EMFAC Modeling Change Technical Memo

SUBJECT: REVISIONS TO VEHICLE ACTIVITY ESTIMATES FROM CHANGING POPULATION OF AGE 45 VEHICLES AND VMT MATCHING

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Summary

Staff noted significant changes in backcasted estimates of vehicle activity and emissions between EMFAC2001 version 2.08 and EMFAC2002 version 2.20. These changes resulted from a spike in the population of age 45 vehicles that were introduced when vehicle populations were updated in EMFAC2002. This population spike was mitigated, resulting in backcasted activity estimates that are in-line with those from EMFAC2001 ver 2.08. Furthermore, the VMT matching algorithm was used to ensure that forecasted estimates of VMT match those from EMFAC2002, hence there is no significant impact of this change to forecasted inventories.

The backcasted 1980 and 1990 calendar year estimates of vehicle miles traveled (VMT) in EMFAC2002 version 2.20 are 35.5% and 11.2% lower, respectively, than those previously estimated in EMFAC2001 version 2.08 (Table 1). In addition, the backcasted population weighted accrual rates[[1]](#footnote-1) (as displayed in the “edit fundamental data” section of the model) for 1980 dropped 35.9%, from an average of 10,982 to 7,042 miles per year. The vehicle population for 1999 calendar year is approximately 4.7% lower in EMFAC2002 ver.2.20 than in version 2.08. However, this alone can not explain the changes to the backcasted estimates of VMT and accrual rates.

Table 1 Comparison of Population, VMT and Accrual Rates from EMFAC2002 version 2.2 and EMFAC2001 ver 2.08



These changes in vehicle activity significantly affect the backcasted emission inventories. Table 2 shows the change in statewide annual average emissions of total[[2]](#footnote-2)-ROG, total-CO and total-NOx in calendar years 1980 and 1990.

Staff investigated parameters that have changed between versions 2.08 and 2.20, and have determined that the only difference between the models that could have caused these changes is a spike in the population of age 45 vehicles relative to age 44 vehicles in EMFAC2002 version 2.20. In EMFAC2002, age 45 contained vehicles with ages 45 and older, whereas in EMFAC2001, age 45 only contained vehicles of age 45.

Table 2 Comparison of Statewide Emission Inventories from EMFAC2002 version 2.2 and EMFAC2001 ver 2.08



To address this issue, staff lowered the population of age 45 vehicles in the 1999 base calendar year by only including vehicles of age 45. An inflationary effect that also caused the pre-1999 calendar year population distributions to age slightly was also removed.

Table 3 shows the resulting change in activity for calendar years 1980, 2000, 2010, and 2020. By reducing the population of age 45 vehicles, the vehicle populations for all calendar years and geographic areas are lower by approximately 0.5%. The 1980 statewide estimate of VMT increases from 260,546,000 to 389,111,000 miles per day, a 49% increase. In general, the backcasted estimate of VMT increases for all areas and calendar years prior to 1999. Statewide forecasts of VMT are lower by approximately 0.5% for 2000 and newer calendar years. The 1980 statewide estimate of trips per day increased by 14%, from 69.8 to 79.5 million trips per day. In general, the backcasted estimates of trips per day increase for all calendar years prior to 1999 and decrease for all 2000 and newer calendar years.

# Table 3 Changes To Vehicle Activity For Various Calendar Years With Proposed Modifications To Base-Year Vehicle Population



Table 4 shows how changes in these activity parameters affect statewide annual average emissions. Please note these inventories are calculated using the simple-average option. These changes increase the 1980 statewide annual average emissions of total-ROG, CO, and NOx by 141, 5,923, and 756 tons per day, respectively. This represents a 4.2% increase in ROG, 23.7% increase in CO and a 44.5% increase in NOx, over current estimates for the 1980 calendar year, and makes the estimates closer to those from EMFAC2001 version 2.08.

# Table 4 Change In Emission Estimates For Various Calendar Years With Proposed Modifications To Base-Year Vehicle Population



By reducing the population of age 45 vehicles, the 1999 base year vehicle population was reduced by approximately 0.5%. As a consequence, the statewide forecasts of Vehicle Miles Traveled (VMT) (see Table 5) were also reduced by approximately 0.5% for 2000 and newer calendar years.

