EMFAC Modeling Change Technical Memo

**SUBJECT**: INCLUSION OF IDLE EMISSIONS FOR GASOLINE AND DIESEL

POWERED SCHOOL BUSES

**LEAD:** CONNIE LEONG

# Summary

# Activity and emission factors needed to calculate idle emissions from school buses are now included in EMFAC. It is assumed that on average school buses idle for eight minutes per trip or approximately 32 minutes per vehicle per day. A trip is defined as an engine-on to engine-off event and school buses are currently assumed to average four trips per vehicle per day. Most school buses fall into the medium-heavy-duty vehicle category. Therefore, the idle emission factors for school buses are assumed to be the same as for medium heavy-duty vehicles in EMFAC. The addition of idle emissions for school buses in EMFAC will increase the statewide total on-road vehicle emissions inventory in 2002 by 0.15 tons per day (tpd) of HC, 0.96 tpd of CO, 1.10 tpd of NOx and 0.02 tpd of PM.

# Reason for Change

Although idle emissions for heavy-duty vehicles were introduced to the inventory in EMFAC2000, no estimates were made for school buses. Because mitigating emissions from school buses has been raised as both a toxic and criteria pollutant control strategy, staff proposes to include idle emissions from school buses in the next update to the emissions inventory.

Note that the Air Resources Board is currently investigating a control measure to limit school bus idling. As additional information is developed during this process, additional changes to the emissions estimates may be made.

# Methodology

EMFAC currently assumes that school buses travel about 13, 000 miles per year, or approximately 40 miles per day. A typical drive cycle is as follows:

Morning route

Bus travels 3 mile from yard to route beginning;

Bus travels 17 miles on the morning route;

Bus arrives at school to drop off students.

Afternoon route

Bus travels 3 miles from yard to school;

Bus picks up students;

Bus travels 17 miles on afternoon route.

EMFAC does not currently have the capability to vary the mileage seasonally, so it is assumed to occur throughout the year. Activity is distributed between 6:00 a.m.-9:00 a.m. for the morning and 3:00 p.m. – 6:00 p.m. for the afternoon.

EMFAC also currently estimates idle emissions by assuming minutes per trip at idle multiplied by a gram per minute emission rate. In a 1992 analysis performed by Valley Research Corporation for the Air Resources Board entitled “On-Road Motor Vehicle Activity Data – Volume I – Bus Population and Activity Pattern”, a “chase car” approach was used to determine the speed distribution and idling habits of school buses.

In this study, fourteen buses operating in both urbanized and small urban communities, and seven buses operating in rural areas, were followed along their normal weekday routes. On a route weighted average basis, it was determined that the average school bus made 5.75 stops along their typical route and idled for approximately one and one half minutes (1.38) per stop. Therefore 7.94 minutes of idle per route is assumed (See table below).

**Table 1**

**School Bus Activity Information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Urbanized** | **Small Urban** | **Rural** |  |
|  | **Week- Day AM** | **Week-****Day PM** | **Week-****Day AM** | **Week-****Day PM** | **Week-****Day AM** | **Week-****Day PM** | **Weighted Average** |
| **# of Routes** | 14 | 14 | 14 | 14 | 7 | 7 |  |
| **Average Distance****in miles** | 8.2 | 7.8 | 7.3 | 7.6 | 11.7 | 10.4 | 8.39 |
| **Average Duration****in minutes** | 29.5 | 27.4 | 25.6 | 25.9 | 25.4 | 28.0 | 27.02 |
| **Average Speed in****Miles/hour** | 16.3 | 17.5 | 16.4 | 17.0 | 27.1 | 22.6 | 18.41 |
| **# of Stops per Route** | 4.0 | 3.6 | 6.0 | 7.0 | 6.7 | 9.6 | 5.75 |
| **% Time****at Idle** | 19 | 31 | 31 | 31 | 19 | 22 | 26.5 |
| **Idle in mins****per Stop** | 1.40 | 2.36 | 1.32 | 1.15 | 0.72 | 0.64 | 1.38 |

**Example of Weighting Methodology:**

Stops/Route = 14routes\*4stops+14routes\*3.6stops+14routes\*6stops+14routes\*7stops+7routes\*6.7stops+7routes\*9.6stops / 14+14+14+14+7+7routes = 5.75 stops/route

Although not expressly covered in the report, it is reasonable to assume that school buses experience other idling events. These events include initial warm up of the engine and daily safety inspection, early bus waiting, idling at stoplights and in traffic, and loading and unloading passengers at school. Therefore, staff suggests doubling the estimate of idling. The resulting estimate is 32 minutes of idle per bus per day. This is consistent with the Air Resources Board’s Risk Management Plan for Diesel Fueled Engines and Vehicles where it is stated that school buses were observed to idle between four and forty minutes per day.

In summary, total idle time per day is calculated as follows:

Pick Up Students 1.38 min. idle per stop\*5.75 stops per route = 7.94 min. idle per morning route

Drop Off Students 1.38 min. idle per stop\*5.75 stops per route = 7.94 min. idle per afternoon route

An additional 15.88 minutes per day for “other idle” events

### Total Idle time per day = 31.76 minutes per day

# Methodology Revised for School Buses

We recommend that EMFAC be modified to incorporate idle activity for both gasoline and diesel school buses.

# Total Idle Time

Buses are currently assumed to make four trips per vehicle per day. As stated earlier, EMFAC currently has no estimate for school bus idle. Staff suggests that all trips (100%) be assumed to have 7.94 minutes of idle (31.76 min / 4.0 trips).

In EMFAC, idle activity is tracked by the duration of the event. This matrix is structured by minute from 1 to 5 minutes, and by five minutes intervals up to one hour. Therefore, no 7.95 minute idle interval exists within the model. To properly assign idle to each trip, a 41%, 59% split between the 5 min. and 10 min. should be assumed for each trip (5min\*0.41+10min\*0.59 = 7.95 min.).

# Emissions Impact

Table 2 below shows the increase in statewide emissions due to the addition of adding idle for school buses, statewide in 2002.

**Table 2.**

## Estimated Emissions Impact

|  |  |  |
| --- | --- | --- |
|  | **Gasoline School Buses** | **Diesel School Buses** |
| **Vehicles** | 6,633 | 23,233 |
| **Trips/Vehicle-Day** | 4 | 4 |
| **Minutes of Idle/Trip** | 7.98 | 7.98 |
| **\*Grams/Minute HC** | 0.45 | 0.06 |
| **\*Grams/Minute CO** | 2.58 | 0.44 |
| **\*Grams/Minute NOx** | 0.03 | 1.35 |
| **\*Grams/Minute PM** | 0.00 | 0.03 |
|  |  |  |
| **Tons per Day HC** | **0.10** | **0.05** |
| **Tons per Day CO** | **0.60** | **0.36** |
| **Tons per Day NOx** | **0.01** | **1.10** |
| **Tons per Day PM** | **0.00** | **0.02** |

\*Model year weighted medium-heavy-duty idle emission rates

Idle emissions in tons per day are product of vehicle population, trips per vehicle day, minutes of idle per trip and emission rate in grams per minute converted to tons per day.

It is important to note that the current version of EMFAC calculates inventories for those vehicles powered by gasoline, diesel or electricity. Although many school buses are known to utilize compressed natural gas (CNG), these vehicles are not currently included in the emissions inventory.