**FUGITIVE DUST FROM PAVED ROADS**

***a. Source Category Description***

Fugitive dust emissions from paved road traffic were estimated for PM10-PRI, PM10-FIL, PM25-PRI, and PM25-FIL. Since there are no PM-CON emissions for this category, PM10-PRI emissions are equal to PM10-FIL emissions and PM25-PRI emissions are equal to PM25-FIL emissions.

For this source category, the following SCC was assigned:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SCC** | **SCC Level 1** | **SCC Level 2** | **SCC Level 3** | **SCC Level 4** |
| 2294000000 | Mobile Sources | Paved Roads | All Paved Roads | Total: Fugitives |

Uncontrolled paved road emissions were calculated at the county level by roadway type and year. This was done by multiplying the county/roadway class paved road vehicle miles traveled (VMT) by the appropriate paved road emission factor. Next, control factors were applied to the paved road emissions in PM10 nonattainment and maintenance status counties. Emissions by roadway class were then totaled to the county level for reporting in the NEI. The following provides further details on the emission factor equation, determination of paved road VMT, and controls.

***b. Emission Factor Equation***

Re-entrained road dust emissions for paved roads were estimated using paved road VMT and the emission factor equation from AP-42:1

E = [k×(sL)0.91×(W)1.02]

where: E = paved road dust emission factor (g/VMT)

k = particle size multiplier (g/VMT)

sL = road surface silt loading (g/ m2) (dimensionless in eq.)

W = average weight (tons) of all vehicles traveling the road (dimensionless in eq.)

The uncontrolled PM10-PRI/-FIL and PM25-PRI/-FIL emission factors are provided in the tab “Emission Factors” of the calculation workbook by county and roadway class. They are provided without utilizing any precipitation correction.

The particle size multipliers for both PM10-PRI/-FIL and PM25-PRI/-FIL for paved roads came from AP-421.

Paved road silt loadings were assigned to each of the fourteen functional roadway classes (seven urban and seven rural) based on the average annual traffic volume of each functional system by county.2 The silt loading values per average daily traffic volume come from the ubiquitous baseline values from Section 13.2.1 of AP-421. Average daily traffic volume (ADTV) was calculated by dividing an estimate of VMT by functional road length and then by 365. State FHWA road length by functional road type data2 was broken down to the county level by multiplying by the ratio of county VMT to state VMT for each FHWA road type.

To better estimate paved road fugitive dust emissions, the average vehicle weight was estimated by road type for each county in the U.S. based on the 2011 VMT by vehicle type. The VMT for each vehicle type (per MOVES road type and county) was divided by the sum of the VMT of all vehicle types for the given road type in each county. This ratio was multiplied by the vehicle type mass (see Table 1) and summed to road type for each county to calculate a VMT-weighted average vehicle weight for each county/road type combination in the database. The VMT-weighted average vehicle weight by MOVES vehicle type was converted to FWHA vehicle type using the crosswalk in Table 2 in order to be used in the emission factor equation above.

***c. Activity***Total annual VMT estimates by county and roadway class were derived from a 2011 EPA Motor Vehicle Emission Simulator (MOVES) modelling run. To estimate the portion of the total VMT occurring on paved roads, first the VMT on unpaved roads were estimated using 2013 state-level FHWA data on length of unpaved roads by road type2 and 1996 ratios from FHWA (the last year these data were available) on average daily traffic volume per mile of unpaved road by road type.3  The estimated VMT on unpaved roads was subtracted from the total VMT from MOVES to estimate the VMT on paved roads.

***d. Allocation***

Total VMT from the MOVES modelling run is available at the county level. VMT on unpaved roads was estimated at the state level and allocated to the county level based on proportion of rural population. The allocated unpaved VMT was subtracted from the total VMT from MOVES to estimate the paved VMT.

***e. Controls***

Paved road dust controls were applied by county to urban and rural roads in serious PM10 nonattainment areas and to urban roads in moderate PM10 nonattainment areas. The assumed control measure is vacuum sweeping of paved roads twice per month. A control efficiency of 79 percent was assumed for this control measure.4 The assumed rule penetration varies by roadway class and PM10 nonattainment area classification (serious or moderate).4 The rule penetration rates are shown in Table 3. Rule effectiveness was assumed to be 100% for all counties where this control was applied.

Note that the controls were applied at the county/roadway class level, and the controls differ by roadway class. No controls were applied to interstate or principal arterial roadways because these road surfaces typically do not have vacuum sweeping. In the excel spreadsheet, the total emissions for all roadway classes were summed to the county level. Therefore, the emissions at the county level can represent several different control efficiency and rule penetration levels, and may include both controlled and uncontrolled emissions in the composite value

***f. Meteorological Adjustment***

After controls were applied, emissions were summed to the county level and converted to tons in order for the meteorological adjustment to be applied. The meteorological adjustment accounts for the impact of precipitation and other meteorological factors on emissions. For example roads will be wet after it rains and therefore will result in significantly lower dust emissions. The county-level meteorological adjustment factors were developed by EPA based on the ratio of the unadjusted NEI2014 version 1 emissions to the adjusted emissions in each county after the emissions were processed to create the SMOKE flat files. The county-level meteorological adjustment is a number between 0 and 1 that is multiplied by the estimated emissions.