# Table 5 Percentage Change in Statewide VMT Forecasts



Without any further changes in activity, the model would have forecasted VMTs that were 0.5% less than the regional estimates of VMT provided by various Councils of Government (COGs), which were incorporated in EMFAC2002 ver. 2.20. To resolve this difference, staff ran the VMT matching algorithm[[3]](#footnote-3) for calendar year 2000, which is the base year for most SIPs. The VMT algorithm modified the 2000 calendar year population growth rate such that the VMT forecasts from the new model match those from EMFAC2002 ver. 2.20.

Table 6 shows the activity changes for calendar years 2000, 2010 and 2020. This table shows that the VMT estimates from version 2.20X, which contains **both** **population (age 45 fix) and VMT** changes, precisely match the VMT estimates from EMFAC2002 ver. 2.20. There are some minor changes in population. However, these can be attributed to rounding differences. Table 7 shows that the accurate VMT matching reduced any potential differences in forecasted annual average emission inventories.

# Table 6 Change In Activity For 2000, 2010, And 2020 Calendar Years



# Table 7 Change in Emissions For Calendar Years 2000, 2010, And 2020



## Reason For Change

Since the release of EMFAC2002 version 2.20[[4]](#footnote-4), staff has fielded several queries regarding backcasted emission inventories. Specifically, questions were raised regarding why the 1980 VMT estimate in EMFAC2002 ver. 2.20 was 35.5 percent lower than in EMFAC2001 ver. 2.08. In addition, it was asked why the 1980 population weighted accrual rate in version 2.20 is 35.9% lower than in version 2.08.

Staff investigated all activity parameters that were changed and could have caused significant changes to historic estimates of vehicle activity. This memorandum documents what caused the backcasted VMT estimates to change between ver. 2.08[[5]](#footnote-5) and ver. 2.20, proposes a fix, and details the impact on emission inventories from correcting the estimates of vehicle activity.

## Background

EMFAC2002 ver. 2.20 contains vehicle population data, from an analysis of Department of Motor Vehicles (DMV) registration data, for calendar year 1999. In this version of EMFAC, this year is referred to as the “base year.” The base year vehicle population varies by area, vehicle class, fuel type, and age. The vehicle populations for all other calendar years are backcast (1970 to 1998) or forecast (2000-2040) from this 1999 base year. The model also contains mileage accrual rates, which vary by area, vehicle class, fuel type, and age. The VMT for a given area is simply the product of vehicle population and mileage accrual rates. For **pre-1999** calendar years, VMT is calculated using the product of accrual rates and backcasted vehicle populations. The backcasted population is a function of the base year (1999) population, vehicle survival rates, and population growth rates. Therefore, any changes to the base population data can affect backcasted estimates.

The next section of this memorandum provides a brief primer on the backcasting algorithm, and is key to understanding what caused backcasted vehicle activity estimates to change significantly between version 2.08 and 2.20. In the methodology section, staff has proposed fixes that will minimize these activity differences. Finally, the result section shows the impact on emission inventories from **two** changes:

1. The effects of changing the population of age 45 vehicles.
2. VMT matching on 2000 calendar year.

These changes are noted as two separate changes (as “ Age 45” and “VMT Matching”) in the result section.

## Backcasting Algorithm

EMFAC7G, and all previous versions of EMFAC, contained static population distributions (registration distribution) where the percentage of vehicles by age is constant regardless of calendar year. For example, if five percent of the vehicles were age two in 1990 then it was assumed that five percent of the vehicles were also age two in 1980. Further, it was assumed that this population distribution was the same for all areas of the state.

There were several criticisms of this methodology. First, it didn’t track historic fluctuations in vehicle sales, which is important in accurately allocating emissions in each calendar year. Second, using the same population distribution for all areas does not account for socio-economic factors that affect population distributions. These comments were key factors in the development of population distributions that vary by geographic area and vary dynamically. All models subsequent to EMFAC7G use a dynamic vehicle registration algorithm to backcast and forecast vehicle distributions. The basic premise of this methodology is that one can estimate the number of vehicles of a given age in a previous calendar year by knowing the current population and the retention rates for each age. The age specific retention rate is calculated as one minus the age specific scrappage rate. For example, if there are 100 1990 model year vehicles at age 10 and 90 at age 11 then the retention rate for age 11 is 0.9. By definition, the survival rate is the product of these age specific retention rates. These survival rates were developed by comparing vehicles with the same model year in the DMV registration data for consecutive calendar years. Figure 1 shows the passenger car survival and retention rates.

