
T6 Instate Delivery Class 7 -Dsl	T6 Instate Delivery Class 7	Medium-Heavy Duty Delivery Truck	T6 Instate heavy	MHDT	T6	Truck	Truck2

EMFAC202x veh & fuel	EMFAC202x Vehicle Class	Description	EMFAC2011 Vehicle Class	EMFAC2007 Vehicle Class	EMFAC2007 Vehicle Code	Truck / Non-Truck	Truck1 / Truck2 /Non-Truck
T6 Instate Delivery Class 7 -Elec		(GVWR 26001-33000 lbs)					
T6 Instate Delivery Class 7 -NG							
T6 Instate Other Class 7-Dsl	T6 Instate Other Class 7	Medium-Heavy Duty Other Truck (GVWR 26001-33000 lbs)	T6 Instate heavy	MHDT	T6	Truck	Truck2
T6 Instate Other Class 7-Elec							
T6 Instate Other Class 7-NG							
T6 CAIRP Class 4-Dsl	T6 CAIRP Class 4	Medium-Heavy Duty CA International Registration Plan Truck (GVWR 14001-16000 lbs)	T6 CAIRP small	MHDT	T6	Truck	Truck2
T6 CAIRP Class 4-Elec							
T6 CAIRP Class 5-Dsl	T6 CAIRP Class 5	Medium-Heavy Duty CA International Registration Plan Truck (GVWR 16001-19500 lbs)	T6 CAIRP small	MHDT	T6	Truck	Truck2
T6 CAIRP Class 5-Elec							
T6 CAIRP Class 6-Dsl	T6 CAIRP Class 6	Medium-Heavy Duty CA International Registration Plan Truck (GVWR 19501-26000 lbs)	T6 CAIRP small	MHDT	T6	Truck	Truck2
T6 CAIRP Class 6-Elec							
T6 CAIRP Class 7- Dsl	T6 CAIRP Class 7	Medium-Heavy Duty CA International Registration Plan Truck (GVWR 26001-33000 lbs)	T6 CAIRP heavy	MHDT	T6	Truck	Truck2
T6 CAIRP Class 7-Elec							
T6 CAIRP Class 7-NG							

EMFAC202x veh & fuel	EMFAC202x Vehicle Class	Description	EMFAC2011 Vehicle Class	EMFAC2007 Vehicle Class	EMFAC2007 Vehicle Code	Truck / Non-Truck	Truck1 / Truck2 /Non-Truck
T6 OOS Class 4-Dsl	T6 OOS Class 4	Medium-Heavy Duty Out-of-state Truck (GVWR 14001-16000 lbs)	T6 OOS small	MHDT	T6	Truck	Truck2
T6 OOS Class 5-Dsl	T6 OOS Class 5	Medium-Heavy Duty Out-of-state Truck (GVWR 16001-19500 lbs)		MHDT	T6	Truck	Truck2
T6 OOS Class 6-Dsl	T6 OOS Class 6	Medium-Heavy Duty Out-of-state Truck (GVWR 19501-26000 lbs)		MHDT	T6	Truck	Truck2
T6 OOS Class 7-Dsl	T6 OOS Class 7	Medium-Heavy Duty Out-of-state Truck (GVWR 26001-33000 lbs)	T6 OOS heavy	MHDT	T6	Truck	Truck2
T6TS-Gas	T6TS	Medium-Heavy Duty Truck	T6TS	MHDT	T6	Truck	Truck2
T6TS-Elec							
T7 Public Class 8-Dsl	T7 Public Class 8	Heavy-Heavy Duty Public Fleet Truck (GVWR 33001 lbs and over)	T7 Public	HHDT	T7	Truck	Truck2
T7 Public Class 8-Elec							
T7 Public Class 8-NG							
T7 CAIRP Class 8-Dsl	T7 CAIRP Class 8	Heavy-Heavy Duty CA International Registration Plan Truck (GVWR 33001 lbs and over)	T7 CAIRP	HHDT	T7	Truck	Truck2
T7 CAIRP Class 8-Elec							
T7 CAIRP Class 8-NG							
T7 Utility Class 8-Dsl	T7 Utility Class 8	Heavy-Heavy Duty Utility Fleet Truck (GVWR 33001 lbs and over)	T7 Utility	HHDT	T7	Truck	Truck2
T7 Utility Class 8-Elec							

EMFAC202x veh & fuel	EMFAC202x Vehicle Class	Description	EMFAC2011 Vehicle Class	EMFAC2007 Vehicle Class	EMFAC2007 Vehicle Code	Truck / Non-Truck	Truck1 / Truck2 /Non-Truck
T7 NNOOS Class 8-Dsl	T7 NNOOS Class 8	Heavy-Heavy Duty Non-Neighboring Out-of-state Truck (GVWR 33001 lbs and over)	T7 NNOOS	HHDT	T7	Truck	Truck2
T7 NOOS Class 8-Dsl	T7 NOOS Class 8	Heavy-Heavy Duty Neighboring Out-of-state Truck (GVWR 33001 lbs and over)	T7 NOOS	HHDT	T7	Truck	Truck2
T7 Other Port Class 8-Dsl	T7 Other Port Class 8	Heavy-Heavy Duty Drayage Truck at Other Facilities (GVWR 33001 lbs and over)	T7 Other Port	HHDT	T7	Truck	Truck2
T7 Other Port Class 8-Elec							
T7 POAK Class 8-Dsl	T7 POAK Class 8	Heavy-Heavy Duty Drayage Truck in Bay Area (GVWR 33001 lbs and over)	T7 POAK	HHDT	T7	Truck	Truck2
T7 POAK Class 8-Elec							
T7 POAK Class 8-NG							
T7 POLA Class 8-Dsl	T7 POLA Class 8	Heavy-Heavy Duty Drayage Truck near South Coast (GVWR 33001 lbs and over)	T7 POLA	HHDT	T7	Truck	Truck2
T7 POLA Class 8-Elec							
T7 POLA Class 8-NG							
T7 Single Concrete/Transit Mix Class 8-Dsl	T7 Single Concrete/Transit Mix Class 8	Heavy-Heavy Duty Single Unit Concrete/Transit Mix Truck (GVWR 33001 lbs and over)	T7 Single	HHDT	T7	Truck	Truck2
T7 Single Concrete/Transit Mix Class 8-Elec							

