

SENSITIVITY OF COMPOSITE EXHAUST EMISSION RATES TO VEHICLE POPULATION AND MILEAGE ACCRUAL ASSUMPTIONS

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ABSTRACT

In the California Air Resources Board's (CARB) newest mobile source emission model, EMFAC 200x V2.08, vehicle population and mileage accrual data have been revised such that regional VMT is calculated from vehicle population and accrual data (as opposed to directly using metropolitan planning organization (MPO) estimates.) Calculated VMT is forced to match the MPO VMT estimate by scaling the mileage accrual rates and altering the vehicle population data. These vehicle population and mileage accrual data also determine how VMT is allocated across the vehicle model years present in the vehicle fleet; when the calculated VMT is forced to match the MPO VMT estimates, the modified vehicle population and mileage accrual data also change the fraction of the VMT associated with each model year in the vehicle fleet. In contrast, MOBILE 6 uses measured vehicle population data from 1996 Polk registration databases, and measured mileage accrual rates from the 1995 Nationwide Personal Transportation Survey for light duty autos. We estimate new composite emission rates based on variety of vehicle population and mileage accrual data. Small perturbations in age distributions and accrual data are shown to have a larger than expected impact on the composite emission rates for light duty autos. For example, TOG emissions varied by nearly a factor of three between the lowest and highest estimated emission rates. Recommendations for modifying VMT and accrual data in the pending release of EMFAC 200x and subsequent revisions are provided.

KEYWORDS

on-road emission inventory, EMFAC, MOBILE, mileage accrual, age distribution, emission models, emission factors, travel fractions

INTRODUCTION

The California Air Resources Board (CARB) is preparing to finalize EMFAC 200x V 2.08 (EMFAC X). One of the driving factors in the model's release is a need to incorporate the latest planning assumptions into transportation conformity analysis [1]. California plans to use EMFAC X to update the regional SIPs prior to the next round of conformity determinations commencing in 2003 [2,3,4].

EMFAC X scales the vehicle population and mileage accrual data such that regional VMT is calculated as the product of vehicle population and average mileage accrual. This study demonstrates that the composite emission rates derived from the revised estimates result in an unexpectedly large increase in estimated emissions when compared to estimates derived using the measured vehicle population and mileage accrual information. For the purposes of this analysis, we focus on gasoline powered light duty autos (LDAs), however, the implications of this work can be extended to the other vehicle classes included in EMFAC X.

BACKGROUND

Light duty auto emission factors estimated by EMFAC X represent the composite impact of all model years in the vehicle fleet categorized by technology groups. For example, an emission factor used to estimate a 2010 emission inventory will composite emissions contributions from vehicles of model year 1966 through 2010. The class specific composite emission rates are based on the combination of model year specific emission rates and a distribution of the activity over the model years covered by the fleet. A distribution of VMT across model years, referred to as travel weighting factors (TFs), is used to weight the model year specific emissions when computing the composite factor. MOBILE6 and prior versions of both EMFAC and MOBILE estimated TFs based on the model year specific VMT normalized by total VMT by vehicle class [5,6,7] (Brzezinski 2002, unpublished data),

Equation 1

$$TF_{age} = \frac{(VPOP_{age} \times Accrual_{age})}{\sum_{\text{all ages}} (VPOP_{age} \times Accrual_{age})}$$

The age distribution and mileage accrual information were taken from Department of Motor Vehicles (DMV) registration data and Bureau Of Automotive Repair (BAR) Smog Check data, respectively. The TF is used to allocate a fraction of the VMT estimated by the MPO to all the model years within the fleet. The emissions for each vehicle class can then be expressed by equation 2.

Equation 2

$$INV = \sum_{age=1}^{45} (TF_{age} \times EF_{age}) \times VMT_{total}$$

The composite emission factor for the fleet, represented by the summation in equation 2, is shown as equation 3. It is important to note that the composite emission factor calculated using the TFs is independent of regional VMT estimates produced by MPOs.

Equation 3

$$\text{Composite EF} = \sum_{age=1}^{45} (TF_{age} \times EF_{age})$$

In EMFAC X, instead of using the MPO estimate of VMT, regional VMT is calculated as the product of vehicle population and annual mileage accrual rates; that is, the calculated VMT is forced to equal the MPO's VMT estimates. This is done by adjusting vehicle population and mileage accrual rate data using a two step process (Carlock, 2002, unpublished data; Long, 2002, unpublished data):

1. For 1997 and 1998, where DMV data were available, an average accrual rate for each vehicle class is computed by dividing the MPO's VMT by the DMV vehicle population data (VPOP):

Equation 4

$$Avg(ACCRUAL) = VMT^{MPO98} / VPOP_{total}^{DMV98}$$

Using the average accrual rate, CARB then calculates a scale factor (Z) that constrains the population weighted 45-year distribution of measured mileage accrual data to be equal to the average accrual rate calculated above:

Equation 5

$$Z = \frac{Avg(ACCRUAL)}{\sum_{age=1}^{45} [ACCRUAL_{age}^{IM98} \times VPOP_{age}^{DMV98} / VPOP_{total}^{VMT98}] / 45}$$