***g. Changes from 2011 Methodology***

The methodology described above contains several adjustments from the methodology used to compose the 2011 version. This is due in part to differences in data sources used to compile the inventory. In 2014, the factors used to adjust for precipitation were removed from the 2011 emission factor equation, and precipitation was not accounted for in the final inventory.

The VMT data used in 2014 was based on EPA’s MOVES model, whereas 2011 VMT data was based on its precursor NMIM model. For this reason, the vehicle types (and as such vehicle weights) changed from 2011 to 2014, though a VMT-weighted average vehicle weight was calculated by county and road type in both years. Furthermore, the VMT data used in 2011 was at the state-level, while the 2014 version had been further broken down into counties. For this reason, subsequent worksheets (including ADTV and silt loading) which were calculated at the state level in 2011 could be immediately calculated at the county level without further manipulation in 2014. The paved roadway types in the 2014 VMT dataset included two additional types not found in the 2011 version. The category “Rural: Other Freeways and Expressways” was newly added, and “Urban: Collector” was further broken down into major and minor collector roads.

**Table 1. Average Vehicle Weights by FWHA Vehicle Class**

|  |  |
| --- | --- |
| **MOVES Vehicle Type** | **Source Mass (tons)** |
| Motorcycle | 0.285 |
| Passenger Car | 1.479 |
| Passenger Truck | 1.867 |
| Light Commercial Truck | 2.0598 |
| Intercity Bus | 19.594 |
| Transit Bus | 16.556 |
| School Bus | 9.070 |
| Refuse Truck | 23.114 |
| Single Unit Short-haul Truck | 8.539 |
| Single Unit Long-haul Truck | 6.984 |
| Motor Home | 7.526 |
| Combination Short-haul Truck | 22.975 |
| Combination Long-haul Truck | 24.601 |

**Table 2. MOVES and FWHA Vehicle Type Crosswalk**

|  |  |
| --- | --- |
| **MOVES Road Type Description** | **FWHA Road Type** |
| Rural Restricted Access | Rural Interstate |
| Rural Unrestricted Access | Rural Principal Arterial |
| Rural Unrestricted Access | Rural Minor Arterial |
| Rural Unrestricted Access | Rural Collector |
| Rural Unrestricted Access | Rural Local |
| Urban Restricted Access | Urban Interstate |
| Urban Unrestricted Access | Urban Principal Arterial |
| Urban Unrestricted Access | Urban Minor Arterial |
| Urban Unrestricted Access | Urban Collector |
| Urban Unrestricted Access | Urban Local |

*\*Note: Other Freeways and Expressways were not included in the crosswalk, and so were assumed to be restricted access like Interstates.*

**Table 3. Penetration Rate of Paved Road Vacuum Sweeping**

|  |  |  |
| --- | --- | --- |
| **PM10**  **Nonattainment Status** | **Roadway Class** | **Vacuum Sweeping Penetration Rate** |
| Moderate | Urban Freeway & Expressway | 0.67 |
| Moderate | Urban Minor Arterial | 0.67 |
| Moderate | Urban Collector | 0.64 |
| Moderate | Urban Local | 0.88 |
| Serious | Rural Minor Arterial | 0.71 |
| Serious | Rural Major Collector | 0.83 |
| Serious | Rural Minor Collector | 0.59 |
| Serious | Rural Local | 0.35 |
| Serious | Urban Freeway & Expressway | 0.67 |
| Serious | Urban Minor Arterial | 0.67 |
| Serious | Urban Collector | 0.64 |
| Serious | Urban Local | 0.88 |

***h. Puerto Rico and US Virgin Islands Emissions Calculations***

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: 12011, Broward County for Puerto Rico and 12087, Monroe County for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory’s activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are “EACH”.

***i. References***

1. United States Environmental Protection Agency, Office of Air Quality Planning and Standards. “Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources, Section 13.2.1, Paved Roads.” Research Triangle Park, NC. January 2011.
2. U.S. Department of Transportation, Federal Highway Administration. [*Highway Statistics 2013*](https://www.fhwa.dot.gov/policyinformation/statistics/2013/)*.* Office of Highway Policy Information. Washington, DC. September 2015.
3. Federal Highway Administration, “[Highway Statistics 1996, Table HM-67](https://www.fhwa.dot.gov/ohim/1996/text/roads.html).” 1996.
4. E.H. Pechan & Associates, Inc. “Phase II Regional Particulate Strategies; Task 4: Particulate Control Technology Characterization,” draft report prepared for U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation. Washington, DC. June 1995.