### Figure 1 Passenger Car Survival and Retention Rates



The following three steps illustrate how **passenger car** population is backcast in EMFAC2001 ver. 2.08. The reason for using version 2.08 is to illustrate how the backcast was done previously, and then show what has changed to affect the vehicle population in ver. 2.20. The base calendar years in EMFAC2001 ver. 2.08 are 1997 and 1998.

**Step 1**: The population of age 1 vehicles in 1996 calendar year (1996 model year) is equal to the population of age 2 vehicles in 1997 calendar year divided the by retention rate for age 1. This step is repeated for vehicles up to age 44.

1996 Model Year: Pop\_1cy=1996 = Pop\_2cy=1997 / R\_1

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1953 Model Year: Pop\_44cy=1996 = Pop\_45cy=1997 / R\_44

where:

Pop\_ is the population of vehicles by age in a given calendar year and

R\_ is the retention rate of that age.

**Step 2**: As an initial guess, the population of age 45 vehicles in the 1996 calendar year is set to equal age 44 vehicles in 1996 calendar year.

1952 Model Year: Pop\_45cy=1996 = Pop\_44cy=1996

**Step 3**: Calculate the total population for 1996 calendar year, by summing the populations in each age.

Tot\_Popcy=1996 = 

**Step 4**: The total population is then adjusted to match the historic trends. This is done by comparing the Tot\_popcy=1996 (from step 3) to one simply calculated by applying a growth rate to the base 1997 population. For example, the target population for 1996 is:

T\_1996 = B\_1997 \* (1 + GR1996)

Where:

T\_1996 is the target population for calendar year 1996

B\_1997 is the base vehicle population

GR1996 is the growth rate for calendar year 1996

The total population of passenger cars ( Tot\_Popcy=1996 ) is then adjusted until it matches the target population (T\_1996) calculated in step 4. Using this process, the model matched historic trends in vehicle population. Table 8 shows the backcasted passenger car populations by calendar year and age calculated using this dynamic registration algorithm.

Table 8 Backcasted Passenger Car Population Distributions – EMFAC2001 Version 2.08



Figure 2 shows the backcasted passenger car population distributions, from version 2.08, for calendar years 1997 (base year), 1990, and 1980. This figure shows that in the base year, the percent of vehicles age 44 and 45 were approximately the same. The model estimates population distributions for all historic calendar years using the dynamic registration algorithm. As mentioned earlier, this algorithm preserves year to year sales differences as observed in the base population data. For example, the 1997 data indicates that a peak in vehicle sales exists at age 9 (1989 MY). When this base population is backcast to 1990, the 1990 distribution indicates a peak in sales for age 2 vehicles, which also corresponds to the 1989 model year. Figure 2 also shows that the average age of passenger cars in 1997, 1990, and 1980 calendar years is 10, 8.9, and 11.7 years, respectively. These are relatively minor fluctuations in vehicle age over a 20-year period.

Figure 2 Backcasted Passenger Car Population Distributions From Version 2.08



In version 2.20 the vehicle populations were changed and backcasts and forecasts of vehicle population were based on the new population estimates for the 1999 calendar year.

Staff noted an increase in the population of age 45 vehicles relative to age 44 vehicles that is significantly higher in version 2.20 compared to 2.08. Table 9 compares the passenger car populations of age 44 and 45 from versions 2.08 and 2.20 and shows that there is approximately a seven-fold increase. The reason is that in version 2.20 all vehicles ages 46 and older are counted in the age 45 bin. The dynamic registration algorithm interprets this as a significant population increase, and attempts to preserve this trend for all backcasts of vehicle population. Table 10 illustrates how the backcasted passenger car populations are affected by this simple change.

#### Table 9 Comparison of Age 45 Passenger Cars



#### Table 10 Backcasted Passenger Car Population Distributions from Version 2.20



Table 10 shows how the population of age 45 vehicles in the 1999 base year affects backcasted estimates of vehicle population. In the first iteration, the age 44 population in 1998 is calculated from the age 45 population in 1999. In addition, the age 45 population in 1998 is initially estimated to be the same as the age 44 population in 1998. These steps are repeated for each subsequent backcasted year. The relative difference between age 44 and age 45 vehicles propagates through time resulting, in this case, in an artificially older population of vehicles. Figure 3 graphically illustrates this point. This figure shows the backcasted passenger car population distributions from version 2.20, the spike in vehicle populations at age 45, and how this spike propagates through backcasts of the 1990 and 1980 calendar years.