Age specific accrual rates used in EMFAC X for ages 1 through 45 are then computed as:

Equation 6

$$ACCRUAL_{age}^{adjusted} = ACCRUAL_{age}^{IM98} \times Z$$

2. For calendar years 1999 and beyond, the vehicle population (VPOP) was estimated by treating the MPO's calendar year (CY) specific VMT and the adjusted accrual rates as constants, and assuming that the vehicle population would grow, via new vehicle sales, as required, to fill any gap between the derived VMT and the VMT estimates provided by the MPOs. There are two steps to this calculation. First, age specific populations for 2 through 45 year old vehicles are estimated by applying an age specific estimate of the fraction of vehicles that remain in the fleet from the previous age year's population in the prior year. Then, the first year population bin, representing new vehicles, is filled such that the dot product of the vehicle population and mileage accrual data is equal to the VMT estimated by the MPO. The aging is done via

Equation 7

$$VPOP_{age}^{CY} = VPOP_{age-1}^{CY-1} \times (SR_{age} / SR_{age-1})$$

where SR is the fraction of the fleet that "survives" to any given age (e.g., if 100K vehicles of model year 2000 were sold, and 80.26% of those vehicles survived for 10+ years the 2010 population of 2000 model year vehicles would be 80,260 vehicles). Class specific statewide average survival rate data are hard coded into EMFAC X. The new vehicle sales are then calculated as

Equation 8

$$VPOP_{age=1} = \left(VMT_{class\ total} - \sum_{age=2}^{45} (VPOP_{age} \times ACCRUAL_{age}^{adjusted}) \right) / ACCRUAL_{age=1}^{adjusted}$$

VPOP is adjusted iteratively as the fleet is aged (e.g., for a 2010 fleet, the model starts with a 1998 population based on DMV data, then estimates a 1999 population, which is used to estimate a 2000 population, then 2001, 2002, 2003, 2004, ... until a 2009 population can be used to estimate the final 2010 population). In EMFAC X this procedure goes one step further to estimate county specific fleet growth rate for each class [8]. Because the MPO's VMT estimates are used at a county specific level, the resulting growth rates are specific to each county, class, and year

Equation 9

$$growth^{year\ x\ to\ x+1} = VPOP_{age=1}^{year\ x+1} / \sum_{ages=1}^{45} VPOP_{age}^{year\ x}$$

The resulting county, class, and year specific growth rates are coded in the “popgassign.mod” source file. And ultimately, new vehicle sales are calculated as

Equation 10

$$VPOP_{age=1}^{calander\ year\ x+1} = \left(\sum_{age=1}^{45} VPOP_{age}^{calander\ year\ x} \right) (growth^{year\ x\ to\ x+1}) - \left(\sum_{age=2}^{45} VPOP_{age}^{calander\ year\ x+1} \right)$$

TFs can be derived from the calculated Vehicle population and mileage accrual as shown in Equation 11; the resulting composite emission factor is shown in Equation 12. Note that equations 11 and Equation 12 look like Equation 1 and Equation 3, except that the EMFAC X form of the equations are also functions of the VMT estimates supplied by the MPO – which were an inputs to Equation 4, Equation 5, and Equation 6.

Equation 11

$$TF_{age}^{CY} = \left(VPOP_{age}^{CY} \times Accrual_{age}^{adjusted} \right) / \sum_{all\ ages} \left(VPOP_{age}^{CY} \times Accrual_{age}^{adjusted} \right)$$

Equation 12

$$Composite\ EF = \sum_{age=1}^{45} \left(TF_{age}^{CY} \times EF_{age} \right)$$

Both EMFAC7f and 7g also used Equation 7 to age the fleet. However, the new vehicle sales were assumed to be a constant 6.11% of the fleet, which was based on historical averages (CARB 1993 and CARB 1995). Equation 4, Equation 5, and Equation 8 were not used thus the TFs were not a function of the VMT estimates supplied by the MPO.

MOBILE6 uses a smoothed 1996 age distributions for light duty vehicles based on Polk data sets for all 1996+ analyses years [9,10]. These methods indicate that the precedence has been to base future sales on historical norms (e.g., historic data is used in MOBILE6 and was the source of the 6.11% in EMFAC7f and 7g); EMFAC X moves in a new direction by tying new vehicle sales to VMT growth.

