

Atlanta Regional Commission Mobile Source Emissions Modeling Process

Transportation and Land Use
Modeling Peer Review

February 3, 2004



Mobile Source Emissions Modeling



ARC utilizes a traditional link-based procedure to estimate mobile source emissions.

- Satisfies federal transportation conformity regulations that direct regional emissions analyses
Transportation Conformity Rule - Section 93.122(b)
- Consistent with methodology used to develop emissions inventories needed to establish MVEB as part of the SIP



Enhancements Since 2000 Peer Review



- **Travel Demand Model recalibration**
 - Initiated after release of 2000 Census data
 - Updated population and employment estimates
 - Multiple structural changes needed to address 2000 Peer Review recommendations and incorporate latest planning assumptions
 - **Expansion to four time-of-day periods**
 - Morning Peak – 6 a.m. to 10 a.m.
 - Mid-Day – 10 a.m. to 3 p.m.
 - Evening Peak – 3 p.m. to 7 p.m.
 - Nighttime – 7 p.m. to 6 a.m.
 - **Conversion to MOBILE6.2 emissions factor model**
 - **Modeling process converted to TP+ platform**
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TP+ Procedure



Emissions model requires the following inputs:

- Loaded travel model networks for each time-of-day period for specific scenario year
- HPMS adjustment factors by HPMS functional class
- MOBILE6.2 emission factors by drive cycle
- HPMS equivalency correction file
- FIPS* code file (for SIP planning purposes only)

*Federal Information Processing Standard - numerical code indicating state and county



TP+ Procedure



Emissions model provides the following output:

- Loaded network files for each time-of-day period
 - Link VMT (post-processed)
 - Link free flow speeds and congested speeds (post-processed)
 - Link FIPS code
 - Link ARC facility type code and HPMS functional class code
 - Link VOC and NOx emissions
- Reports summarizing daily VMT, VHT, VOC emissions, and NOx emissions by ARC facility type and HPMS functional class
- Report listing any link with incorrect HPMS code and associated correction



TP+ Procedure



C:\tracy_work\Emissions_2030RTP\modeling files\emiss_mob6a_new.000 -> C:\tracy_work\Emissions_2030RTP\modeling files\emiss_mob6a

Done Cancel

Enter Year:	2000	Browse ...
Enter Title for Reports:	2000 Base Year	Browse ...
Enter Second line of Title for Reports:	Include Post Processing of Speeds Using MOBILE6	Browse ...
Enter Total Number of Zones:	1740	Browse ...
Enter Starting Node Number for External Stations:	1684	Browse ...
Enter Ending Node Number for External Stations:	1740	Browse ...
Enter AM Peak Period Loaded Network:	lod00am_fin.net	Browse ...
Enter Mid Day Period Loaded Network:	lod00md_fin.net	Browse ...
Enter PM Peak Period Loaded Network:	lod00pm_fin.net	Browse ...
Enter Night Period Loaded Network:	lod00nt_fin.net	Browse ...
Enter Filename with HPMS VMT Adjustments:	HPMS_test.DAT	Browse ...
Enter Filename with HPMS Corrections Mapping:	HPMS_CORR.DAT	Browse ...
Enter Filename with FIPS Codes:	TAZ1683_FIPS.PRN	Browse ...
Enter Filename with Emission Factors:	EF_MOB6_2000.DAT	Browse ...
Enter Output Emissions Summary Filename by Facility Type:	Emissions_fac_2000.lst	Browse ...
Enter Output Emissions Summary Filename by HPMS Code:	Emissions_hpms_2000.lst	Browse ...
Enter Output Text Filename of Links for All Periods:	Lod00_mob6.txt	Browse ...
Enter Output Filename for Links with Bad HPMS Codes:	links_bad.txt	Browse ...



Interface with Travel Demand Model



To calculate emissions, need link-based travel attributes from the travel demand model.

Two primary variables affecting mobile source emission estimates:

- VMT
- Speed

Emissions model “reads” loaded networks for each time-of-day period and post-processes speeds and VMT for emissions modeling purposes.



Post-Processing Speed – VDF Curves



Unique set of volume-delay functions applied for each time-of-day period for individual roadway classes:

- Freeways/Expressways/Principal Arterials
- Minor Arterials
- Collectors

VDF curves applied at the link-level (as opposed to facility type level) to calculate link-based congested speeds.



Post-Processing Speed – VDF Curves



Built-in lookup table that defines ratios of free flow time to congested flow time as a function of facility type and V/C ratio.

