

Guidance for Applying EMFAC2021 Off-Model Adjustment Factors to Project-Level (PL) Assessment

This guide describes how to apply EMFAC2021 off-model adjustment factors¹ to Project-Level (PL) analyses to account for the removal of the Advanced Clean Trucks (ACT), Zero-Emission Airport Shuttle, Omnibus, and Warranty Phase I regulations after the original model release. The U.S. EPA approved these adjustment factors in November 2025 (see [U.S. EPA's approval letter](#) for additional information).

CARB staff converted these adjustment factors for PL analysis for one Sub-Area as an example to help readers navigate the process. These converted PL adjustment factors are listed in the 'Factors by Truck_NonTruck' and 'Factors by EMFAC2007 Category' sheets of the attached spreadsheet titled '**EMFAC2021 factors for PL Guidance.xlsx**' (hereafter referred to as the '**PL-spreadsheet**'). Part A explains how these PL factors were generated by CARB staff. These example factors were generated for the 'Los Angeles (SC)' Sub-Area. Users will need to follow the same steps to generate PL factors for other Sub-Areas, if needed. Part B of this document describes how users can apply these adjustment factors to PL outputs.

Part A: Conversion of Off-model Adjustment Factors for EMFAC2021 Project-Level Use

This section describes the necessary steps to convert the November 2025 off-model adjustment factors to a format that can be used for PL analysis. As mentioned above, these factors were developed for the 'Los Angeles (SC)' Sub-Area as an example and are tabulated in the attached '**PL-spreadsheet**'.

- 1) Emissions of PM2.5_TOTAL, PM10_TOTAL, NO_x_TOTEX, and ROG_TOTAL at the sub-area or county level can be obtained by querying the EMFAC2021 v1.0.2 model results in the 'Emissions Inventory' module of the EMFAC web application (<https://arb.ca.gov/emfac/emissions-inventory>). This example used 'Los Angeles (SC)' as the Sub-Area. Other inputs used in this example are shown in Table 1 and Figure 1 below. These emissions ('Include Regulations Emissions' hereafter) reflect the benefits of all regulations adopted at the time EMFAC2021 was finalized, including, but not limited to, ACT, Zero-Emission Airport Shuttle, Omnibus, and Warranty Phase I regulations. The obtained model output was copied into the 'EMFAC2021EI-EMFAC202XClass' sheet of the PL-spreadsheet.

Table 1: An example list of inputs used in EMFAC2021 v1.0.2 model to generate 'Include Regulations Emissions'

| Output | Model Version | Region Type | Region | Calendar Year |
|-------------------|------------------|-------------|------------------|---------------|
| On-Road Emissions | EMFAC2021 v1.0.2 | Sub-Area | Los Angeles (SC) | 2022 - 2050 |

| Season | Vehicle Category | Model Year | Speed | Fuel | Output Unit |
|--------|------------------|------------|-----------|------------|--------------|
| Annual | EMFAC202x | Aggregate | Aggregate | Select All | tons per day |

The screenshot displays the EMFAC web application interface with the following settings:

- Navigation:** Home, EMISSIONS (highlighted), PROJECT ANALYSIS, SCENARIO ANALYSIS, FLEET DATABASE, COMMUNITY-LEVEL.
- Section Header:** Emissions Inventory (highlighted).
- Output:** Onroad Emissions (selected), Onroad Emission Rates.
- Model Version:** EMFAC2025 v2.0.0, EMFAC2021 v1.0.2 (selected), EMFAC2017 v1.0.2.
- Region Type:** Sub-Area (selected), County, Metropolitan Planning Organization, Air District, Air Basin, Statewide.
- Region:** Los Angeles (SC) (selected). Note: Please note that the output size can become very large (potentially exceeding several gigabytes) if you select multiple calendar years, multiple locations, and many vehicle classes.
- Calendar Year:** Select, Range. Timeline shows From 2022 to To 2050, with 2022 and 2050 selected.
- Season:** Annual (selected), Summer, Winter.
- Vehicle Category:** EMFAC202X (selected), EMFAC2011, EMFAC2007, Deselect All.
 - LDA, LDT1, LDT2, MDV, MCY, MH, LHD1, LHD2
 - T6 Public Class 4, T6 Public Class 5, T6 Public Class 6, T6 Public Class 7
 - T6 Utility Class 5, T6 Utility Class 6, T6 Utility Class 7
 - T6 Instate Tractor Class 6, T6 Instate Delivery Class 4
 - T6 Instate Delivery Class 5, T6 Instate Delivery Class 6, T6 Instate Other Class 4
 - T6 Instate Other Class 5, T6 Instate Other Class 6, T6 Instate Tractor Class 7
 - T6 Instate Delivery Class 7, T6 Instate Other Class 7, T6 CAIRP Class 4
 - T6 CAIRP Class 5, T6 CAIRP Class 6, T6 CAIRP Class 7, T6 OOS Class 4
 - T6 OOS Class 5, T6 OOS Class 6, T6 OOS Class 7, T6TS
 - T7 Public Class 8, T7 CAIRP Class 8, T7 Utility Class 8, T7 NNOOS Class 8
 - T7 NOOS Class 8, T7 Other Port Class 8, T7 POAK Class 8, T7 POLA Class 8
 - T7 Single Concrete/Transit Mix Class 8, T7 Single Dump Class 8
 - T7 Single Other Class 8, T7 Tractor Class 8, T7 SWCV Class 8, T7IS
 - PTO, UBUS, SBUS, Motor Coach, OBUS, All Other Buses
- Model Year:** Aggregate (selected), Select, Range.
- Speed:** Aggregate (selected), Select.
- Fuel:** Deselect All. Gasoline (selected), Diesel, Electricity, Natural Gas, Plug-In Hybrid.
- Output Unit:** tons / operation day (selected), tons / year.
- Buttons:** Show Results, Download as CSV.