##### Figure 3 Backcasted Passenger Car Population Distributions from version 2.02



## Methodology

This section details two proposed fixes to the backcasted estimates of vehicle population. In the first fix, vehicles ages 46 and older are removed from the age 45 estimate in the 1999 base year. Table 11 shows that this reduces the population of age 45 passenger cars in 1999 by 46,331.

Table 11 New Estimate of Age 45 Passenger Cars

|  |  |  |
| --- | --- | --- |
|  | **1999\_Base\_Ver. 2.20** | **1999\_Base\_Ver. 2.20X\*** |
| **Age** | **Pop\_PC** | **Percent** | **Pop\_PC** | **Percent** |
| 44 | 8254 | 0.06% | 8254 | 0.07% |
| 45 | 55534 | 0.41% | 9203 | 0.07% |
| Total PC | 12329764 |  | 12283433 |  |
| Ratio |  | 6.73 |  | 1.11 |

**\*Ver 2.0X is the temporary title selected for noting difference in this doucment.**

The new estimate of age 45 passenger cars is still inflationary; in that it is higher than the age 44 estimate. The ratio of age 45 to age 44 estimate is 1.11, which over time will inflate the numer of older vehicles. This effect is illustrated in Figure 4, which shows the backcasted populations with new estimates for age 45. Figure 4 shows that the tail of the population distribution increases the further the backcast year is from the base population year. Again, the net effect is that this artificially ages the passenger car fleet.

Figure 4 Backcasted Passenger Car Population Distributions from Version 2.20X



The second fix is subtle, and assumes that the initial population of age 45 vehicles in the first iteration of the backcast is the same as that of age 45 vehicles in the base year. For example, if there are 9,203 passenger cars that are age 45 in the 1999 calendar year, then this same number is used as an initial guess for the number of age 45 vehicles in the 1998 calendar year. This number is then adjusted up or down based on the corrections outlined in Step 4 of the backcasting algorithm. Table 12 shows the backcasted passenger car populations from the final EMFAC2002 ver 2.20X. Figure 5 graphically shows the resulting population distributions.

#### Table 12 Backcasted Population Distributions from EMFAC2002 ver 2.20X final



Figure 5 Backcasted Passenger Car Population Distributions from Ver. 2.20X



With these two fixes, the backcasts of vehicle population are more reasonable in that they don’t overestimate the population of older vehicles. This is evident in the fact that the average age of passenger cars for 1999, 1990, and 1980 is 9.8, 8.9, and 12.1 years, respectively. Again, these are minor changes in vehicle age over a 20 year period.

Changing the base vehicle population on its’ own will reduce both backcasted and forecasted estimates of VMT. As an additional fix, staff suggest modifying the growth rates for 2000 calendar year such that the VMTs for 2000 and later calendar years match those from EMFAC2002 ver. 2.20.

The next section details the impact that population and VMT matching has on forecasts and backcasts of vehicle activity and emissions.

Results – Age 45

Removing vehicles with ages greater than 45 reduced the base 1999 population by approximately 103,000 vehicles or by 0.5%. Table 13 shows how this change affects regional estimates of total vehicle population in calendar year 2000. Table 14 gives a breakdown of the number of vehicles removed by vehicle class. This table also shows the percentage change relative to the population in each vehicle class. This indicates that the population of light-heavy, heavy heavy-duty, school bus and urban buses are impacted more by this change.

Table 13 Regional Effects From Changing Population of Age 45 Vehicles In Calendar Year 2000



### Table 14 Population Changes By Vehicle Class in 2000 Calendar Year



The reduction in the base population also affects estimates of VMT for forecast calendar years. Since the base population was reduced by approximately 0.5%, and the population growth rates remain the same, estimates of VMT for future calendar years should also be reduced by approximately 0.5%. Table 15 shows the percentage reduction in VMT by calendar year.

### Table 15 Effect of Dropping Vehicles on VMT Forecasts



The following figures compare statewide **annual** **average** emission and activity estimates from three versions: ver. 2.08, ver. 2.20 and the tentatively titled EMFAC2002 ver. 2.20X[[6]](#footnote-6). These emission inventories were run using the simple-average option. Further, the emission inventories were run in 5 year increments beginning with 1975 and ending with 2020. Figure 6 shows a comparison of population estimates from these three models. This Figure shows that both ver. 2.20 and 2.20X follow the same backcast (pre-1997) population trend as ver. 2.01 indicating that the historic growth rates have not been changed.

