**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.

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 |

Table 1 provides a national summary of the estimated 2008 annual vehicle miles traveled (VMT) activity and emissions by pollutant.

**Table 1. 2008 National Criteria Air Pollutant Emissions Summary for Fugitive Dust from Paved Roads**

|  |  |  |  |
| --- | --- | --- | --- |
| **Pollutant Description and NIF 3.0 Pollutant Code** | **Emission Factor**  Reference 1 Reference 1 Reference 1 Reference 1 | **National Activity (Million Miles)**  2,762,373 2,762,373 2,762,373 2,762,373 | **National PM Emissions (Tons)** |
| PM10-FIL | Reference 1 | 2,717,343 | 1,037,320 |
| PM10-PRI | Reference 1 | 2,717,343 | 1,037,320 |
| PM25-FIL | Reference 1 | 2,717,343 | 259,330 |
| PM25-PRI | Reference 1 | 2,717,343 | 259,330 |

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 VMT by the appropriate paved road emission factor. Next, control factors were applied to the paved road emissions in counties containing PM10 nonattainment areas and counties with areas previously in nonattainment that now have maintenance plans. Emissions and VMT 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***

Reentrained road dust emissions for paved roads were estimated using paved road VMT and the emission factor equation from AP-42, which was updated in January 2011:1

E = [k×(sL)0.91×(W)1.02]×[1-P/(4×N)]

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

k = particle size multiplier (1 g/VMT for PM10-PRI/-FIL and 0.25 g/VMT for PM25-PRI/-FIL)

sL = road surface silt loading (g/square meter [m2]) (dimensionless in eq.)

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

P = number of days in the year with at least 0.01 inches of precipitation

N = number of days in the year

The uncontrolled PM10-PRI/-FIL and PM25-PRI/-FIL emission factors are provided in the accompanying file “Paved\_Roads\_229400000\_CAP\_Emissions.xlsx” by county and roadway class for 2008.

Paved road silt loadings were assigned to each of the twelve functional roadway classes (six urban and six rural) based on the average annual traffic volume of each functional system by State.2 The silt loading values per average daily traffic volume come from the ubiquitous baseline values from Section 13.2.1 of AP-42. The resulting paved road silt loadings calculated from the average annual traffic volume data are shown in Table 2.

To better estimate paved road fugitive dust emissions, the average vehicle weight was estimated by road type for each county in the U.S. (plus Puerto Rico and the U.S. Virgin Islands) based on VMT data used in the 2008 onroad NEI. For state and local agencies that provided VMT data to EPA for use in the 2008 NEI, those data are included in this data set. Additionally, if a state/local agency did not provide VMT data for the 2008 NEI, but had provided information for either the 2005 or 2002 NEI, the state/local-supplied data were grown to 2008 based on 2008 VMT data from the Federal Highway Administration (FHWA). The VMT data for the remaining counties were based on 2008 Federal Highway Administration data. (See the NEI onroad documentation for more details on how the default VMT data were calculated from the FHWA data set.)

The 2008 VMT data set from the NEI included in EPA’s National Mobile Inventory Model (NMIM) BaseYearVMT table includes 2008 VMT for each county by road type and 28 MOBILE6 vehicle types. An average vehicle weight was estimated for each of these 28 vehicle types, as shown in Table 3. For the heavy-duty Class 2B through Class 7 vehicle classes, the average of the gross vehicle weight rating (GVWR) range was selected as the average weight of the vehicle class. More detailed information for the heavy-duty Class 8A and 8B vehicle classes were available from the U.S. Bureau of the Census Vehicle Inventory and Use Survey (VIUS). The Class 8A and 8B subcategories by weight from VIUS were weighted by annual mileage to estimate the average 8A and 8B average vehicle class weights. For the light-duty vehicle and truck classes, data from the U.S. Department of Energy Annual Energy Outlook 2010 were used to represent the average vehicle weights. The average weight of motorcycles and the three bus categories were estimated using professional judgment based on information about existing model weights for these vehicle classes. Once the average vehicle weight was assigned to each of the 28 MOBILE6 vehicle classes, these averages were then assigned to each VMT record in the NMIM BaseYearVMT table, corresponding to the vehicle class that the VMT represented. A VMT-weighted average vehicle weight was then calculated by county and road type for each county/road type combination in the database.