Figure 1: Screenshot showing the inputs selected in EMFAC web application to generate 'Include Regulations Emissions'

- 2) **Region, Calendar Year, Vehicle Category, Fuel, NO_x_TOTEX, PM2.5_TOTAL, PM10_TOTAL, and ROG_TOTAL** fields (Columns **A, B, C, F, P, W, AD, and AX**) from the **'EMFAC2021EI-EMFAC202Xclass'** sheet were copied to Columns **A, B, C, F, H, K, N, and Q** of the **'Calculation Process'** sheet in the 'PL-spreadsheet', respectively (see Figure 2 below for the PL-spreadsheet's sheet names). Table 2 shows the mapping of the columns between these two sheets.

Table 2: Mapping of columns between the 'EMFAC2021EI-EMFAC202Xclass' and 'Calculation Process' sheets

| Field Name | Columns | |
|------------------------|------------------------------------|-----------------------------|
| | 'EMFAC2021EI-EMFAC202Xclass' sheet | 'Calculation Process' sheet |
| Region | A | A |
| Calendar Year | B | B |
| Vehicle Category | C | C |
| Fuel | F | F |
| NO _x _TOTEX | P | H |
| PM2.5_TOTAL | W | K |
| PM10_TOTAL | AD | N |
| ROG_TOTAL | AX | Q |

- 3) U.S. EPA-approved EMFAC2021 off-model adjustment factors (see the 'Appendix A Factors' sheet of the 'PL-spreadsheet') were then applied to the emissions obtained in Steps 1-2. These factors were matched appropriately by 'Calendar Year', 'EMFAC2021 Vehicle Category', 'Fuel', and pollutants to calculate updated emissions for NO_x_TOTEX, PM2.5_TOTAL, PM10_TOTAL, and ROG_TOTAL (Columns J, M, P, S of the 'Calculation

Process' sheet, respectively). The updated emissions (Remove Regulations Emissions' hereafter) represent a scenario in which emissions reductions from the ACT, Zero-Emission Airport Shuttle, Omnibus, and Warranty Phase I regulations are not reflected.

- 4) Each EMFAC2021 Vehicle Category was then reclassified as Truck or Non-Truck (Column D of the 'Calculation Process' sheet), and also mapped to the corresponding EMFAC2007 category (Column E of the 'Calculation Process' sheet), based on the EMFAC database (see the 'Truck_NonTruck' sheet of the PL-spreadsheet)
- 5) 'Include Regulations Emissions' (Step 1-2) and 'Remove Regulations Emissions' (Step 3) were then summed by Truck/Non-Truck category (see 'Factors by Truck_NonTruck' sheet). This aggregation provided a single 'Include Regulations Emissions' and 'Remove Regulations Emissions' value for the Truck and Non-Truck categories, for each pollutant in each Calendar Year. The same process was repeated for EMFAC2007 categories (see the 'Factors by EMFAC2007 Category' sheet).
- 6) The user can refresh pivot tables in the 'Factors by Truck_NonTruck' sheet or the 'Factors by EMFAC2007 Category' sheet and select the desired Calendar Year using the pivot table filter.
- 7) Finally, adjustment factors were calculated for each pollutant and Calendar Year for Truck and Non-Truck categories using equation 1. These adjustment factors are tabulated in the 'Factors by Truck_NonTruck' sheet of the PL-spreadsheet. Similarly, PL adjustment factors for EMFAC2007 categories were calculated by applying equation 2, and tabulated thereafter in the 'Factors by EMFAC2007 Category' sheet.