### Figure 6 Comparison of Statewide Population Estimates



Figure 7 shows a comparison of statewide VMT estimates. Figure 7 shows that with the proposed changes the 1980 statewide estimate of VMT increases from 260,546,000 to 389,259,000 miles per day, a 49% increase over the ver. 2.20 estimate. In general, the backcasted estimate of VMT increases for all areas and calendar years prior to 1999. Whereas statewide forecasts of VMT are lower by approximately 0.5%, relative to ver. 2.20 for 2000 and newer calendar years.

### Figure 7 Comparison Of Statewide Estimates of VMT



Figure 8 shows a comparison of statewide total-ROG emissions. With the change in population of age 45 vehicles, the total-ROG emissions from ver. 2.20x are more in-line with previous estimates from ver. 2.08. These estimates are lower, for calendar years 1985-2000, than those from ver. 2.20. This reduction is caused by a change in population, which lowers the average age of the vehicle fleet and lowers evaporative emissions. However, beyond 1980 calendar year the total-ROG emissions from ver. 2.20X and 2.08 are higher than those from ver. 2.20 because exhaust emissions dominate. The emission process is dependent on VMT, which is higher in ver. 2.20X and ver. 2.08 because the average age of the fleet is younger than in ver. 2.20. Newer vehicles travel more miles per year than older vehicles and hence their exhaust emissions, in this case, tend to dominate.

Figures 9 and 10 show a comparison of statewide total-CO and total-NOx emissions. Both of these pollutants are dominated by VMT, which increases for pre-1999 calendar years in ver. 2.20X relative to ver. 2.20.

#### Figure 8 Comparison of Statewide Annual Averaged Total-ROG Emissions



Table 16 shows the resulting change to the activity parameters for calendar years 1980, 2000, and 2020. By reducing the population of age 45 vehicles, the vehicle populations for all calendar years and geographic area are lower by approximately 0.5%. The 1980 statewide estimate of VMT increases from 260,546,000 to 389,111,000 miles per day, or 49%, and the backcasted estimate of VMT increases for all areas and calendar years prior to 1999. Statewide forecasts of VMT are lower by approximately 0.5% for 2000 and newer calendar years. The 1980 statewide estimates of trips per day increase by 14%, from 69.8 to 79.5 million trips per day. Backcasted estimates increase for all calendar years prior to 1999 and decrease for all 2000 and newer calendar years.

Table 17 shows how changes in these activity parameters affect statewide annual average emissions calculated using the simple-average option. The activity changes increase the 1980 statewide annual average emissions of total-ROG, CO, and NOx by 141 tons per day (tpd) (4.2%), 5,923 tpd (23.7%), and 756 tpd (44.5%), respectively. The 1980 total-ROG emissions in the South Coast Air Basin by only increase 0.64%, because the increase in exhaust emissions, associated with the increase in VMT and trips per day, are partially offset by reductions in the evaporative emissions from changes in the age distribution.

#### Figure 9 Comparison of Statewide Annual Averaged Total-CO Emissions



#### Figure 10 Comparison of Statewide Annual Averaged Total-NOx Emissions



# Table 16 Changes In Activity For Various Calendar Years With Proposed Changes To Base-Year Vehicle Populations



Table 17 Change to Emission Estimates for Various Calendar Years with Proposed Changes to Base-Year Vehicle Populations



## Result - VMT Matching

Without any further changes in activity, the model would have forecasted VMTs that were 0.5% less than the regional estimates provided by various Councils of Government (COGs), which were incorporated in EMFAC2002 ver. 2.20. To resolve this difference, staff ran the VMT matching algorithm for calendar year 2000, which is the base year for most SIPs. The VMT algorithm modified the 2000 calendar year population growth rate such that the VMT forecasts from the new model match those from EMFAC2002 ver. 2.20.

Table 18 shows the activity changes for calendar years 2000, 2010, and 2020. This table shows that the VMT estimates from version 2.20X, which contains **both** population (age 45 fix) and VMT changes, precisely match the VMT estimates from EMFAC2002 ver. 2.20. The minor differences in population can be attributed to rounding. Table 19 shows that the accurate VMT matching reduced any potential differences in forecasted annual average emission inventories. Please note, version 2.20X includes changes to the population of age 45 vehicles and VMT changes noted in this memorandum.