Conceptually, in this new method CARB is forcing continuity between VMT, POP, and mileage accrual, in part, to mitigate the disagreement between accrual rates used for deterioration rate calculations and those implied by the travel weighting factors, VMT, and population (Long, 2002, unpublished data). For example, EMFAC 7f assumed a 2-year old catalyst equipped light duty auto (CAT LDA) would accrue 13,563 miles per year for deterioration rate calculations, and that in 1990 these vehicles would represent about 13.53% of the CAT LDA VMT and 10.86% of the CAT LDA VPOP. The 1994 ozone SIP for the South Coast estimated the CAT LDA VPOP as 6,073,689 vehicles with a total CAT LDA VMT of 18,7858,000 miles per day[11] This implies an accrual rate of 14,046 miles per year, a discrepancy of 483 miles. This difference has resulted in questions about the credibility of EMFAC’s methods in prior releases, and created ambiguity when trying to estimate total emissions over a vehicles lifetime (e.g., which accrual rate data should be used?) (Long, 2002, unpublished data)

TECHNICAL ISSUES ASSOCIATED WITH NEW METHOD

There are a number of technical issues associated with CARB's new approach. First, of the three variables: mileage accrual rates, vehicle population, and VMT, VMT is almost universally estimated while the other two can be ascertained from actual data recorded at I/M stations and collected by DMV. Past studies have suggested that travel demand forecasted VMT could be off by $\pm 10\%$ to 20% [12,13]. Moreover, the travel network from which VMT is calculated is usually a link-based representation in which multiple roadways, including local roads, can be represented by a single link. The VMT estimates produced by travel forecast models were also never intended to represent annual averages and are highly dependent on modeling assumptions. The uncertainty of class specific VMT estimations is highlighted in Table 1, where 1990 backcast VMT for light duty trucks in the South Coast Air Basin differ by a factor of more than 1.7 even though the estimates were produced only three years apart and describe past, reasonably understood conditions in the South Coast [11,14].

In addition, the premise that VMT must equal the product of vehicle population and accrual holds only in a closed system and where all three inputs can be considered reasonably correct. The MPOs forecasted VMT includes trips contained entirely within the modeling region (internal-internal trips), trips traveling through the modeling region (external-external trips), and trips from outside the modeling region to and from within the modeling region (internal-external trips). The vehicle population data is derived at a county specific level for each air basin; the modeling domains used by most MPOs do not coincide with county boundaries. If the vehicle population used to represent external-external and internal-external trips are not representative either in proportion or type to the vehicles actually making the trips, then the accrual rates will also be inaccurate. In Sacramento, internal-external and external-external trips represent approximately 4% of the total trips, the fraction crossing county lines internal to the modeling domain is not currently estimated [15].

The new EMFAC X method also assumes that vehicles retire at the same rate statewide, yet new vehicle sales can vary both across and within regions. EPA showed that, on average, about 5% to 6% of the LDA fleet is retired each year [9], which is consistent with CARB's application of age specific scrappage summed over the LDA age distribution. Since vehicles are retiring at essentially the same rate everywhere, but being replaced by new vehicles on a county specific level based on VMT growth, the age distributions develop a bias toward newer vehicles in areas with rapidly growing VMT as the analysis year moves further into the future from the 1998 base.

Additionally, if county specific growth factors are used, then county specific survival data may be needed to prevent distorting the age distributions over time. Zhao and Kockelman [12] noted that Nashville I/M data showed that older vehicles appeared to have stable or even declining odometer readings. They proposed a selective scrappage model, where higher mileage vehicles were assumed to be preferentially retired compared to lower mileage vehicles from the same model year. Their selective scrappage model appears to account for the mismatch they observed between odometer and accrual data. This suggests that areas with lower accrual rates should have lower scrappage rates as well.

Finally, the new EMFAC X method breaks precedence set by prior generations of EMFAC models, and with EPA's MOBILE model, where measured vehicle population and mileage accrual data were used to estimate a relative distribution of the VMT over the various ages of vehicles in the fleet, rather than explicitly calculating it based on VMT growth rates.

ANALYSIS APPROACH

The analytical approach used in this study was to compute weighted fleet average emission rates for LDAs by combining model year specific emission rates with several TF distributions, where each TF distribution represented different assumptions for the vehicle population data and the mileage accrual data. For example, if a particular model year accounted for 2% of the VMT in a given TF distribution, then that model year's emission rate would be multiplied by 0.02 to arrive at that model year's contribution to the fleet composite emission rate associated with the vehicle population and mileage accrual rates used to calculate the TF distribution. We used this approach to estimate several different composite emission rates, looking at TOG emissions from gasoline powered light duty autos in the Los Angeles county portion of the South Coast Air basin in 2010. We utilized emission rates from EMFAC X and several data sets that described vehicle population / age distributions and mileage accrual rates, combined with the calculation methodologies described in the background section.

Empirical Data

The source of the emission rates, vehicle population, and mileage accrual data are detailed below.

Emission Rates

Model year specific TOG emission rates were extracted from the “*.my2” output files from the CALIMFAC portion of EMFAC X. These rates represent the emissions from the federal test procedure, corrected for I/M, deterioration, temperature, etc such that they are representative of the Los Angeles County portion of the South Coast Air Basin in 2010.

Vehicle Population / Age Distribution

We had three sets of population data from which to draw the age distributions:

- 2010 EMFAC7g data, which is considered dated;
- 1998 (LA county) EMFAC X data, which is based directly on DMV data, and
- 2010 (LA county) EMFAC X population and age data, which is the 1998 data adjusted such that fleet growth is directly calculated from VMT.

Figure 1 shows the variation in age distribution between the three data sets.