Ratios of free flow time to congested time referred to as Speed Functions.

Speed functions allow increase in travel time (delay) to be applied for each combination of V/C ratio and facility type.



Post-Processing Speed – VDF Curves



V/C	Freeway	Exrway	Prin Art	Min Art	Collector	Cent.
0.00	1.000	1.000	1.000	1.000	1.000	1.000
0.10	0.995	0.995	0.995	0.992	0.990	0.960
0.20	0.990	0.990	0.990	0.975	0.960	0.920
0.30	0.950	0.950	0.950	0.935	0.920	0.880
0.40	0.910	0.910	0.910	0.880	0.860	0.800
0.50	0.860	0.860	0.860	0.830	0.800	0.720
0.60	0.790	0.790	0.790	0.760	0.730	0.660
0.70	0.670	0.670	0.670	0.650	0.630	0.560
0.80	0.560	0.560	0.560	0.540	0.520	0.480
0.90	0.460	0.460	0.460	0.450	0.420	0.400
1.00	0.350	0.350	0.350	0.340	0.310	0.360
1.01	0.350	0.350	0.350	0.340	0.310	0.360
1.02	0.350	0.350	0.350	0.340	0.310	0.360
1.03	0.350	0.350	0.350	0.340	0.310	0.360
1.04	0.350	0.350	0.350	0.340	0.310	0.360
1.05	0.295	0.295	0.295	0.285	0.260	0.340
1.06	0.295	0.295	0.295	0.285	0.260	0.340
1.07	0.295	0.295	0.295	0.285	0.260	0.340
1.08	0.295	0.295	0.295	0.285	0.260	0.340
1.09	0.295	0.295	0.295	0.285	0.260	0.340
1.10	0.240	0.240	0.240	0.230	0.210	0.320
1.11	0.240	0.240	0.240	0.230	0.210	0.320
1.12	0.240	0.240	0.240	0.230	0.210	0.320
1.13	0.240	0.240	0.240	0.230	0.210	0.320
1.14	0.240	0.240	0.240	0.230	0.210	0.320
1.15	0.200	0.200	0.200	0.195	0.185	0.300
1.16	0.200	0.200	0.200	0.195	0.185	0.300
1.17	0.200	0.200	0.200	0.195	0.185	0.300
1.18	0.200	0.200	0.200	0.195	0.185	0.300
1.19	0.200	0.200	0.200	0.195	0.185	0.300
1.20	0.160	0.160	0.160	0.160	0.160	0.280
1.21	0.160	0.160	0.160	0.160	0.160	0.280
1.22	0.160	0.160	0.160	0.160	0.160	0.280
1.23	0.160	0.160	0.160	0.160	0.160	0.280
1.24	0.160	0.160	0.160	0.160	0.160	0.280
1.25	0.155	0.155	0.155	0.155	0.155	0.260
1.26	0.155	0.155	0.155	0.155	0.155	0.260
1.27	0.155	0.155	0.155	0.155	0.155	0.260



Post-Processing Speed – VDF Curves



The post-processed congested speed is calculated by multiplying the free flow speed on a link by the appropriate speed function.

$$\frac{\text{Link Distance}}{\text{Free Flow Time}} * \frac{\text{Free Flow Time}}{\text{Congested Time}} = \frac{\text{Link Distance}}{\text{Congested Time}}$$

↑ ↑ ↑

Free Flow Speed Speed Function Post-Processed (Congested) Speed



Post-Processing Speed – Centroids



Centroid connectors serve as abstract representation of intrazonal local and collector streets that feed into the coded transportation network.

Centroid connector should provide accurate estimate of time for each intrazonal trip, so that trips can be allocated from within TAZ to transportation network correctly.

Centroid connector speeds not based on observations. Within travel model, they are adjusted along with centroid distances to provide intrazonal travel times needed for model calibration.



Post-Processing Speed – Centroids



For emissions modeling purposes, VMT and speeds for centroid connectors must be post-processed to yield accurate reflection of intrazonal activity.