$$\text{Adjustment factors}_{[Truck\ or\ Non-Truck]} = \text{'Remove Regulations Emissions'}_{[Truck\ or\ Non-Truck]} / \text{'Include Regulations Emissions'}_{[Truck\ or\ Non-Truck]} \quad \dots\dots\dots \text{Equation 1}$$

$$\text{Adjustment factors}_{[EMFAC2007\ Category]} = \text{'Remove Regulations Emissions'}_{[EMFAC2007\ Category]} / \text{'Include Regulations Emissions'}_{[EMFAC2007\ Category]} \quad \dots\dots\dots \text{Equation 2}$$

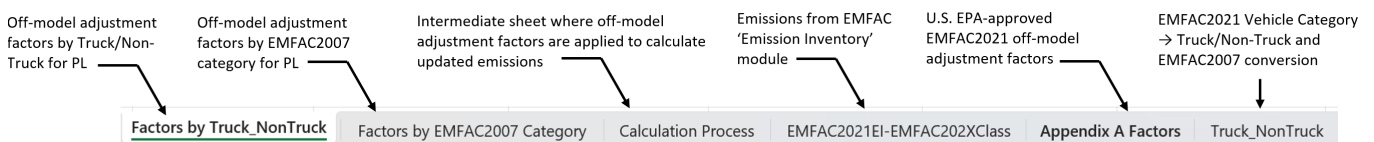


Figure 2: Screenshot displaying the sheet names of the spreadsheet named EMFAC2021 factors for PL Guidance.xlsx' (the 'PL-spreadsheet')

Part B: Application of PL Off-model Adjustment Factors to EMFAC2021 Project-Level Outcome

This section describes how users can apply the PL Truck/Non-Truck (or EMFAC2007) adjustment factors to PL outputs.

Generate a Project-Level (PL) Analysis File

Generate a PL analysis file using the EMFAC2021 application by following the procedures described in the *EMFAC2021 User's Guide*. Alternatively, the PL analysis file can be downloaded directly from the EMFAC website: <https://arb.ca.gov/emfac/project-analysis>. The following model inputs must be selected to use PL off-model Adjustment Factors derived in Part A. All other inputs may be chosen based on the user's specific analysis needs.

- Model Version: EMFAC2021 v1.02
- Vehicle Category: Truck/Non-Truck or EMFAC2007
- Model Year: Aggregate
- Fuel: Aggregate

To help readers navigate the process, an example PL analysis file (Figure 4) was generated for Sub-Area: Los Angeles (SC) so that PL adjustment factors that were generated for the same Sub-Area in Part A could be applied directly. The additional settings of the example PL analysis file (Figure 3) are given below.


- Region Type: Sub-Area
- Region: Los Angeles (SC)
- Calendar Year: 2026
- Season: Annual

Project Analysis

The project-level (PL) web tool allows users to generate emission rates based on custom meteorological conditions (temperature and relative humidity). Please note that the emission rates produced by this web tool may differ slightly from those generated by the EMFAC PC application. [?](#)

Model Version

Region Type [?](#)

Region
 

Calendar Year

Season

Vehicle Category [?](#)

Model Year

Speed

Fuel

Figure 3: Screenshot of the EMFAC web application showing the inputs selected for the example PL analysis

| calendar_year | season_month | sub_area | vehicle_class | temperature | relative_humidity | process | speed_time | pollutant | emission_rate |
|---------------|--------------|------------------|---------------|-------------|-------------------|---------|------------|-----------|---------------|
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | PM2_5 | 0.000650567 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | PM10 | 0.000707551 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | CH4 | 0.067263962 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | CO2 | 75.12307022 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | ROG | 0.433537434 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | TOG | 0.47466892 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | PM | 0.000791444 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | SOx | 0.000891484 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | NOx | 0.29803884 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | CO | 9.677106115 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 720 | HC | 0.454785438 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | PM2_5 | 0.000635827 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | PM10 | 0.00069152 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | CH4 | 0.065115949 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | CO2 | 71.32364651 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | ROG | 0.417664801 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | TOG | 0.457290385 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | PM | 0.000773512 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | SOx | 0.00085209 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | NOx | 0.311795252 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | CO | 9.601791126 |
| 2026 | Annual | Los Angeles (SC) | Truck | 70 | | STREX | 660 | HC | 0.438134875 |

