EMFAC Modeling Change Technical Memo

**SUBJECT:** ACTIVITY CHANGES FOR SCHOOL BUSES

**LEAD:** DILIP PATEL

# Summary

The EMFAC2000 model released to the public assumed that school buses in the South Coast Air Basin (SCAB) traveled during two periods (6 a.m. to 9 a.m. and 3 p.m. to 6 p.m.) of the day, and in the rest of the State traveled throughout the day. In EMFAC2001 version 2.06, the speed distributions were changed to reflect that school buses in the State only traveled during the two periods of the day. However, in SCAB and the rest of the State, the hourly activity profiles for Vehicle Miles Traveled (VMT) and Trips were not changed resulting in VMT being allocated to hours when the buses were not operating.

On a statewide basis in 2010, correcting the error results in an increase in ROG by about 1.0 ton per day, NOx by about 10.9 tons per day, and PM10 by about 0.5 tons per day. These represent large changes in the school bus inventory, but small changes in the total inventory.

Depending on the calendar year, correcting this error increases statewide school bus emissions of ROG by 154 to 171%, CO by 161 to 194%, NOx by 211 to 235% and PM10 by 217 to 248%. Again depending on calendar year these increases total statewide emissions of ROG by 0.1 to 0.2%, CO by 0.2 to 0.3%, NOx by 0.3 to 2.1% and PM10 by 0.6 to 0.8%. The emissions from the SCAB region also increase by similar percentages since the change to the hourly activity profiles of VMT and Trips apply to **all** areas of the state.

# Reason for Change

A staff member of MSCD asked why the “*NOx emissions for diesel school buses are significantly lower in EMFAC2001 than they are in EMFAC2000--even before implementation of 2007 standards--around 70% Lower*.” This memorandum details why the emissions from school buses were inadvertently lowered in EMFAC2001, and quantifies the emissions increase as a result of fixing the error.

# Background

# In EMFAC2000 school buses were added as a new vehicle class and its’ emissions and activity were explicitly modeled. This new vehicle class posed new challenges, one of them being the lack of instrumented vehicle data with which one could populate the hourly activity matrices such as the hourly distribution of trips, vehicle miles traveled (VMT) and distribution of speeds.

# During the development of EMFAC2000, it was initially assumed that school buses would travel like medium-heavy duty vehicles. This assumption was changed prior to finalizing EMFAC2000, and school buses were given their own speed distributions. These distributions assumed that school buses would only be driven during the hours 6 a.m. to 9 a.m. and 3 p.m. to 6 p.m. The change in speed distributions was included in the EMFAC2000 model released to the public. However, this change was only applied to activity in SCAB.

# During the development of EMFAC2001 version 2.06, this error was corrected and the school bus speed distribution in areas other than SCAB was changed to be consistent with then one used in SCAB. This had the effect of lowering emissions from school buses. It was assumed that this result was correct since the daily total VMT had not changed, and school buses now traveled during two periods of the day.

# Due to the MSCD staff’s question and the time afforded to investigate any anomalies in EMFAC2001 ver 2.08, staff performed an in-depth check to analyze the effects that resulted in the lowering of emissions from school buses in EMFAC2001. During this investigation, staff noted that the total daily VMT was being distributed to hours when the buses were not traveling. In addition, trips were distributed to hours when the buses were not traveling. The reason for this anomaly is that the school bus activity profile was originally based on medium-heavy duty trucks, which travel through-out the day. When the school bus speed distributions were changed, the hourly activity profiles should also have been changed to ensure that the VMT and trips were all allocated to the hours when the school buses were operating.

# Affected Source Code & the Version Change was Implemented

Run\_assign.for

# Methodology Revised

The EMFAC2001 model has data arrays, which contain hourly distributions of trip starts and VMT. These arrays vary with vehicle class and fuel type. Table 1 shows the hourly distributions of trip starts and VMT for school buses in EMFAC2001 ver2.08. These distributions, which are applied to **all** areas in the state, are used to allocate the total **daily** number of trips and VMT into each hour of the day. Currently these distributions imply that school buses are driven throughout the day, which is contrary to the assumption used for the speed distribution for school buses.