- Post-process VMT through HPMS adjustment for local roads (explained in next step)
- Post-processing speeds
 - Upward adjustment to match free-flow speeds of minor collectors by area type
 - Assumption is that intrazonal system serves same function as, and experiences impedances no greater than, a minor collector and should reflect similar free flow speeds
 - Free flow speeds used to estimate emissions because it is assumed local roads do not experience congestion



Post-Processing Speed – Centroids



Centroid Connector Speeds by Area Type

Centroid Connector Free Flow Speed (mph)	Area Type						
	Central Business District	Urban Very High Density	Urban High Density	Suburban Moderate Density	Suburban Low Density	Exurban	Rural
In Travel Model	7	11	11	11	11	14	14
In Emissions Model	15	18	21	24	27	30	35



Post-Processing VMT – HPMS Adjustment

EPA guidance requires HPMS based forecasts of VMT for emission analyses.

- Average daily, summer-adjusted HPMS VMT estimates for year 2000 compared to average daily travel model VMT for same year, at functional class level

HPMS Adj. Factor_i = 2000 HPMS VMT_i / 2000 Model VMT_i
i = HPMS functional class

- Adjustment factors applied at link level using HPMS functional class code



HPMS Adjustment Factors

HPMS Functional Class (Code)	2000 HPMS VMT Summer-Adjusted Average Daily VMT	2000 Travel Demand Model VMT Average Daily VMT	HPMS Adjustment Factors
Rural Interstate (1)	5,840,728	8,488,287	0.69
Rural Principal Arterial (2)	3,569,720	3,090,694	1.15
Rural Minor Arterial (6)	3,811,482	3,168,965	1.20
Rural Major Collector (7)	3,708,389	3,452,056	1.07
Rural Minor Collector (8)	1,249,317	1,091,894	1.14
Rural Local (9)	3,490,796	12,864,647	0.27
Urban Interstate (11)	37,694,171	34,376,364	1.10
Urban Other Freeway (12)	6,478,628	2,348,406	2.76
Urban Principal Arterial (14)	10,350,324	15,653,577	0.66
Urban Minor Arterial (16)	21,924,642	18,473,757	1.19
Urbanized Collector (17)	7,617,087	6,174,256	1.23
Urbanized Local (19)	15,412,042	7,999,419	1.93
Total VMT	121,147,325	117,182,322	

Latest available HPMS adjustment factors calculated for emissions inventory needed for Severe Rate of Progress SIP



HPMS Code Corrections



Number of links in travel model may have incorrect HPMS code.

- Error in data entry / coding
- Errors flagged if HPMS code falls outside of standard HPMS classification scheme
- Corrected using "HPMS equivalency correction file" that provides a given HPMS code based on the link facility type and area type codes



Emission Factors



MOBILE6.2 input files are produced by EPD in coordination with ARC.

- Ensures consistency between ARC emissions modeling methodology used in conformity analyses and EPD methodology used to develop mobile source emissions inventory for the SIP

MOBILE6.2 reflects federal and regional emission control programs as well as other regional parameters.

Federal Programs
NLEV Standards
HDV Standards
Tier 1 / 2 Standards

Regional Parameters
Average fuel volatility
Registration Data
Ambient Temperature
I/M Program
Low-Sulfur GA Gasoline
VMT Fractions



Emission Factors



Most important change with update to MOBILE6.2 is implementation of emission factors by roadway type (drive cycle).

- Arterials/Collectors
- Freeways/Interstates
- Ramps
- Local Roads

Only emissions for arterials/collectors and freeways/interstates are speed sensitive.

Emission factors produced for 2.5 mph, then 3 mph to 65 mph, inclusive, in one mph increments.



Emission Factors



ARC facility types mapped to MOBILE6.2 roadway types and appropriate drive cycle emission factor applied to link VMT to calculate link-level emissions of VOC and NOx.

$$\text{Avg. Daily Emissions} = \sum (\text{VMT}_i * \text{EMISSION FACTOR}_i)$$

↑
HPMS-Adjusted

↑
Based on
Post-Processed
(Congested)
Speed

i = each link in the network, for each time-of-day period



Emissions Modeling Process Summary

Loaded Networks for Each Time Period

- Final assigned VMT and VHT from a capacity-restrained assignment procedure

HPMS Adjustment Factors

Emission Factors

HPMS "Equivalencies"

TP+ Emissions Model

- Post-process link congested flow speed
- Post-process link VMT
- Calculate link emissions
- Summarize link-level emissions over entire network for four time periods

Future Updates to ARC Emissions Model

- Incorporate PM2.5 emission factors
- Additional modifications will be needed based on conformity requirements defined in final transportation conformity rule under the new 8-hour ozone and PM2.5 NAAQS
 - Additional conformity tests?
 - Additional precursors to evaluate?
- Peer review suggestions



Thank You!

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