Mileage Accrual Rates

Three sets of mileage accrual data were available for this analysis:

- Accrual data from EMFAC7g (originally from EMFAC7f). According to CARB (1993), these data were based directly on BAR data for vehicles between 2 and 22 years in age and extrapolated to the 35-year vehicle fleet;
- Accrual data from EMFAC X, which has been adjusted as described in the background section above, and
- Accrual data from EMFAC 2001 V 2.02 (an older version of EMFAC X).

The data in EMFAC X used for LDAs is currently scaled LDT data (Long, 2002). The accrual data from the EMFAC 2001 V 2.02 are located in the EMFAC 2001 v2.02 technical documentation (e.g., CARB 2001) The decision to scale the accrual rates was not yet implemented when EMFAC 2001 V 2.02 was released (Long, 2002), thus it should represent relatively unaltered data. Figure 2 shows the variation in the distribution of accrual rates.

Methods

The data sets were combined using the calculation methodologies discussed below. A sample calculation is presented that also helps characterize the precision of the calculations, in terms of correctly recreating results produced by EMFAC X.

Calculations

Equation 1 was used to calculate model year specific travel fractions for the 9 possible combinations of the vehicle population and mileage accrual rates listed above. This is the approach historically used by EMFAC and MOBILE to calculate travel fractions. Figure 3 shows the variation in TFs for the combinations of vehicle population data and mileage accrual rates, representing the defaults from EMFAC 7g, EMFAC X, and the TF that we believe are the most appropriate given the available data sets. The composite emission rate is then calculated by combining these TFs and the model year specific emission factors using equation 3.

Calculation Check and Sample Calculation

Table 2 provides an example calculation in spreadsheet form. In this example, we have used the vehicle population / age distribution and mileage accrual rates from EMFAC X, as well as the EMFAC X emission rates. For each model year (MY), the table presents the assumed vehicle population (POP) and mileage accrual (Accrual), the calculated travel fraction (VMT by MY), the TOG emission rate from EMFAC X (TOG EF), and the resulting contribution to the composite emission rate. The model year specific contributions to the composite emission rate are then summed to produce the composite TOG emission factor of 0.168 g/mile.

This calculation also helped us verify the methodology used to calculate travel fractions and the composite emission rates. By using the vehicle population, mileage accrual, and model year specific TOG emission rates for the federal test procedure from EMFAC X, if the procedure is correct, the resulting composite emission factor should match the composite emission rate for the federal test procedure produced by the CALIMFAC portion of EMFAC X. The composite emission factor produced by EMFAC X is 0.17 g/mile, clearly matching the composite emission rate calculated by our methodology.

ASSUMPTIONS AND LIMITATIONS

For the purpose of our analysis, we selected one distribution for vehicle age / population data and one distribution for accrual rates and identified it as “best available information.” Specifically, we assumed that

- The unadjusted 1998 vehicle population / age distribution data from EMFAC X was more likely to be accurate than adjusted 2010 data from EMFAC X, and similarly
- The EMFAC 2000 V 2.02 accrual data was better than EMFAC X accrual data

The 1998 population data from EMFAC X was assumed preferable to the data from EMFAC7g, which was calculated using 1991 DMV data because it comes from more recent DMV data. The 1998 population data was also assumed to be preferable to the 2010 age distribution from EMFAC X, which was designed to calculate VMT that matches the MPO’s. This assumption is analogous to EPA’s use of 1996 age distributions for all future analysis years in MOBILE6. It should be noted that some changes to the fleet may occur over time and that some adjustment to the 1998 data could be justifiable. Our concern is, however, that fleet adjustments should be based on changing demographics and economic conditions, rather than forcing the vehicle fleet to match the VMT growth through an adjusted accrual rate. Similarly, the EMFAC 2000 V 2.02 light duty auto mileage accrual rates are assumed to be from more recent smog check data and thus more applicable than the EMFAC7g mileage accrual data. The EMFAC 2000 V 2.02 light duty auto mileage accrual data were preferable to the EMFAC X mileage accrual data because the EMFAC X mileage accrual data have been scaled, and are based on trucks rather than cars (Long 2002). We have not tried to determine which set of vehicle population data and which set of mileage accrual data are most appropriate.

For the purposes of this analysis, we have ignored the impact of deterioration. The EMFAC X odometer estimates are higher than those estimated from the other accrual data; thus if we had accounted for deterioration, composite emission rates calculated using the EMFAC 7g and EMFAC 2001 v2.02 accrual data would have been lower than what we have estimated here – increasing the differences between the various composited emissions. The impact of neglecting deterioration appears to be minor. For example using the “best available information” mileage accrual and vehicle population data, we estimate an FTP emission rate of 0.101 g/mile of TOG, applying model year specific emission rates adjusted for deterioration effects reduces that emission factor to 0.098 g/mile of TOG.

RESULTS

Our analysis shows that changes in EMFAC X with respect to how vehicle population and mileage accrual are used leads to EMFAC X significantly overestimating exhaust emissions from light duty autos in the Los Angeles portion of the South Coast air basin. The root cause for this is that older vehicles are given more weight in the composite emission factors under CARB’s procedure. Because those older vehicles were certified to less stringent emission standards, small perturbations in travel fractions can have large impacts on the composite emission rate. The

composite emission factors that result from the nine possible combinations of the three distributions of vehicle population / age and the three distributions of mileage accrual rates are shown in Table 3.