The AP-42 equation listed above includes a correction factor to adjust for the number of days with measurable precipitation in the year. The factor of “4” in the precipitation adjustment accounts for the fact that paved roads dry more quickly than unpaved roads and that precipitation may not occur over the entire 24-hour day period. The number of days with at least 0.01 inches of precipitation in each month by State was obtained from the National Climatic Data Center.3 Data were collected from a meteorological station selected to be representative of urban areas within each State.

***c. Activity***Total annual VMT estimates by county and roadway class were derived from a 2008 NMIM run, totaling all vehicle types and speeds for each county and road type. Paved road VMT was estimated using a ratio of state-level paved road VMT to total VMT. State level paved road VMT was calculated by subtracting the State/roadway class unpaved road VMT from total State/roadway class VMT. Federal Highway Administration’s (FHWA) annual Highway Statistics report was used to determine the unpaved VMT in each state.2

***e. Controls***

Paved road dust controls were applied by county to urban and rural roads in counties with serious PM10 nonattainment or maintenance areas and to urban roads in counties with moderate PM10 nonattainment or maintenance 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.5 The assumed rule penetration varies by roadway class and PM10 nonattainment area classification (serious or moderate).5 The rule penetration rates are shown in Table 4. 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 CERS submission, the 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. The county/roadway class control efficiency and rule penetration levels are reported in the Controlled PM by County&Type table in the accompanying file “Paved\_Roads\_229400000\_CAP\_Emissions.xlsx.” .

**Table 2. 2008 Silt Loadings by State and Roadway Class Modeled in Paved Road Emission Factor**

**Calculations (g/m2)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Rural | | | | | | Urban | | | | | |
| State | Interstate | Other Principal Arterial | Minor Arterial | Major Collector | Minor Collector | Local | Interstate | Other Freeways and Expressways | Other Principal Arterial | Minor Arterial | Collectors | Local |
| Alabama | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Alaska | 0.015 | 0.2 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.6 |
| Arizona | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.06 | 0.2 |
| Arkansas | 0.015 | 0.06 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.6 |
| California | 0.015 | 0.03 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.2 | 0.2 |
| Colorado | 0.015 | 0.2 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Connecticut | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Delaware | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.06 | 0.2 |
| Dist. of Columbia | 0.015 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.06 | 0.2 |
| Florida | 0.015 | 0.06 | 0.06 | 0.2 | 0.2 | 0.2 | 0.015 | 0.015 | 0.03 | 0.03 | 0.06 | 0.2 |
| Georgia | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.06 | 0.2 |
| Hawaii | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 | 0.2 | 0.015 | 0.015 | 0.03 | 0.03 | 0.06 | 0.2 |
| Idaho | 0.015 | 0.2 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Illinois | 0.015 | 0.2 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.06 | 0.2 |
| Indiana | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Iowa | 0.015 | 0.2 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Kansas | 0.015 | 0.2 | 0.2 | 0.6 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Kentucky | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Louisiana | 0.015 | 0.06 | 0.06 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.6 |
| Maine | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.06 | 0.2 |
| Maryland | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.06 | 0.2 |
| Massachusetts | 0.015 | 0.03 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Michigan | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Minnesota | 0.015 | 0.06 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Mississippi | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Missouri | 0.015 | 0.06 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Montana | 0.015 | 0.2 | 0.2 | 0.6 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Nebraska | 0.015 | 0.2 | 0.2 | 0.6 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Nevada | 0.015 | 0.2 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.2 | 0.2 |
| New Hampshire | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.2 | 0.2 |
| New Jersey | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| New Mexico | 0.015 | 0.2 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| New York | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.2 | 0.2 |
| North Carolina | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| North Dakota | 0.015 | 0.2 | 0.2 | 0.6 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.2 | 0.2 | 0.2 |
| Ohio | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Oklahoma | 0.015 | 0.06 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Oregon | 0.015 | 0.2 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Pennsylvania | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Rhode Island | 0.015 | 0.06 | 0.06 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.6 |
| South Carolina | 0.015 | 0.06 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| South Dakota | 0.015 | 0.2 | 0.2 | 0.6 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.6 |
| Tennessee | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Texas | 0.015 | 0.06 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.6 |
| Utah | 0.015 | 0.2 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.2 | 0.2 |
| Vermont | 0.015 | 0.06 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Virginia | 0.015 | 0.03 | 0.2 | 0.2 | 0.2 | 0.6 | 0.015 | 0.015 | 0.03 | 0.03 | 0.2 | 0.2 |
| Washington | 0.015 | 0.06 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| West Virginia | 0.015 | 0.06 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.6 |
| Wisconsin | 0.015 | 0.06 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.03 | 0.06 | 0.2 | 0.2 |
| Wyoming | 0.015 | 0.2 | 0.2 | 0.2 | 0.6 | 0.6 | 0.015 | 0.015 | 0.06 | 0.06 | 0.2 | 0.2 |