Figure 4: Screenshot displaying a part of the generated PL analysis file

Obtain Adjustment Factors

The Excel file “**EMFAC2021 factors for PL Guidance.xlsx**” (**PL-spreadsheet**) contains PL adjustment factors generated for the Los Angeles (SC) Sub-Area in Part-A. In this file, ‘**Factors by Truck_NonTruck**’ and ‘**Factors by EMFAC2007 Category**’ sheets contain the PL factors for Truck/Non-Truck and EMFAC2007 categories, respectively. A screenshot of ‘Factors by Truck_NonTruck’ worksheet is shown in Figure 5 for reference. Note that if users need to analyze data for a different Sub-Area, the steps outlined in Part A must be followed to generate PL adjustment factors specific to that Sub-Area.

In the worksheets:

- Column J contains NOx adjustment factors
- Column K contains PM2.5 adjustment factors
- Column L contains PM10 adjustment factors
- Column M contains ROG adjustment factors

These factors are available for calendar years 2022 through 2050. For the same pollutant, these factors can be applied to all processes and speed-time bins (e.g., NOx adjustment

factors can be used for NOX STREX or RUNEX or IDLEX emission rates).¹ For pollutants not listed above or for years beyond this range, the adjustment factors will be equal to 1.

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|-----------------|------------------|--------------------|--------------------|----------------------|-------------------|---------------------|------------------|--------------------|------------|--------------|-------------|------------|
| 1 | Calendar Year | 2026 | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | Truck/Non-Truck | Sum of NOx_TOTEX | Sum of NOx Updated | Sum of PM2.5_TOTAL | Sum of PM2.5 Updated | Sum of PM10_TOTAL | Sum of PM10 Updated | Sum of ROG_TOTAL | Sum of ROG Updated | NOx factor | PM2.5 factor | PM10 factor | ROG factor |
| 4 | NonTruck | 25.88057412 | 25.89234276 | 1.986306087 | 1.986357983 | 5.530381887 | 5.530483816 | 38.89538437 | 38.89572813 | 1.0005 | 1.0000 | 1.0000 | 1.0000 |
| 5 | Truck | 30.5090167 | 31.04846271 | 0.9910216 | 0.99517295 | 2.435540536 | 2.445232377 | 2.712017593 | 2.722261291 | 1.0177 | 1.0042 | 1.0040 | 1.0038 |

Figure 5: A screenshot of the 'EMFAC2021 factors for PL Guidance.xlsx' (PL-spreadsheet) highlighting an example of the 'Factors by Truck_NonTruck' sheet.

Apply Adjustment Factors

The adjustment factors were then applied to the generated PL analysis file by matching:

- Calendar year (CY2022-2050)
- Vehicle class (Truck/Non-Truck or EMFAC2007)
- Pollutant (PM2.5, PM10, NOx, ROG)

Example:

In calendar year 2026, the adjustment factors for Truck category at Los Angeles (SC) are:

- PM2.5: 1.0042
- PM10: 1.0040
- NOx: 1.0177
- ROG: 1.0038

PM factors are assumed to be equal to the PM10 factors. Adjustment factors for all other pollutants are 1.

The adjusted emission rates from Truck category at Los Angeles (SC) in calendar year 2026 were then calculated using Equation 1.

¹ The EPA-approved factors aggregated all processes for a given pollutant together. For example, PM2.5 factors represent an average for all processes including running, start, and idle exhaust, as well as brake wear and tire wear. Therefore, the same factor should be applied to all processes, and it is not possible to develop unique factors for each process.

For example, for process = STREX, temperature = 70 and speed_time = 720 (Figure 4),

$$\textit{Adjusted PM}_{2.5} \textit{ emission rate}_{[Truck]} = 0.000650567 \times 1.0042$$

$$\textit{Adjusted PM}_{10} \textit{ emission rate}_{[Truck]} = 0.000707551 \times 1.0040$$

$$\textit{Adjusted NO}_x \textit{ emission rate}_{[Truck]} = 0.29803884 \times 1.0177$$

$$\textit{Adjusted ROG emission rate}_{[Truck]} = 0.433537434 \times 1.0038$$