The lowest composite TOG emission factor, 0.065 g/mile, results from fleet assumptions that were used in EMFAC 7g. The highest composite TOG emission factor, of 0.168 g/mile, results from fleet assumptions that were used in EMFAC X. The difference between the high and low estimate is a factor of 2.58, considering that either value could justifiably be used right now, this is a fairly substantial level of uncertainty. It is particularly interesting to contrast the 4 scenarios we examined:

- Using EMFAC 7g default vehicle age distribution and mileage accrual rate resulted in a composite emission factor of 0.065 g/mile for TOG;
- Using the measured vehicle population from EMFAC X and measured mileage accrual data from EMFAC 2000 V2.02, consistent with the methodology employed by MOBILE 6, resulted in a composite emission factor of 0.101 g/mile for TOG,
- Using the modified vehicle population from EMFAC X and measured mileage accrual data from EMFAC 2000 V2.02, which is one modification CARB has identified they might consider, resulted in a composite emission factor of 0.135 g/mile for TOG, and
- Using the modified vehicle population and mileage accrual data that is used by EMFAC X resulted in a composite emission factor of 0.168 g/mile for TOG.

All of the g/mile rates represent LDA fleet average FTP results with I/M, for the Los Angeles county portion of the South Coast Air Basin.

The data used to composite the emission factor of 0.101 g/mile (calculated with the 1998 vehicle population data from EMFAC X and mileage accrual data from EMFAC 2000 V 2.02) is consistent with the MOBILE 6 approach of using the latest measured vehicle population and mileage accrual data in travel fraction calculations. Thus the 66% increase in emissions associated with the EMFAC X default emission rate of 0.168 g/mile is attributable to differences between the procedures that EPA and CARB use to handle the vehicle population and mileage accrual data inside of MOBILE 6 and EMFAC X respectively. The 24% increase from 0.135 g/mile to 0.168 g/mile is associated solely with the way that EMFAC X isolates the impact of the vehicle population adjustments made in EMFAC X.

The joint EPA / FHWA latest planning assumptions guidance [1] that requires current estimates of vehicle population and mileage accrual data be used in conformity determinations, combined with the sensitivity of composite emission rates to the vehicle population and mileage accrual rates demonstrated here, has significant implication for transportation conformity. Every region in California has emission budgets based on different vehicle population and mileage accrual rates than those currently being put forth in EMFAC X. There will be an 18 month review period of the new model by EPA after the first SIP is submitted that uses the EMFAC X. If new emission budgets based on EMFAC X are not adopted by the end of the 18 month period, conformity determinations will have to be made against existing emission budgets, using the EMFAC X vehicle population and mileage accrual rates, which we know significantly increases the transportation emissions. We show that a large amount of that increase in the emissions rates may be an artifact of differences in how CARB and EPA treat the measured vehicle population and mileage accrual data inside their models.

Given that EMFAC X is being quickly finalized for SIP application, we have three recommendations, one addressing short-term needs and two that would require additional time to implement.

Recommendation 1. Encourage each region to develop region-specific data

This recommendation could be implemented without delaying the adoption of a final version of EMFAC X. It addresses our concern that manipulated vehicle population and mileage accrual data apparently overstate transportation emissions. However, the logic of trying to force the conservation of region specific VMT, Pop, and accrual in an open system remains intact.

Description

EMFAC X currently allows the user to specify vehicle population data, mileage accrual data, VMT, and trips/starts. Under this recommendation, each region would need to develop region-specific vehicle population data and mileage accrual rate data and be allowed to use those data for modeling in EMFAC X. The data sets could be developed during the SIP process. When the user specifies their own vehicle population, mileage accrual, VMT and trip / start data, it appears to override the calculated VMT travel fractions described above. This approach will result in the use of Equation 3 to generate the travel fractions. The proportion of the mileage accrual that occurs outside of the county, and the proportion of the vehicle population operating within the county that is registered externally, will cause errors in the estimated TF, similar to the problems with calculated VMT. However in this case those errors are not being feed back into future estimates of new vehicles sales, which could compound any errors in the population distribution, and resulting travel fractions as estimated by Equation 12. To mitigate this, the model could be run multiple times with different VMT and fleet data corresponding to external and internal activity.

Implementation

No code changes would be required. The current EMFAC X user interface allows for the input of vehicle population, mileage accrual, VMT, and trip data. To implement this recommendation CARB needs to revise their June position in the material submitting the model for review by EPA. Specifically, CARB would need to:

- Require that the interagency consultation process be used to determine the best data (i.e., regional versus defaults) to be used for model inputs such as the vehicle population distributions and mileage accumulation rates, and
- Specify that EPA should consider only the underlying emission rate data as part of EMFAC X, and that supporting data, such as the vehicle population data and mileage accrual rates can and should be updated by end users to ensure the best analysis / data possible.