**Table 3. Average Vehicle Weights by MOBILE6 Vehicle Class**

|  |  |  |
| --- | --- | --- |
| **Vehicle Class Abbreviation** | **Vehicle Class Description** | **Vehicle Weight Estimate (lbs)** |
| LDGV | Light-Duty Gasoline Vehicles (Passenger Cars) | 3,369 |
| LDGT1 | Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW) | 4,150 |
| LDGT2 | Light-Duty Gasoline Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW) | 4,150 |
| LDGT3 | Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVWR, 0-5750 lbs. ALVW) | 5,327 |
| LDGT4 | Light-Duty Gasoline Trucks 4 (6,001-8,500 lbs. GVWR, 5751 lbs. and greater ALVW) | 5,327 |
| HDGV2B | Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs. GVWR) | 9,250 |
| HDGV3 | Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR) | 12,000 |
| HDGV4 | Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR) | 15,000 |
| HDGV5 | Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR) | 17,750 |
| HDGV6 | Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR) | 22,750 |
| HDGV7 | Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR) | 29,500 |
| HDGV8A | Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR) | 48,000 |
| HDGV8B | Class 8b Heavy-Duty Gasoline Vehicles (>60,000 lbs. GVWR) | 71,900 |
| LDDV | Light-Duty Diesel Vehicles (Passenger Cars) | 3,369 |
| LDDT12 | Light-Duty Diesel Trucks 1 and 2 (0-6,000 lbs. GVWR) | 4,150 |
| HDDV2B | Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs. GVWR) | 9,250 |
| HDDV3 | Class 3 Heavy-Duty Diesel Vehicles (10,001-14,000 lbs. GVWR) | 12,000 |
| HDDV4 | Class 4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs. GVWR) | 15,000 |
| HDDV5 | Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs. GVWR) | 17,750 |
| HDDV6 | Class 6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs. GVWR) | 22,750 |
| HDDV7 | Class 7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs. GVWR) | 29,500 |
| HDDV8A | Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR) | 48,000 |
| HDDV8B | Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs. GVWR) | 71,900 |
| MC | Motorcycles (Gasoline) | 500 |
| HDGB | Gasoline Buses (School, Transit and Urban) | 32,500 |
| HDDBT | Diesel Transit and Urban Buses | 32,500 |
| HDDBS | Diesel School Buses | 25,000 |
| LDDT34 | Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs. GVWR) | 5,327 |

**Table 4. 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 |

***f. 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 2008.* Office of Highway Policy Information. Washington, DC. 2011. Available at <http://www.fhwa.dot.gov/policyinformation/statistics/2008/>.
3. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Summary of the Day Element TD-3200, 2008 data provided via FTP. National Climatic Data Center. 2009.
4. E.H. Pechan & Associates, Inc. “Documentation for the Onroad National Emission Inventory (NEI) for Base Years 1970 - 2002,” report prepared for U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. January 2004.
5. 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.
6. EPA, 2006. Western Governors' Association. 2006. Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors. Western Regional Air Partnership (WRAP), 1515 Cleveland Place, Suite 200, Denver, Colorado 80202 .