# Table 18 Change In Activity For 2000, 2010, And 2020 Calendar Years



# Table 19 Change in Emissions for Calendar Years 2000, 2010, and 2020



As a result of VMT matching, Figure 11 shows that versions 2.20 and 2.20X have virtually the same estimates of vehicle population for 2000 plus calendar years.

# Figure 11 Comparison Of Statewide Population Estimates



Figure 12 shows a comparison of statewide VMT estimates confirming that the VMT matching algorithm matched the estimates from EMFAC2002 ver. 2.20.

Figure 13 presents a comparison of the statewide total-ROG emissions. With the change in population of age 45 vehicles and the subsequent VMT matching on the 2000 calendar year, the forecasted (2000 plus) total-ROG emissions match those from ver. 2.20.

# Figure 12 Comparison of Statewide VMT Estimates



#### Figure 13 Comparison of Statewide Annual Averaged Total-ROG Emissions



Figures 14 and 15 show a comparison of statewide total-CO and total-NOx emissions, respectvely. Both figures show that the 2000 and newer calendar year estimates from version 2.20 and 2.20X are identical.

# Figure 14 Comparison of Statewide Annual Averaged Total-CO Emissions



# Figure 15 Comparison of Statewide Annual Averaged Total-NOx Emissions



Table 20 presents the statewide activity changes, by vehicle class, for calendar years 2000 and 2020. This table also shows the percentage change relative to the population in each vehicle class. Table 19 shows that population and VMT estimates, by vehicle class, from version 2.20X match those from version 2.20.

# Table 20 Activity Changes by Vehicle Class



# Mexican Vehicles

# In assessing what items may have changed between versions 2.20 and 2.20X with the VMT matching on 2000 calendar year, staff noted a slight increase in the population of Mexican vehicles[[7]](#footnote-7) in San Diego and Imperial counties. While the population of Mexican vehicles increased slightly the population of native vehicles decreased by a similar amount. Hence, there is little or no change to the total vehicle population or VMT in San Diego County and, therefore, no significant change to the emissions inventory for San Diego County. The small increase in Mexican vehicle population is caused by an increase in the 2000 calendar year growth rate for San Diego County. As noted earlier, the 2000 calendar year growth rates, for all areas, in version 2.20X are slightly higher than those in version 2.20. The growth of Mexican vehicles entering San Diego is tied to the growth rate of vehicles in San Diego County. To conserve VMT in San Diego County, the slight increase in the population of Mexican vehicles, and hence VMT from Mexican vehicles, is offset by a slight decrease in the population of native vehicles.

# Table 21 shows that with VMT matching the total population of passenger cars in calendar year 2000 in San Diego County is reduced by 3 cars. However, this increases Mexican cars by 46, and reduces native cars by 49. In order to note this difference on a percentage basis it was necessary to show 4 decimal places. This table also shows that the total number of heavy heavy-duty trucks increased by 2. The population of Mexican trucks increased by 22, and the native truck population was reduced by 20.

# Table 21 Population of Mexican Vehicles in San Diego County



## Recommendations

Staff recommends that the proposed changes be made to EMFAC2002 ver. 2.20. However, staff should revisit the backcasting algorithm and verify that the average age of the fleet predicited by the model for the historic calendar years does track historical vehicle registration data or some other source. Staff also believes that in a future update, the growth rate of Mexican vehicles should be de-coupled from that of San Diego and Imperial counties. The Mexican vehicle growth rate should be tied to the annual statistics on vehicular border crossing in San Diego and Imperial counties.

1. In the model, the vehicle accrual rates **do not** change by calendar year. However, for editing purposes the model displays a population weighted accrual rate that by definition can change by calendar year. [↑](#footnote-ref-1)
2. Summation of emissions from all emission processes. [↑](#footnote-ref-2)
3. This algorithm is detailed in memorandum titled “Updating Estimates of Vehicle Miles Traveled,” dated 07/31/02. [↑](#footnote-ref-3)
4. In this memorandum, EMFAC2002 version 2.20 is also referred to as ver. 2.20. [↑](#footnote-ref-4)
5. EMFAC2001 version 2.08 is also referred to as ver. 2.08 [↑](#footnote-ref-5)
6. Ver 2.20X. The official version will be 2.20 with a new release date. However, for the purpose of this document the new version has an X until the release date and changes have been finalized. [↑](#footnote-ref-6)
7. Passenger cars and heavy-heavy duty trucks crossing the international border into San Diego and Imperial counties. [↑](#footnote-ref-7)