These recommendations are also consistent with the EPA / FHWA latest planning assumptions guidance [1]. Care should be taken to avoid inappropriately projecting economic changes in the current data into the future. For example, the 1998 recession, resulting from the Asian currency downturn, might have produced a small year old vehicle population in the 1998 DMV data. That impact should not be carried to year vehicles in 2010.

Recommendation 2. Remove calculated VMT from EMFAC X

This recommendation might require significant coding and probably can only be implemented in a future update to EMFAC X. It addresses our major concerns by eliminating the calculated VMT portions of EMFAC X.

Description.

This approach would require that data be made available that specified each regions vehicle population, mileage accrual, VMT and trips / starts. Additionally, the algorithms that address the calculated VMT would need to be removed from EMFAC X. As with the first recommendation, each region would need to identify the appropriate inputs for their respective areas and supply that information as part of a normal model run.

Implementation

The implementation of this recommendation can be thought of as having two steps. First, when EMFAC X is submitted to EPA for approval, CARB would need to make clear that the portion of the model that EPA is acting upon is only the emission rates. This will allow for subsequent modification of the model with triggering regulatory clocks that impact the timing of conformity determinations and SIP submittals. Second, the actual (re)coding of the model would have to be undertaken.

Recommendation 3. Linkage between vehicle populations, mileage accrual, regional trips and VMT

This paper has focused on travel fractions, vehicle population, mileage accrual rates, and their impact on the composite emission rate. EMFAC X also calculates the number of starts, soaks, resting, and diurnal events based in part on per vehicle distributions and vehicle population estimates. Thus, our recommendations need to discuss these issues to avoid leaving a gap in the proposed solution.

Vehicle population estimates should be calculated based on the best available data from the regional planners and state agencies combined with local demographic information. For example, the travel demand models require information about light duty vehicle population, even including sub-models to estimate vehicle population within the travel demand model [15,16]. Population and trip data used for the inventory processes should be consistent with the assumptions used by the metropolitan planning organization. This data could be disaggregated across the model years based on survey results. This strategy will require that the modeler, rather than the model, make sure that when VMT changes, there are corresponding adjustments to mileage accrual, population, and trip data.

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Table 1. Recent Estimates of Light Duty Truck VMT in the South Coast During 1990

Source	1990 Light duty Truck VMT (SCAB)
1994 AQMP	39,404,000
1997 AQMP	67,922,000