Table 1. Distribution of Trip Starts and VMT for School Buses

## Currently Used For All Areas of the State



Table 2 shows the proposed hourly distributions of trip starts and VMT for school buses. These distributions assume that the activity is evenly distributed during the hours that the school buses are operating. This assumption is necessary given the lack of instrumented data regarding the activity of school buses.

Changing the VMT distribution will affect running exhaust emissions since this process is dependent on miles traveled. Changing the Trip distribution will affect starting, hot soak and running loss emissions. These emission processes are dependent on vehicle trips. Diurnal and resting loss emissions will not change since these processes are dependent on per vehicle estimates which are not affected by changes in VMT and Trip distributions.

## Table 2. Proposed Distribution of Trip Starts and VMT for School Buses



# Emissions Impact

Tables 3a and 3b show the current emissions from school buses operating in SCAB and in the state, respectively. Tables 4a and 4b show the proposed emissions from school buses operating in SCAB and in the state, respectively, with changes to the hourly VMT distribution. Tables 5a and 5b show the net increase in emissions in SCAB and in the state, respectively, from changing the hourly VMT and Trip distributions. In comparison to EMFAC2001 ver.2.08 the statewide ROG emissions from school buses will increase from 154%-171%, depending on the calendar year. This amounts to a 0.1%-0.2% increase in the total[[1]](#footnote-1) ROG emissions inventory. The CO emissions from school buses will increase from 161%-194%, depending on the calendar year. This will increase the total CO emissions inventory by 0.2%-0.3%, depending on calendar year. Similarly, the NOx inventory for school buses will increase from 211%-235%, depending on calendar year. This change represents a 0.3%-2.1% increase in the total NOx emissions inventory. The PM10 emissions from school buses will increase from 217%-248%, depending on the calendar year. This change will increase the total PM emissions from 0.6%-0.8%, depending on the calendar year. The emissions from the SCAB region also increase by similar percentages since the change to the hourly activity profiles of VMT and Trips apply to **all** areas of the state.

## Table 3a. Current Emissions From School Buses In SCAB



Note several evaporative processes report zero tons per day emissions. These emissions are not truly zero but are less than 0.0049 tons per day. The model, for reporting purposes, rounds these emissions to zero.

## Table 3b. Current Emissions From School Buses Operating Statewide

 Note several evaporative processes report zero tons per day emissions. These emissions are not truly zero but are less than 0.0049 tons per day. The model, for reporting purposes, rounds these emissions to zero.

## Table 4a. Proposed Emissions For School Buses In SCAB



Note several evaporative processes report zero tons per day emissions. These emissions are not truly zero but are less than 0.0049 tons per day. The model, for reporting purposes, rounds these emissions to zero.

## Table 4b. Proposed Emissions For School Buses Operating Statewide



Note several evaporative processes report zero tons per day emissions. These emissions are not truly zero but are less than 0.0049 tons per day. The model, for reporting purposes, rounds these emissions to zero.

## Table 5a. Emissions Increase in SCAB



## Table 5b. Emissions Increase in the State



# Remaining Issues

Staff has assumed that trip starts and vehicle miles traveled are distributed evenly during the assumed hours of operation for school buses. This assumption should be updated with more detailed activity data gathered from instrumentation of school buses. This information is also necessary to update other activity matrices (time-off, rest-off) which are currently populated with data gathered from the instrumentation of medium-heavy duty vehicles.

1. Total in this context implies emissions from all vehicle classes. This total percentage increase is shown for comparison purposes and to indicate that although the percentage increase from school buses is very large; the overall impact on emissions from all vehicle classes is small. [↑](#footnote-ref-1)