EMFAC202x veh & fuel	EMFAC202x Vehicle Class	Description	EMFAC2011 Vehicle Class	EMFAC2007 Vehicle Class	EMFAC2007 Vehicle Code	Truck / Non-Truck	Truck1 / Truck2 /Non-Truck
T7 Single Concrete/Transit Mix Class 8-NG							
T7 Single Dump Class 8-Dsl	T7 Single Dump Class 8	Heavy-Heavy Duty Single Unit Dump Truck (GVWR 33001 lbs and over)	T7 Single	HHDT	T7	Truck	Truck2
T7 Single Dump Class 8-Elec							
T7 Single Dump Class 8-NG							
T7 Single Other Class 8-Dsl	T7 Single Other Class 8	Heavy-Heavy Duty Single Unit Other Truck (GVWR 33001 lbs and over)	T7 Single	HHDT	T7	Truck	Truck2
T7 Single Other Class 8-Elec							
T7 Single Other Class 8-NG							
T7 Tractor Class 8-Dsl	T7 Tractor Class 8	Heavy-Heavy Duty Tractor Truck (GVWR 33001 lbs and over)	T7 Tractor	HHDT	T7	Truck	Truck2
T7 Tractor Class 8-Elec							
T7 Tractor Class 8-NG							
T7 SWCV Class 8-Dsl	T7 SWCV Class 8	Heavy-Heavy Duty Solid Waste Collection Truck (GVWR 33001 lbs and over)	T7 SWCV	HHDT	T7	Truck	Truck2
T7 SWCV Class 8-Elec							
T7 SWCV Class 8-NG							
T7IS-Gas	T7IS	Heavy-Heavy Duty Truck	T7IS	HHDT	T7	Truck	Truck2
T7IS-Elec							
PTO-Dsl	PTO	Power Take Off	PTO	HHDT	T7	Truck	Truck2
PTO-Elec							
SBUS-Gas	SBUS	School Buses	SBUS	SBUS	SB	Non-Truck	Non-Truck
SBUS-Dsl							
SBUS-Elec							

EMFAC202x veh & fuel	EMFAC202x Vehicle Class	Description	EMFAC2011 Vehicle Class	EMFAC2007 Vehicle Class	EMFAC2007 Vehicle Code	Truck / Non-Truck	Truck1 / Truck2 /Non-Truck
SBUS-NG							
UBUS-Dsl	UBUS	Urban Buses	UBUS	UBUS	UB	Non-Truck	Non-Truck
UBUS-Gas							
UBUS-Elec							
UBUS-NG							
Motor Coach-Dsl	Motor Coach	Motor Coach	Motor Coach	OBUS	OB	Non-Truck	Non-Truck
Motor Coach-Elec							
OBUS-Gas	OBUS	Other Buses	OBUS	OBUS	OB	Non-Truck	Non-Truck
OBUS-Elec							
All Other Buses-NG	All Other Buses	All Other Buses	All Other Buses	OBUS	OB	Non-Truck	Non-Truck

Appendix D EMFAC2021-PL Emission Rate Aggregation (Units and Activity)

Process type	Unit	Vehicle Specific Activity	Equation used to aggregate
Running Exhaust	grams/vehicle-mile	Daily VMT by speed	$\frac{\sum[\boldsymbol{ER}] \cdot [\boldsymbol{VMT}]}{\sum[\boldsymbol{VMT}]}$
Start Exhaust	grams/vehicle-start	Number of starts per day	$\frac{\sum[ER] \cdot [\#\ Starts]}{\sum[\#\ Starts]}$
Idle Exhaust	grams/vehicle-idle hours	Number of idle hours per day	$\frac{\sum[ER] \cdot [Idle\ Hours]}{\sum[Idle\ Hours]}$
Hot Soak Evaporative	grams/vehicle-start	Number of starts per day	$\frac{\sum[ER] \cdot [\#\ Starts]}{\sum[\#\ Starts]}$
Running Loss Evaporative	grams/vehicle-operation hour	Operation hours per day	$\frac{\sum[ER] \cdot [Operation\ Hours]}{\sum[Operation\ Hours]}$
Diurnal Loss Evaporative	grams/vehicle-cold soak hour	Cold soak hours per day	$\frac{\sum[ER] \cdot [Cold\ Soak\ Hours]}{\sum[Cold\ Soak\ Hours]}$
Brake Wear	grams/vehicle-mile	Daily VMT by speed	$\frac{\sum[ER] \cdot [VMT]}{\sum[VMT]}$
Tire Wear	grams/vehicle-mile	Daily VMT (over all speeds)	$\frac{\sum[ER] \cdot [VMT]}{\sum[VMT]}$

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