Table 2: Example Calculation

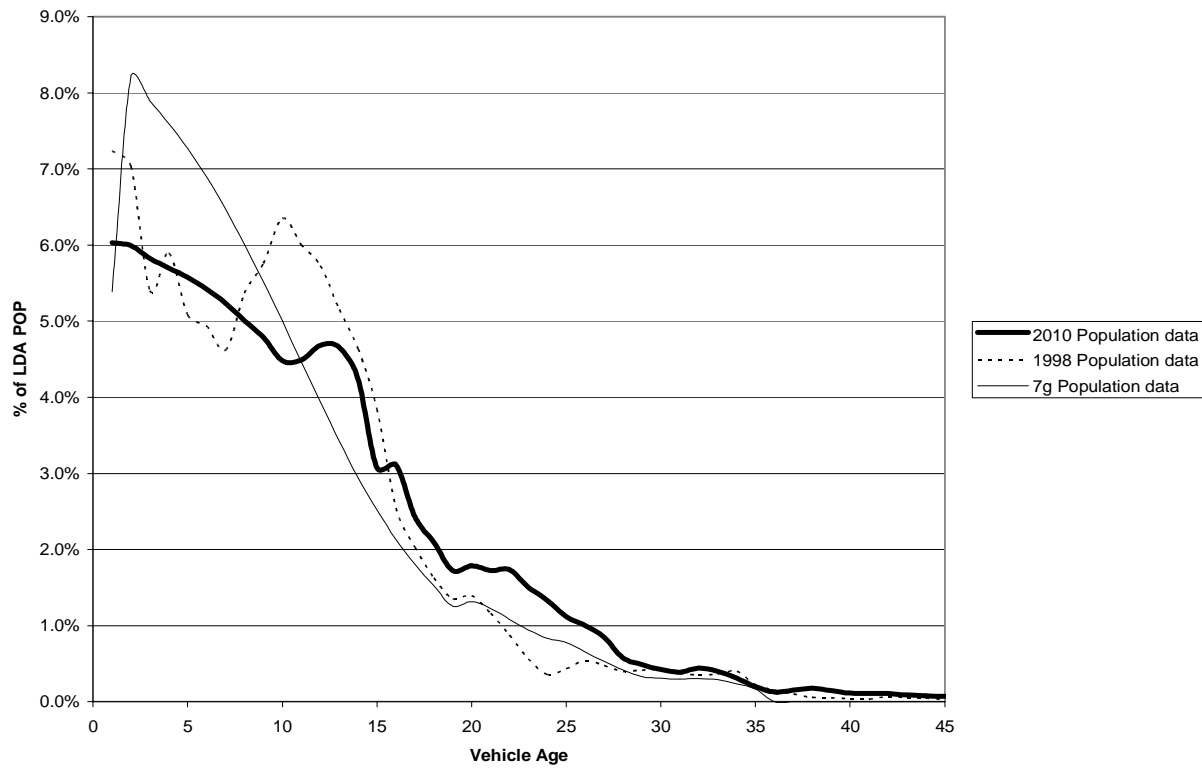
MY	POP (vehicles)	Accrual (mile/yr)	VMT by MY	TOG EF (g/mile)	TF Weighted EF (g/mile)
2010	249411.1	13690.5	7.17%	0.0021	0.00015
2009	247914.1	13220	6.89%	0.0025	0.00017
2008	240902.6	12870.6	6.51%	0.0035	0.00023
2007	235693.3	12578.5	6.23%	0.0045	0.00028
2006	230739.1	12326.2	5.98%	0.0054	0.00032
2005	224284.4	12102	5.70%	0.0122	0.00070
2004	216476.8	11901.4	5.41%	0.0273	0.00148
2003	207067.3	11716.4	5.10%	0.0362	0.00185
2002	198082.6	11546.4	4.81%	0.0429	0.00206
2001	185356	11388.3	4.44%	0.0457	0.00203
2000	185671	11236.6	4.38%	0.0492	0.00216
1999	193591.3	11098.3	4.51%	0.0810	0.00366
1998	192673.5	10963.4	4.44%	0.1177	0.00522
1997	175339.4	10838	3.99%	0.1599	0.00638
1996	127245.6	10729.3	2.87%	0.1837	0.00527
1995	128791.3	10614.2	2.87%	0.2653	0.00762
1994	100489	10508.9	2.22%	0.2981	0.00661
1993	86836.2	10401.9	1.90%	0.3834	0.00728
1992	71456.4	10298.3	1.55%	0.4386	0.00678
1991	73949.6	10198.4	1.58%	0.4394	0.00696
1990	71317.3	10104.1	1.51%	0.4406	0.00667
1989	71716.9	10013.8	1.51%	0.4343	0.00655
1988	62233.3	9925.5	1.30%	0.4209	0.00546
1987	55195.9	9838.9	1.14%	0.4195	0.00479
1986	46256.7	9755.3	0.95%	0.4185	0.00397
1985	41401	9675.8	0.84%	0.4313	0.00363
1984	35078.4	9594.5	0.71%	0.4857	0.00343
1983	23879.2	9517.8	0.48%	0.5138	0.00245
1982	20125.6	9441.3	0.40%	0.5293	0.00211
1981	17546.2	9368.5	0.35%	0.5209	0.00180
1980	16106.9	9298.9	0.31%	0.6288	0.00198
1979	18229.6	9232.1	0.35%	1.0492	0.00371
1978	16600.3	9165.2	0.32%	1.1557	0.00369
1977	12733.1	9099.8	0.24%	1.2351	0.00301
1976	8229.6	9035.1	0.16%	1.3975	0.00218
1975	5184.3	8969.7	0.10%	1.4227	0.00139
1974	6261.5	8909.6	0.12%	4.8664	0.00570
1973	7381.4	8850.6	0.14%	5.7680	0.00792
1972	6031	8790	0.11%	5.7787	0.00644
1971	4670.5	8733.7	0.09%	5.7381	0.00492
1970	4543.9	8678.4	0.08%	5.6996	0.00472
1969	4361	8622.1	0.08%	5.7218	0.00452
1968	3576.5	8565.7	0.06%	5.7277	0.00369
1967	3122.3	8507.3	0.06%	5.7323	0.00320
1966	2930.3	8452.6	0.05%	5.7381	0.00299
Totals			100.00%		0.168

Table 3. Light Duty Auto TOG in the LA County portion of the South Coast As a Function of Fleet Data

Population Data.	Accrual Rate	EF	Notes
EMFAC 7g	EMFAC 7g	0.065	7g fleet mix w/ EMFAC 200x EF's
EMFAC 7g	EMFAC X	0.090	
EMFAC 7g	EMFAC 2000	0.078	
EMFAC X, 2010	EMFAC 7g	0.121	Accrual for ages 36 to 45 was assumed to = age 35 accrual rate
EMFAC X, 2010	EMFAC X	0.168	EMFAC X default
EMFAC X, 2010	EMFAC 2000	0.135	CARB has hinted that this may be the final configuration
EMFAC X, 1998	EMFAC 7g	0.089	Accrual for ages 36 to 45 was assumed to = age 35 accrual rate
EMFAC X, 1998	EMFAC X	0.122	
EMFAC X, 1998	EMFAC 2000	0.101	Our best guess

Note: 2010, FTP bases, "corrected" to represent I/M, temp, etc in the LA portion of the South Coast.

Figure 1. Age Distributions



Note: 2010 and 1998 population data comes from EMFAC X

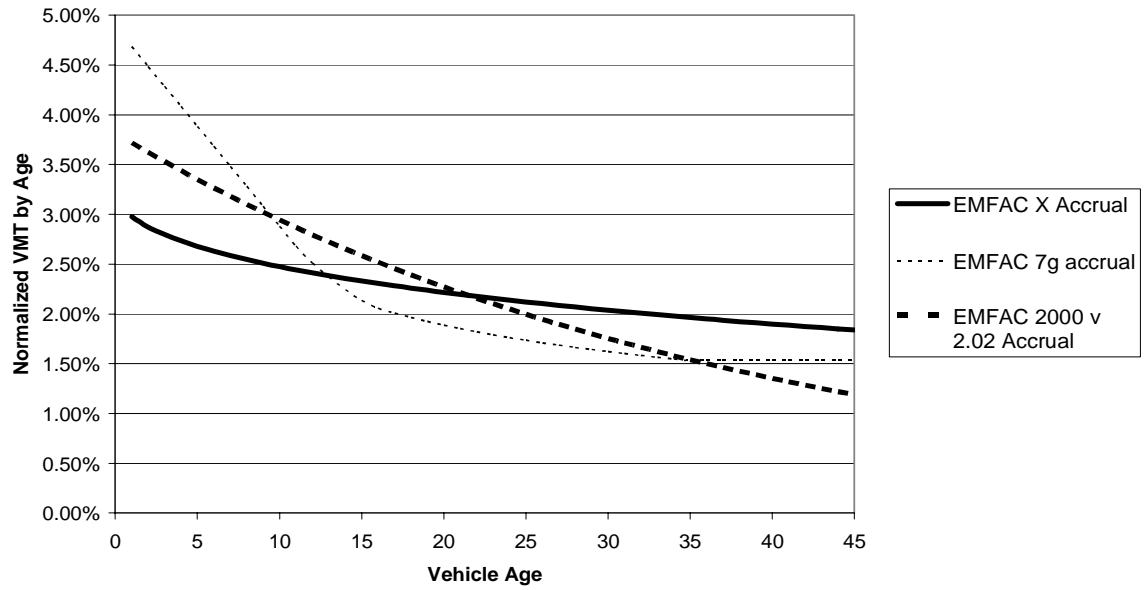
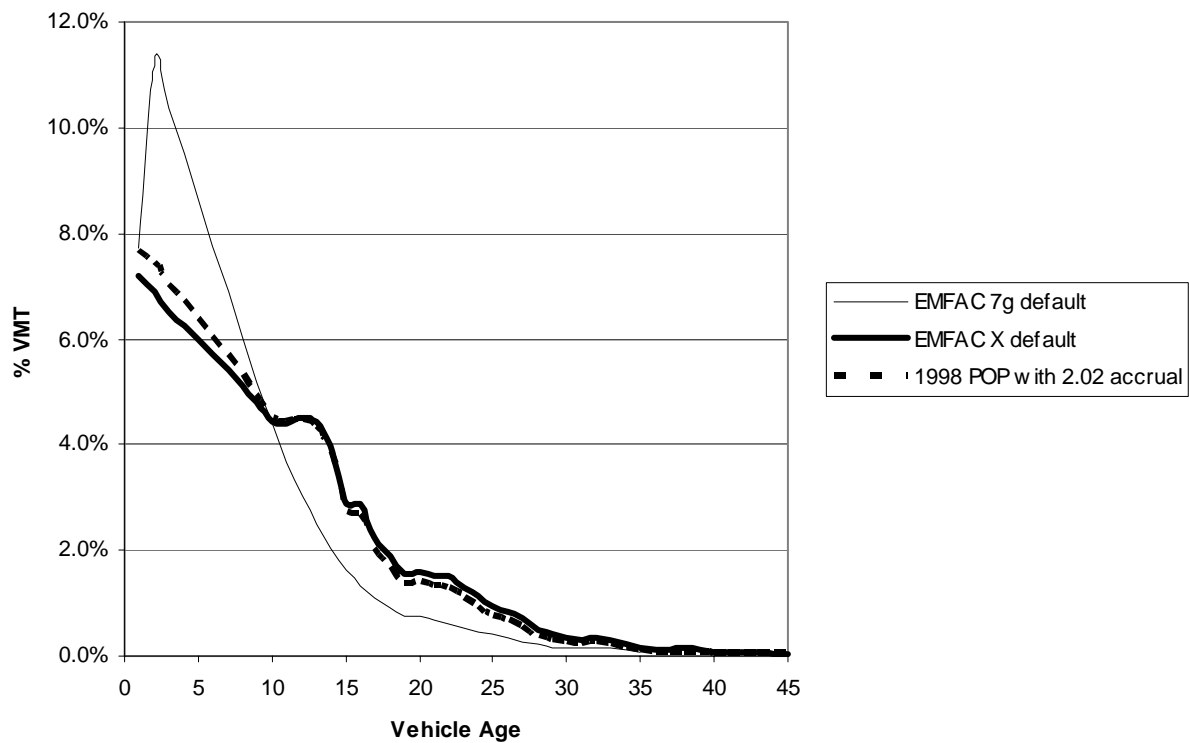
Figure 2. Accrual Rates

Figure 3. LDA Travel Fractions



Notes:

1. "Default" indicates that the population and accrual data used to generate the TF represent the data used by the stated model for LDAs in the LA portion of the South Coast in 2010.
2. The 1998 population data comes from EMFAC X, 2.02 accrual data refers to EMFAC 2000 V 2.02